Journal of Engineering and Applied Sciences 12 (3): 559-563, 2017
ISSN: 1816-949X
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Designing a Mobile App to Support a Healthy Lifestyle (MAS-HeaL) for Type-2 Diabetes Patients in Malaysia

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Abstract: M-Health applications targeting diabetics have not only been inapplicable and inappropriate to people's cultures, context and experiences. Many mobile application designs show general design that fits all types of diabetes and all types of users regardless of their cultures and countries. Therefore, the aim of this research study is to establish the requirements for type-2 diabetes in Malaysia using the user-centered approach. The result of the evaluation shows that the proposed application has been proven in sum to be effective in achieving its objectives, efficiency and satisfactory with regards to the user requirements. In addition, the proposed application will assist developers and other researchers to design and implement an effective, highly usable and ease to use M-Health application for consumer health technology for Asian type-2 diabetes patients.

Key words: User-centered design, type-2 diabetes, mobile design, healthy lifestyle, human computer interaction

INTRODUCTION

Diabetes is a major health concern worldwide and is increasing due to a high blood sugar levels, population, aging as well as the huge increasing of obesity and physical inactivity (World Health Organization, 2012). Diabetes requires carefully regulated management that calls for strict adherence to diet, exercise and medical regimens. Given the life-long, austere and disruptive nature of these regimens, patients find it hard to integrate diabetes therapy and medication into their daily routine often resulting to sub-optimal management that results in debilitating effects.

In the year 2015, 3.3 million people in Malaysia were living with diabetes and 34, 422 succumbed to diabetes related complication (IDF, 2015). According to International Diabetes Formation (IDF) estimates, diabetes costs per person amount to 570 USD yearly. Given the substantial health, economic and human burden of the disease, there is an urgent need to find improved methods of preventing, detecting and treating diabetes (IDF, 2015). The second deficit present in mobile health applications is the design of one-dimensional models based on a generic, one-size fits all approach (Gemert-Pijnen *et al*., 2011). Applications grounded on this principal assume that information on specialty-diseases like diabetes is transferable to each and every patient afflicted by the disease and therefore simply provide general-purpose information. Such applications fail to consider the users socio-cultural context, psycho-social factors, needs and preference which have a bearing on how users interact with medical devices and information. They also lack human-centeredness with users occupying a peripheral position during the design, development, implementation and evaluation of the application (Gilliland *et al*., 2015).

In this study, we focus on the designing of mobile application for type-2 diabetes patients in Malaysia. The mobile app design is definitely more usable and compatible with Asian lifestyle and diet.

Literature review: Human Computer Interaction (HCI) research produce increasingly sophisticated Information Technology (IT) products for wide ranging purposes from entertainment to running household errands and completing job-related tasks (Grimes *et al*., 2010; Wilson and Djamasbi, 2015). Hence, it simultaneously improving reliability and functionality. HCI research in health domains has shown the importance and needs to focus on human, technology and environment (Grimes *et al*., 2010) to design a more usable solutions to particular domains.

Icrave (Hsu *et al*., 2014) was developed to be used during the onset of a food craving that asks the user to imagine a particular scene for 10 sec and then report on whether they had a healthy snack, unhealthy snack or no snack at all. The application also allowed the user to track

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their food choice based on the reporting option after the imagery task. This feature was the only part of study that was thought to promote healthy vs non-healthy snack choices. On other hand, the negative issues of this application was the usability issues which is due to simplistic design and concept which prevents a user to be engage with it and this could be due to one-goal-fits all approach (Hsu *et al*., 2014).

In contrast to Hsu *et al*. (2014) order UP (Grimes *et al*., 2010) is hypothetical persuasive mobile tool designed as nutrition coaching tool and uses conditioning strategy to reinforce a change of player's attitude and behaviour by rewarding the player with points whenever the player makes healthier choices during the gameplay. In another hand when the player makes poor meal choices then the play will lose some points. This will make the player guilty and try to avoid making unhealthy choices by then the player learns the different between making healthy and unhealthy meal choices and the decrease in cumulative points portrays how eating unhealthy meals decreases one's general wellbeing and makes. This application was mainly designed for a low-income African American groups. The overall result of this study was promising where it improved user's understanding of how to choice and eat healthy meals as well as helped them to engage in nutrition-related analytical thinking, revaluated the healthiness of a real life habit and drove the users to start replacing unhealthy meals with more nutritious foods (Grimes *et al*., 2010).

Similarly, lunch time (Orji *et al*., 2013) is a persuasive tool that motivate and encourage young adults toward healthy. This application adopts a tailoring technology strategy where players will be as restaurants visitors and their goal is to choose the healthiest option from a list of meal choices. The players are awarded points based on the relative healthiness of their choice. If the player makes unhealthy food choices, the cumulative points will be reduces to give the player a sense of guilt and advices him to make better healthy choices. Additionally, this type of intervention increase the self-efficacy by reflecting the degree of confidence in which individuals have to maintain their desired behaviour change in situations that often trigger relapse. Orji *et al*. (2013) focuses on creating a persuasive technology tool which is culturally-driven and that means the tool was built on a user-centered approach.

MATERIALS AND METHODS

The development of MAS-Heal application phases are described here. We employed a User-Centered Design (UCD) approach in order to provide a better and usable prototype to type-2 diabetes patients situated in Malaysia. The UCD approach consists of four basic process: understanding user, designing the prototypes (screen's flow samples, information architecture, paper prototyping, user testing ecetra), prototyping and evaluating.

Understanding user: One of the important activities in UCD approach is understanding user. In this case, our user was Malaysian type-2 diabetes patients. This phase focused on few activities to have a better understanding of their daily lives such as food intake, exercising and healthy living. We have conducted few observations ranging from attending a workshop about type-2 diabetes and interviewing them. As a result from this phase, we produced few milestones to be used as a guideline or tool throughout the UCD phases.

The 13 type-2 diabetes patients participated in our study. The participants were members from Diabetes Malaysia (DM). This was one of the quicker ways to get users participation in the study. They were asked to answer a short survey then interviewed to have a better and clear information and understanding about type-2 diabetes. We analysed the survey and transcribed the interview. Based from this data analysis, we have classified our type-2 diabetes patients into three: Body Mass Index (BMI) 25-29.9; BMI 18-24.99 and BMI >30. The categorization was important because we could design our application according to their needs. Hence, the design could be tailored to their BMI. Details about our type-2 diabetes patients described in Imhemed (2016). Another milestone from this stage was a use-case diagram (Fig. 1) (Imhemed, 2016). These milestones were important throughout the UCD process. Next stage was designing alternatives described in B).

Designing alternatives: At this phase, the designing stage has grouped into two: conceptual design and physical design (Preece *et al*., 2016). Conceptual model is describing what the design can do for users in this case is how to use the application and what type of metaphor is suitable for the application. Whereas, physical design is about the designing the details of the MAS-Heal application design in terms of its color, text, menu design and icon design. Table 1 shows icon design for the application (Imhemed, 2016).

Both conceptual and physical designs have been formatively evaluated with type-2 diabetes patients. The reason for iteratively evaluated by type-2 diabetes patients were to make sure that the users would not have difficulty in understanding the meaning of the icons

Table 1: Icons metaphor design for MAS-Heal application (Imhemed, 2016)

Icon	Application	Icon	Application
	Activity and goals: This icon represents the activity and goals on which the user will view to check the pre-set daily activity as well as the goals on which the patient will set on a daily, weekly or monthly basis		**Meal logbook:** This icon represents the meal tab on which the patient will click on to log all his/her daily food consumption
	Add button: This icons located in the meal screen, the user clicks on this to add either one of the meal-course per day "Breakfast, Lunch, Snack, Dinner"		**Blood-glucose meter:** This symbol represents or illustrates the blood-sugar test on which the patient does on daily basis
	Award: This icon is to be used for incentives and motivational purposes, as when the patient achieves new points, this will be rewarded		**Weight measure:** This icon represents the measurement of the weight
	Badge: This icon is another set of incentives which has the same purpose as Award icon		**Good decision:** This icon represents the good decision that the patient makes after choosing healthy meals
	Blood drop-blood glucose: This type of icon will be used as indicator of the type of blood-test the patient		**Bad Decision:** This icon represents the bad decision that the patient makes after choosing unhealthy meals
	BMI indicator: This icon is used on the BMI progress bar to indicate where the user's BMI falls at		**Female:** This icons represents the female gender
	Calorie: This icon represents a burning energy which is called Calorie		**Male:** This icons represents the male-gender
	Overall health indicator: This icon represents the overall health of the patient's condition.		**Healthy indicator:** This icon is used to show if the meal is healthy
	Deleting: This icon represents a trashcan for deleting certain items whenever needed		**Unhealthy indicator:** This icon is used to show if the meal is unhealthy
	Editing: This icon represents the editing pen which is universally used among computer-element metaphor		**Encourage:** This icon is used in the information page of each meal item. This is just an indicator to either encourage the patient to choose this instead of unhealthy meal
	Avoid: This icon is an indicator to discourage the patient of choosing unhealthy meal and guess him/her to avoid		

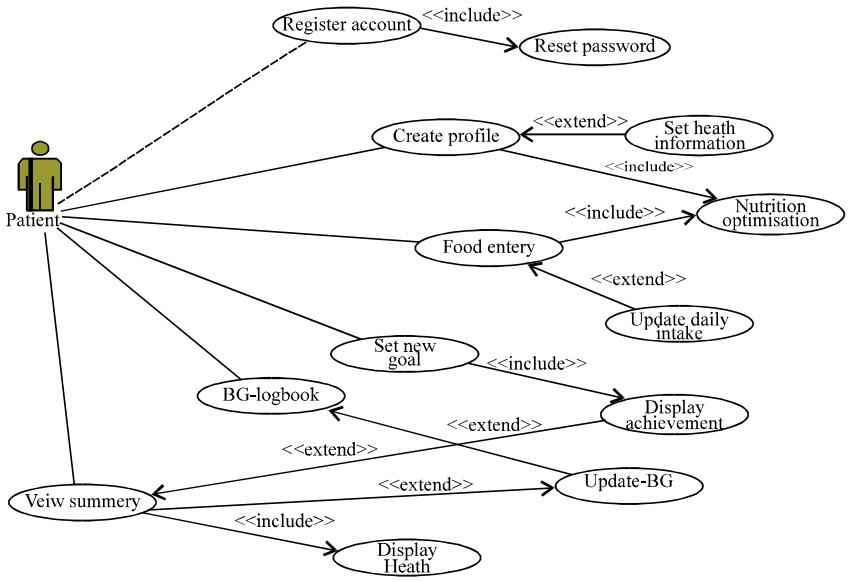

Fig. 1: Use case diagram for MAS-Heal application (Imhemed, 2016)

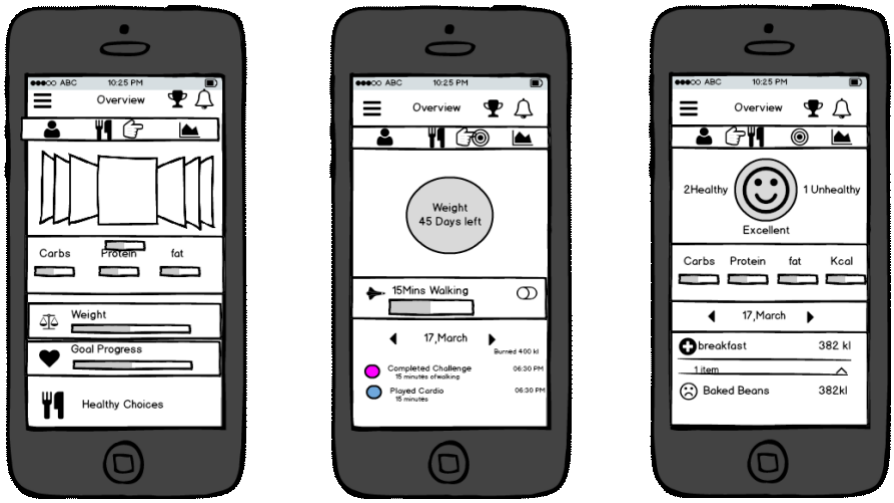

Fig. 2: Low fidelity prototype dashboard design (Imhemed, 2016)

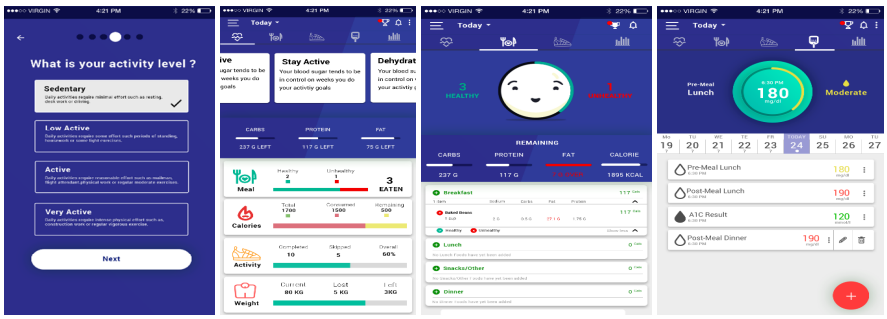

Fig. 3: Final high fidelity prototype design (Imhemed, 2016)

hence reducing their cognitive effort in operating the application. In addition, we have applied Nielsen's design principles at the analysis phase to highlight our application usability criteria.

Prototyping: We have designed, developed and assessed our low and high fidelity prototypes with our type-2 diabetes patients shown in Fig. 2 and 3 (Imhemed, 2016). The low fidelity prototype start with the icon and screen flow designs tested with few type-2 diabetes patients with several main tasks. We observed and timed the task completed when the participants interact with our prototype. We suggested them to use think-aloud protocol (Preece *et al*., 2016) when testing with our prototype. This technique could assist us to acquire issues and opportunities with the design. We have iteratively evaluated our design with type-2 diabetes. This is to capture what the users really needs in this type of application and finally the users would use the application that is designed to suit local or Asian needs.

RESULTS AND DISCUSSION

Evaluating: Evaluation is an important activity in UCD methodology. The formative and summative evaluation are two types evaluation conducted during the process to gauge the usability quality criteria in MAS-Heal application design in the Malaysian perspectives. We conducted expert review (Preece *et al*., 2016) and System Usability Scale (SUS) (Bangor *et al*., 2008). It is important to get the review from experts about the content and knowledge in this domain. We must verify our findings and interpretations of the suggested information to the user, since we are not the expert in the health domain. We have conducted the expert review to three experts: one was the dietician whereas the other two are the application experts.

Earlier our evaluation was to get experts verification and validation of our design. Next, SUS testing (Brooke, 1996) was conducted to five type-2 diabetes patients. The aim is to ensure that the proposed application prototype

is usable and efficient to use. The descriptive statistics of the SUS for the patients have been run and the interpretations mean that the highest occurring score is 80. This means that a greater population of the parameters studied just feels the work is excellent. The standard deviation is 3.535 which is very low and suggests that the scores are not so far apart from each other. Therefore, we do not have a lot of outliers in the score. This is good for business as the patients tasted have almost uniform observations of the application.

Throughout this study, we have observed several issues that sparked our intention at the understanding user's stage, designing alternatives, prototyping and evaluating.

Understanding users It was one of the important stage in the UCD methodology. We are aware about the lifestyle issue in the design. Many studies conducted that focusing on the western or European type-2 diabetes patients in which have totally different lifestyles from the Asian domain. The obvious distinctions are what we eat? our daily routine such as exercising. In western or European domains the application stored and organised data in their database are based on their data. So, there is a need to have Asian mobile application domain in which the database design will have the record of Asian type of food and calorie contains. Another factor is the BMI calculation, Asian, particularly Malaysian need to have a normal BMI not >23. The Malaysian Ministry of Health has changed the BMI from 25-23 due to different type of food intake and daily routines that Malaysian performed. In addition with deeper understanding of Asian type-2 diabetes especially Malaysian requirements for the MAS-Heal mobile application design it will affect the physical and conceptual design hence influence the design of the application to suit the Malaysian type-2 diabetes patients.

CONCLUSION

Designing a mobile application that adopt to a certain users and lifestyle is crucial in order to increase the usability of the design. One size fits all design principle has to be amended due high differences in different countries, cultures and lifestyle. UCD methodology is one of the systematic approaches that proved to design usable application which has different needs and requirements.

ACKNOWLEDGEMENTS

We would like to express our gratitude to our supportive participants from Diabetes Malaysia Association (DM) dietician and many kind people that assisted this study. Their involvement is a starting point to move further to design a better application for Asian type of user.

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