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# USER INTERFACE DESIGN ISSUESFOR MOBILE APP USAGE AMONG ELDERLY ARABS: ACTIVITY THEORY DESIGN APPROACH

Ahmed Alsswey and Irfan Naufal Umar
Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Pulau Penang, Malaysia
E-Mail: Ahmad_suwwi@yahoo.com

## ABSTRACT

There is a need for activities that promote the use of technology among the elderly. Mobile applications (M- apps) open up new opportunities for improving the quality of life for the elderly. However, the cognitive psychology of design is unable to recognise human preferences of the interface. To overcome this problem, a different approach to interface design is required. Activity theory is used commonly to provide suitable concepts and contexts to help researchers analyse and design activities for mobile applications. It helps identify ineffective aspects of the user interface design. Activity theory includes notions of history, mediation, intentionality, understanding, motivation, community, culture and is proven to improve interface design. It is also used to investigate and improve the understanding of the behaviour of the individuals when interacting with technology and how the related social entities interact with technology such as mobile applications for daily activities. This paper explains the reasons for using activity theory as a methodology to study the interaction between elderly Arabs and the user interface of mobile applications. It also describes the problems faced by elderly Arabs when using mobile applications' user interface(m – appsUI) and their preference. Based on this, the paper then designs a mobile health application based on their preferences using activity theory.

**Keywords:** activity theory, smartphone, interface, design issues, the elderly.

## INTRODUCTION

Over the last few decades, the smartphone has developed rapidly to become an essential part of contemporary lifestyle (Lin, 2010). Most people, young or old, own a smartphone and use it in different fields such as business, communications, entertainment, and learning(Al-Barashdi, Bouazza, & Jabur, 2015). In addition, the number of mobile phone users is expected to exceed 6.2 billion by 2018(Radicati, 2014)involving approximately 84% of the world population. This makes it crucial that mobile phone interfaces are designed to be suitable and usable for users of different ages and backgrounds. Recently, the number of people over 65 years has increased rapidly, and it is predicted that they will number about 1 billion by 2030(Mamolo & Scherbov, 2009). Such significant growth of this population means that technologies will need to be developed for this group of users to meet their demands (Boustani, 2010; Zaphiris, Ghiawadwala, & Mughal, 2005).The population of people aged 65 and above is expected to be about 6.7% of the Arab world by 2030(Kronfol, Sibai, & Rizk, 2013). This shows the need to design technologies suitable for elderly Arab users.

Recently, researchers have noted the gap between user interface design and the users' needs in human-computer interaction (HCI). This gap occurs as a result of the limitations of the traditional cognitive psychology approach. Bannon (1995)Mentioned numerous limitations of the traditional cognitive psychology approach: (i) the human actors are casual, simple and not independent actors with the ability to control and coordinate their behaviour; (ii) such an approach is dependent on predefined needs for products design; (iii) limited and artificial laboratory experiments have tended to replace practical application in the workforce. Finally, there is a growing belief that the real use of a system is a long-term process that cannot be understood sufficiently by studying just the primary steps of usage. The consensus is that the cognitive approach to HCI may be incomplete. It does not offer a suitable conceptual base for studies of mobile use in organisational, authorial, and social contexts, the goals, values, and plans of the user, or in the field of development. Therefore, this paper presents a case study of the design of a mobile health app using activity theory. To make activity theory valuable, an activity checklist was applied to help the designer when trying to understand the context and evaluation of app design.

## ACTIVITY THEORY

Mobile technologies offer new opportunities for users such as learning, shopping and entertainment. They can be used at any time and place. Designing a successful mobile app UI needs to consider the context. The context has an important effect on the understanding, designing and development of different technologies and mobile applications such as learning applications and e-commerce applications. This means that user actions are important elements and cannot be isolated from the surroundings because the user is an actor within an environment (Winograd & Flores, 1986). For this reason, the individuals' actions with mobile devices cannot be isolated from the environment in which they take place.

Mobile applications and devices are vulnerable to the context and the user interaction with that context. Therefore, the authors trust that the complexity of the relationships concerned can be analysed using activity theory. The goal of using activity theory is to understand the behaviour and relevant properties of individuals better and how relationships of these social entities connect with the technologies they use in the activities of their daily life (Soegaard & Dam, 2012). Also, it is used to describe the relationship between human or user interaction and smartphones.

Activity theory is a psychological and multidisciplinary theory with a naturalistic focus on a framework for understanding and describing the activity to give a set of abstractions and concepts that connect people and social levels. The theory originated in Soviet psychology in the 1920s (Engestrom, 1987; Leont'ev, 1974; Nardi, 1996). Activity theory involves a subject, an object, tools, instruments, rules, and division of labour. A subject can be a single or a group engaged in an activity. An activity is started by a subject using tools to achieve an object (goal), thus transforming it into an output (Kuutti, 1996). Tools are physical such as a technology device or emotional, such as language, culture or style of thinking. Mobiles and computers are classified as special tools (mediating tools) (Kaptelinin, 1996). Figure1 shows the elements of activity theory.

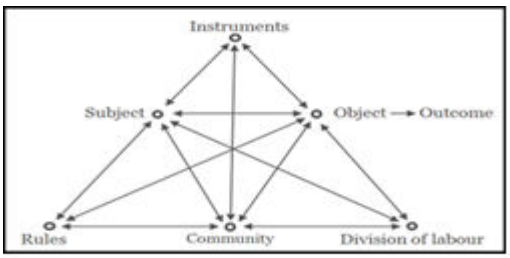


**Figure-1.** Activity system diagram.

According to Jonassen and Rohrer-Murphy (1999), five elements make up activity theory as follows:

a) **Subject (User):** the type/person participating in the activity

b) **Tools:** the tools used in this activity

c) **Object:** the outcome expected from the activity

d) **Rules:** the formal and informal rules used in the activity

e) Division of labour: those who are interested in and affected by the activities.

## ELDERLY PROBLEMS

The elderly suffer from the effects of ageing, including different levels of hearing loss, psychomotor impairments, diminished vision as well as reduced attention, memory loss and learning skills. Changes in vision are the most popular physiological change associated with ageing. Many older adults will experience vision changes, including presbyopia and a loss in near vision (Czaja & Sharit, 1998). Older adults will also suffer a decline in concentration sensitivity as well as reduced colour sensitivity, especially in the green range and blue(Helve & Krause, 1972). Also, hearing declines with age, and roughly50% of all men aged 65and above and 30% of women face hearing loss. The majority of people observe visual problems around the age of 40 (Fisk, Rogers, Charness, Czaja, & Sharit, 2009). In addition to the physical problems faced by the elderly, their mental health also deteriorates with age. Therefore, understanding the potential and limitations of elderly users when using mobile applications could help designers and developers to design an acceptable and usable mobile application user interface.

Nowadays, smartphones use touchscreen technology as the main input method. Using touchscreen technology increases the usability of technology. Consequently, several studies adjusted the touchscreen technology to computer despite the different device size. On the other hand, a rising age causes a decline inthe perceptual, cognitive, and psychomotor role which cause a decline in the usability of technology. Elderly users have to make the strenuous effort to use and learn these technologies. The conclusion of previous studies shows that user interface can help the elderly engage, but should be supported by components of user interface design suitable for different categories of devices and users. This study seeks to determine a suitable user interface design to resolve the problems facing elderly Arabs when using mobile applications.

## ARAB ELDERLY IN THE WORLD

The number of older people in the Arab world has increased rapidly. At present, among the Arab countries, Tunisia and Lebanon have the highest percentage of older people, i.e., those who are at least 65 years old (7.0% and 7.3 % respectively). By the year 2050, the percentage of older people will rise above 20% in six out of the 22 Arab countries and will range between 12% and 19% in nine others (Kronfol et al., 2013). Most Arab countries will reach the top of their demographic dividend before 2030. This will affect the labour force market, social care costs, as well as health, social security systems and income requirements (Kronfol et al., 2013). The significant growing number of elderly creates the need to develop technologies for this user group to achieve their demands (Boustani, 2010; Zaphiris et al., 2005).

## METHODOLOGY

To identify user interface requirements for elderly Arab users, it is important to understand and analyse the components that influence the usability and acceptance of technologies. This was the aim of the preliminary study, a part of which identifies the challenges that elderly Arabs face when using mobile applications. To achieve these aims, a qualitative approach through semi-structured interviews was selected. A total of 40 elderly Arab users were interviewed (the length of the individual interviews ranged from 30 to 40 minutes) and their responses to the following questions were analysed:

- What are the main barriers and challenges that elderly Arab users face when using mobile UI?
- What UI components should be applied when designing a mobile application interface for elderly Arab users?

- What rules and preferences should be applied when designing a mobile application interface for Arab elderly people?

**Participants**

This study focused on the aged 65 and above based on the definition of Gorman (1999).The study involved only elderly Arabs all of whom were experienced in using mobile devices (the majority had owned a mobile phone for more than three years) and volunteered to take part in the interviews. Prior to the interview, each participant was given a brief overview of the study and his/her role in it.

**Procedure**

Prior to the interview, each participant was given a brief overview of the present study. Each participant was aware that the interview session would divide into three parts: demographic assessment (Part A), current mobile UI components (Part B), the problems of using mobile apps (Part C). After the participants consented to continue with the experiment, they were asked to complete the demographic assessment questionnaire, which was read to them. Subsequently, the interview session started. The session was audio recorded for analysis.

**Demography**

Out of the 40 participants, 19 were within the 60-64 age group, while 17 were within the 65-69 age group. Also, four participants were within the 70-74 age group. None of the participants aged 75 years and above reported using mobile apps.

**The problems of using mobile UI among elderly Arab users**

To identify the potential challenges faced by elderly Arab users during use of the mobile UI, they were asked to list the main issues associated with their use of current mobile design. The result showed that aspects related to vision, physical change (shivering in the fingers or hand movements, slow movement); stress, boredom, and confusion were the main challenges.

## USER INTERFACE COMPONENTS

Studies in field mobile applications have stated that the mobile user interface plays an important role in smartphone adoption for the elderly (Abdulrazak, Malik, Arab, & Reid, 2013). The difficulties such as, amount of information displayed on the application user interface, navigability, the lack of consistency of interface components, acceptance and usability are the major problems that complicate the mobile interface. Hunter, Sayers, and McDaid (2007)stated that user interface has a significant effect in comfortably using computers and applications.As information technology and applications extend rapidly and are associated closely with our daily life, these technologies and applications are already suitable for young people, but the elderly users are not the main target of design technology and mobile applications(Rodríguez, Fuentes, Herskovic, & Pino, 2017). Also, Khaddam and Vanderdonckt (2014)stated that the elderly have different requirements for mobile application use. Several components of the user interface can be adapted for elderly users. This adaptation is necessary to avoid several of the problems frequently faced by this group of users.

he problems facing the elderly Arabs when using mobile applications include the vision, physical changes such as shivering in the fingers or hand movements, slow movement, trust, boredom, stress and confusion. Most of the elderly have near-sightedness problems and blurred vision. Today, mobile user interfaces are designed commonly for normal users who do not have cognitive decline or vision problems. Among the criteria of user interface components that must be prioritised are font size, font type, button size and the colour used.

**Font**

The font size used in the user interface is usually small but readable by users not having vision problems like functional regression. Caprani *et al.* (2010) stated that the font size used in the user interface design is too small and unclear. It should be larger and readable for older users. The type of font also plays an important role in clear vision, especially for elderly users and the designers should use a common font that is clear (Mahmud & Kurniawan, 2005). Different types of Arabic fonts presently used by mobile users are believed to influence the overall user experience. For example, the use of certain types of fonts when presenting Arabic text may make it hard for users to recognise or make inferences from the text. Chadwick-Dias, McNulty, and Tullis (2003) stated that most older people need more time to read text and information on the screens. Special requests for displaying text on screens should be considered when designing the user interface. Furthermore, Arab fonts affect websites' usability of the Arab world. For instance, there are many examples of websites using Arabic text that is hard to read or understand. The Arabic fonts used for designing websites should be optimised for a wide range of Arab users.

**Colour**

A suitable colour should be used in the user interface design as the elderly are less sensitive to colour contrast than younger people and are prone to vision problems when using applications. Also, the type of colour plays a significant role in the UI design. Therefore, it should be chosen carefully by balancing the three colour properties of value (light vs. dark), hue (warm vs. cool), and saturation (vivid vs. dull) to create a suitable contrast between letters and their background(Carter, 2002). For example, using a white background should be avoided. While using dark colours as the background will lead to weakness and reducing the readability among the elderly(Lorenz & Oppermann, 2009). On the other hand, using blue increases the Arab user trust in applications. Lichtlé (2007) stated that colours play a powerful role in enhancing user trust when using applications.

**Buttons**

Most elderly users face problems to click on buttons, icons and drag and drop accurately. The result of this study shows that to enhance the ability to use a mobile user interface, elderly Arab users prefer the buttons, clickable icons and labels that range in size between 11.43 $mm^2$ and 19.052 $mm^2$(Jin, 2007). Also, to provide a better impression, the spacing between adjacent buttons in a row should reach from 3.17 mm to 12.7 mm (Kobayashi et al., 2011).On the other hand, for the elderly suffering from slow movement control of the hand, the proposed space and size between bottoms is 16.51 $mm^2$ and 3.17 to 6.35 $mm^2$.Consequently, the space and size between bottoms should be between 19.05 $mm^2$ and 6.35 to 12.7 $mm^2$ for the elderly people with weak hands. Abrahão, Cavalcanti, Pereira, and Roque (2013) believed that reducing the space between the interface components and maximising the interactive complexity will reduce the accuracy for the elderly. Meanwhile, avoiding the need to access the contents frequently will enhance usability and avoid boredom.

**Case study**

The case study of this research focuses on the mHealth appUI design for elderly Arab users. The users will be able to manage, obtain and browse information via the interface of the mobile app for the following types of information: (i) general information about common diseases in the Arab world; (ii) general healthcare information; and (ii) manage medical information such as edit, add and delete. The following sections describe how we applied activity theory to the designing the mHealthappUI for elderly Arab users. The approach is based on the design approach of Ehn(Ehn, 1988).

**Requirements specification**

The first step is to identify the activities involved in the process design. To do this,Brooks and Kugler (1987) posted that the first step in designing software or application process is to determine exactly what to build. Engineering requirements are interested in the goals of the proposed systems, concerned services and constraints of the system and the assignment of responsibilities to mediators such as devices, people, and software. We believe that one of the most important factors for the success of the app and to capture the users' interest in using the app is to consider and analyse the needs of the users accurately when designing the app.

We believe that activity theory presents an enjoyable framework for understanding and analysing human task, action and cognition. It gives the opportunity to the designer to consider persons in isolation from others or with their relationships with other individuals in the framework in which they endeavour to complete the task. This study has applied the diagram structure to analyse the activities and relationships between the subject (elderly Arabs), the current standard smartphone interface, the division of labour (the researchers, developer and designers involved in smartphone interface design), and community which involves all of the interested people. The rules show the criteria of elderly Arab users. Figure-2 shows how this research covered the interaction between elderly Arab users and user interface of the mobile application. Activity theory helped the researcher to recognise which parts of the user interface cause problems and which were useful.

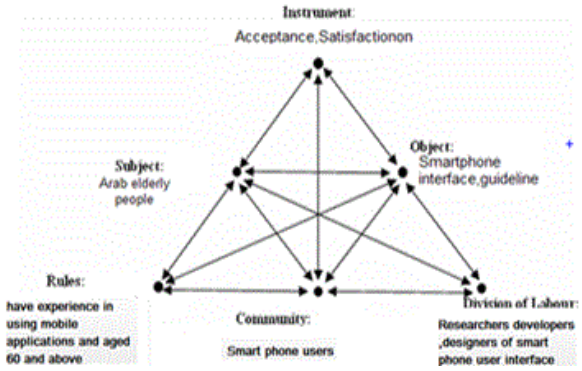


**Figure-2.** Activity diagram adapted to design a smartphone interface for elderly Arab users.

**Design**

This mobile health app is designed based on the preferences of elderly Arab. Figure-3 presents a graphical image of the interfaces for this mobile health application.

**Figure-3.** Screenshots of the designed mHealth app.

Standard Arabic is used in designing this app UI to ensure that the functions are clear and understandable for elderly Arab users to avoid confusion that can occur due to the different meaning of local terms and words. The colours of Arab culture and Islam (green, blue and black) are used in designing the app UI to enhance the acceptance of Arab users since Arabs are proud of their culture, customs, and religion. Green reflects the Islamic symbol, while black is linked to a specific period in the Islamic era. Blue is related to the sea and sky. Red and yellow are used in designing the application UI to attract the users. Since these colours are frequently used in the Arab world to capture the attention of users and attract them to try its usage and buy different things such as clothes, foods, cars, etc.

The app UI used a font size of 12pt and font type "الرقعة"to display the information while font size 14pt was used for heading. This is because it is one of the easiest Arabic fonts and the most widespread among people in their daily writings. Additionally, its simplicity and distance from the complexity and ease of reading and

writing are very much appreciated in the Arab world(Azmi & Alsaiari, 2010). The information architecture of app UI was designed based on previous studies conducted on Arab cultures such as by Hall (1976)andHofstede (2001). They showed that Arab culture is an uncertainty avoidance culture, which means that Arabs do not like risk, and prefer simple use and avoid complex design of systems.

Arab culture has strong individualism and collectivism(Hall, 1976; Hofstede, 2001). This means that Arab users have a high concern for the group and exchange for devotion. Reputation, dignity, shame, honour, and pessimism occupy higher considerations. Therefore, common Arab icons and symbols are used in the app UI design. Also, Arab writing and reading are from right to left. Therefore, the UI layout was designed from right to left. Finally, labels and messages were used in the app UI design to inform users about the various stages of usage and completed tasks. Thiswas targeted at providing easy assistance and information on progress made with the app use.

**Activity checklist**

The activity checklist is determined as a guide to a particular field to which a designer or research should pay attention when trying to understand the context in which a tool will be or is used(Kaptelinin, Nardi, & Macaulay, 1999). It is vital to explain the most significant related factors in human-computer interaction. The activity checklist has two versions, namely the design version and the evaluation. Both versions are used as ordered sets of elements covering the related factors that can affect the use of technology in real life. Also, the activity checklist can be used to recognise the essential issues such as possible trouble spots that designers can report. The activity checklist reveals the five basic principles of activity theory: the hierarchical structure of activity, object orientation; mediation and development and internalisation and externalisation. Since the checklist is projected to be implemented in analysing how elderly Arab people use the mobile app, the principle of tool mediation is highlighted. This principle has been implemented throughout the checklist and systematically combined with the other four principles.

The results after implementation in four sections correspond to four main viewpoints on the use of the target technology to be designed or evaluated.

**A. Means and ends** - the degree to which the technology enables and limits the success of users' goals and the influence of the technology on frustrating or determining conflicts between different goals.

a) **Social and physical aspects of the environment**- a combination of target technology with needs, resources, tools, and social values of the environment.
b) **Learning, cognition and articulation -** internal versus outer components of activity and support for their common transformations with target technology.
c) **Development**-the developmental transformation of the prior components as a whole. This paper used the activity checklist to evaluate mobile health app information.

**Table-1.**Depicts a sample of the activity checklist used for evaluation.

| Means/ends | Environment | Learning/cognition/ | Means/ends |
|---|---|---|---|
| Arab elderly people<br>1-Target goal<br>i. ease of use<br>ii. usefulness<br>2-Subgoals<br>i. simple design<br>ii. simple language<br>iii. simple terminology | 1-Economical<br>i. save time<br>ii. save money<br>iii. save effort<br>2-Healthcare information<br>3- Managing medical information | 1- Demo software<br>2- Use of common and standardised icons | **1- Requirements**<br>UML, Use case, Interview Questionnaires, Activity Theory<br>2-Analysis & Design<br>RAD, activity theory<br>3- Implementation<br>Android SDK<br>4- Testing<br>User testing, Programmer testing. |

**CONCLUSION AND FUTURE WORK**

Activity theory is the key claim for HCI and as a research framework to understand the efficiency of the current smartphone interface design towards elderly users. It also helped to recognise the problems that exist in the current activity technology systems. Activity theory explains all the important elements of designing a smartphone interface as it delivers basic principles that connect the various levels of contribution. This paper found that elderly users' vision, trust, boredom, physical change, stress and confusion were the main problems that elderly Arab users are concerned about when designing the mobile app UI. Also, the findings offer insightful directions for the design of mobile UI components to increase the acceptance and satisfaction of mobile technology in real life.

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