Mobile Application on Healthy Diet for Elderly based on Persuasive Design

Mohamad Hidir Mhd Salim[#], Nazlena Mohamad Ali[#] and Shahrul Azman Mohd Noah[*]

[#]Institute of Visual Informatics, Universiti Kebangsaan Malaysia, Bangi, Malaysia
E-mail: mhdhidir@siswa.ukm.edu.my, nazlena.ali@ukm.edu.my

[*]*Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, Bangi, Malaysia*
E-mail: noah@ukm.edu.my

Abstract— **Diet was known for many years to play a key role as a risk factor for chronic diseases especially for elderly. The capability to interact effectively on health information application among elderly is becoming essential. Mobile technology can monitor diet and lifestyle of the elderly. We developed Nutrihealth application that comprises information on Body Mass Index (BMI), suggested menus, and calories intake. Persuasive techniques were implemented in the design of Nutrihealth mobile apps, to increase user engagement and behaviour change in healthy diet. The work starts with an initial study to select suitable persuasive techniques for elderly. The aim of this work is to evaluate the mobile application that implements a persuasive design. A technology acceptance model named Unified Theory of Acceptance and Use of Technology (UTAUT) has been used in the evaluation phase. Nine (9) elderly participants take part in the in-depth usage study in which they were asked to use the mobile apps for 3-days. The findings show majority of participants (90%) gave positive opinion on the design of the persuasive mobile apps. There is also an improvement in their calories intake during the 3-days study.**

Keywords— **nutrihealth application, diet; mobile application; elderly; monitor diet**

I. INTRODUCTION

Diet has been known for many years to play a key role as a risk factor for chronic diseases [1]. It is now widely accepted that the major causes of morbidity and mortality in Malaysia are related to unhealthy eating habits and a sedentary lifestyle. Besides an alarming increase in the prevalence of overweight and obesity, diet-related disease such as type 2 diabetes, cardiovascular disease, hypertension and certain forms of cancer have recorded an increase during the last few decades in Malaysia [2]. Interactive information technology designed for changing users' attitudes or behaviour is known as persuasive technology [3]. Persuasion has meant "human communication designed to influence the autonomous judgments and actions of others" [4]. There are certain areas where persuasive technology could be especially useful. For example, health care software applications were developed to motivate people towards healthy behaviour, and thereby possibly delay or even prevent medical problems [5]. A mobile application can be used to monitor diet and lifestyle among the elderly. An implementation of some persuasive techniques in mobile interface development will be a value added. For example, an interactive persuasive user interaction will be able to review the calories that have been taken by them, and they will get feedback based on their calories reading. It can persuade them to change their behaviour for a better lifestyle. The implementation of smartphone applications and tools may be an effective option in improving the quality of life [6].

The main aim of this study is to evaluate the mobile application that implements a persuasive design for the elderly. The following sections explain some background work, the methods and analysis of the study carried out.

A. Background Work

Providing healthcare services via mobile technology would be advantageous in many aspects. Currently, there are many mobile health projects under development for elderly such as a mobile health monitoring system called iCare that was developed by students from the Dalian University of Technology. It offers remote monitoring for the elderly and provides tailored services for each person based on their personal health condition [7]. A more strategic approach is desirable, concerning planning, development and the evaluation, to increase the impact of mobile health systems especially for elderly. This would increase the success rate

of the technology [8]. Persuasive Technology was defined as technology that attempts to change people's attitude or behaviour or both without coercion [9].

Some works have been carried out for the elderly in designing for an educational nutritional. The work by Nazlena et. al [10] explored the use of touch screen interaction in developing an educational, nutritional package for elderly. Findings show that most of the elderly involved in this work agree that the educational package is helpful in providing an education on nutritional and healthy lifestyle. Meanwhile, a study by Hazwani [11] shows that elderly participants were interested in learning more advanced smartphone functionalities. For this group of users, who are currently dealing with increasing physical impairments due to aging, the application may need to tailor the content based on their physical limitations and suggest relevant physical activities that were feasible for them to perform [12]. Fogg [8] suggests a three-function triad to design computers as persuasive technology. Additionally, when information sources must be very accurate, credibility should be a key determining. The dimension of perceived credibility a combination of perceived trustworthiness and perceived expertise. When the information contains credibility, it is able to persuade users to use devices. The design principles that involve in this study are reduction, tunnelling, tailoring, self-monitoring, similarity, trustworthiness, attractiveness, readability, and terminology. Table 1 shows the persuasive design principles that were implemented in the design interfaces.

TABLE I
A DESCRIPTION OF PERSUASIVE DESIGN PRINCIPLE ADAPTED FROM [5]

	Design Principles	Description
1.	Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behaviour, and it may increase the benefit/cost ratio of a behaviour
2.	Tunnelling	Using the system to guide users through a process or experience provides opportunities to persuade along the way
3.	Tailoring	Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group
4.	Self-monitoring	A system that helps track one's own performance or status supports in achieving goals
5.	Attractiveness	Design interface with more attractive and more reliable should motivate users to pay more attention to the application
6.	Readability	The need to implement a display with appropriate illumination and colours to attract this type of user. The size and legibility of fonts and icons are considerable keys of good design
7.	Terminology	The application should be more utilized by them if the terminology is clear and has direct meaning

8.	Similarity	People are more readily persuaded through systems that remind themselves in some meaningful way
9.	Trustworthiness	A system that is viewed as trustworthy (truthful, fair, and unbiased) will have increased powers of persuasion

The Unified Theory of Acceptance and Use of Technology (UTAUT) associate between eight models of acceptance of information technology. The model consists of four determinant factors that are significant in user perception which are performance expectancy, effort expectancy, social influence, and facilitating condition [13]. Table 2 shows the four core determinants of UTAUT. In order to gain more understanding of user's attitudes in different contexts, the UTAUT model was extended in various factors that might influence health information in technology adoption. For example, perceived value has been added to the model to explain the quality of the system, emotional value, social value, and price value.

TABLE II
THE FOUR CORE DETERMINANTS OF UTAUT ADAPTED FROM [13]

UTAUT Determinant	The Determinant
Performance Expectancy/PE	Perceived usefulness Extrinsic motivation Job-fit Relative advantage Outcome expectations
Effort Expectancy/EE	Perceived ease of use Complexity Ease of use
Social Influence/SI	Subjective norm Social factors Image
Facilitating Conditions/FC	Perceived behavioural control Facilitating conditions Compatibility

II. MATERIALS AND METHODS

To evaluate Nutrihealth mobile apps we have developed, a qualitative approach with semi-structured interviews was chosen. A convenience sampling was chosen to be the method of sampling technique in this study. We recruited nine healthy Malaysian elderly aged 55 and above. Those respondents that involved in this study must have a smartphone. They were requested to use the mobile apps that for 3-days. Due to an in-depth study design including the 3-days usage trial and interview process among the elderly, the number of participants is considerable, as we need to observe them individually. They need to fill in some information such as weight, height, and level of activeness. The application will calculate their Body Mass Index (BMI) based on input on their height and weight. Nutrihealth apps then suggest the suitable food calorie intake according to participant BMI result. Participants also need to upload their meals every time they eat. This activity is to monitor their eating habit and calories intake. All the participants were given an explanation of the objectives of the study from the beginning of the study, which was to evaluate the mobile

application that has been developed using the chosen persuasive design principles. Fig. 1 shows the examples of Nutrihealth interfaces screenshots.
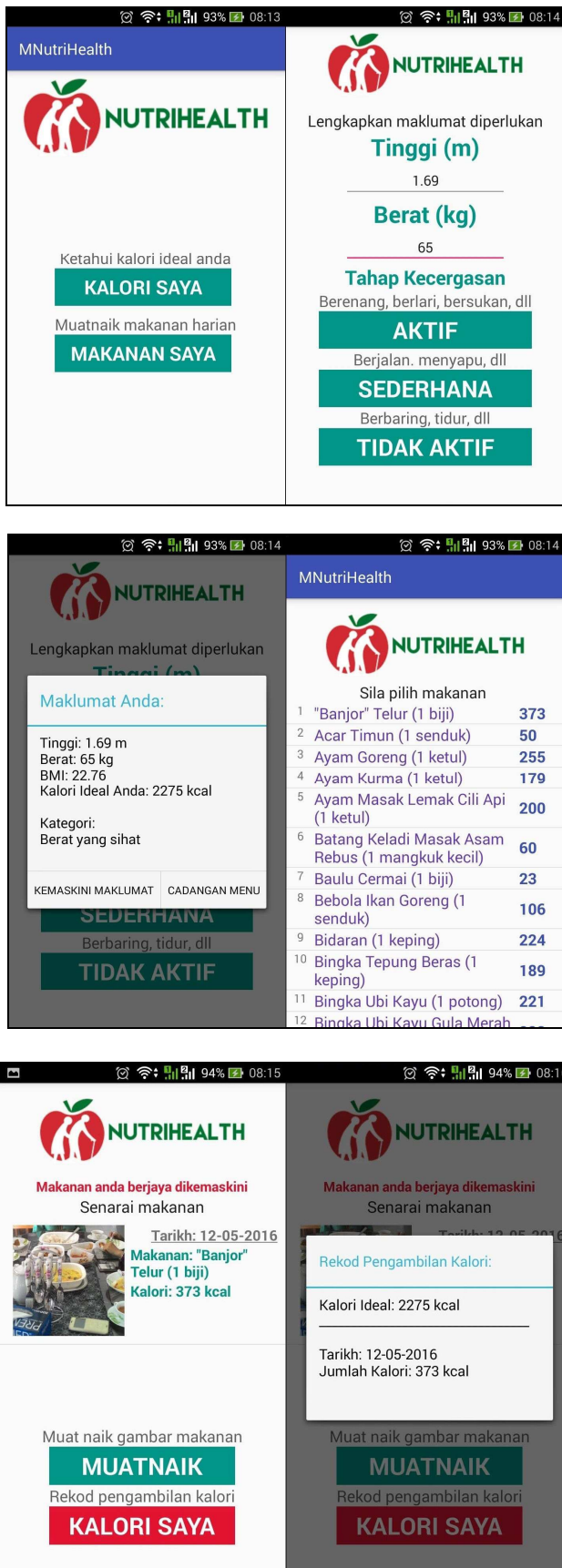

Fig. 1 The examples of Nutrihealth interfaces screenshots

After the 3-day usage of the mobile application, participants were asked to answer a set of questions. The questionnaires were divided into 3 parts to capture different aspects: demographic information, user acceptance of technology and persuasive component. The questionnaires were carried out together with a face-to-face interview to clarify some of the answers to the questionnaires. The interview sessions were recorded and analysed with the participants' permission. Fig. 2 shows the study flowchart.
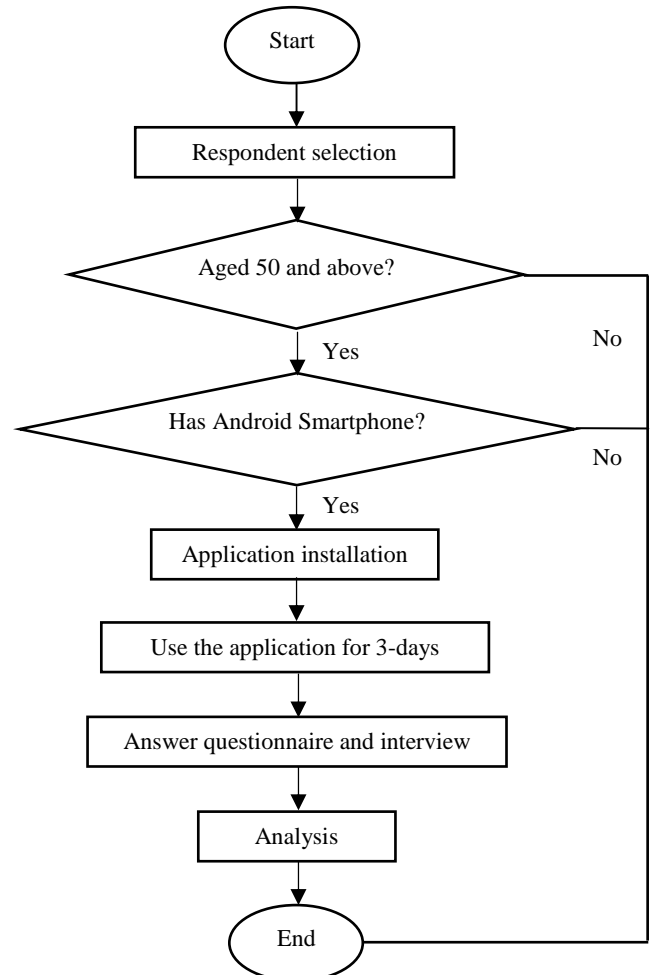

Fig. 2 The study flowchart

III. RESULTS AND DISCUSSION

In this section, we report our findings in terms of the participants' demography (Part A) and user acceptance of technology (Part B) and persuasive design (Part C). Frequency distributions were used to analyse the results.

A. PART A: Demographic Information

Demographic information is personal information of the participants. The purpose of capturing this information was to review the background of the participants involved.

TABLE III
DEMOGRAPHIC INFORMATION

	Elderly (n = 9)
Age	
50 - 54	1
55 - 59	8
Education Level	
Not Attending School	1
Primary School	1
Secondary School	7
Higher Level Education	
Never	0

Job Status	
Not Working	2
Working	3
Retirees	4
Experience in Using a Mobile Application	
Yes	9
No	0
Frequency Using a Mobile Application	
Always	0
Often	6
Sometimes	3
Never	0

As Table 3 summarizes, this study involved nine (9) elderly participants, age between 50 and 59 years old. Most of them only have a secondary school education level, which is seven (7) participants. Two participants did not work while three worked and four of them are retirees. All of them had experience in using mobile applications. Majority of the participants often use a mobile application: three of them sometimes used a mobile application.

B. PART B: User Acceptance of Technology

The results for this part is about user acceptance of technology, specifically for mobile phone applications. The questionnaire was provided to them to answer after they used the mobile application for 3 days.

TABLE IV
NUTRIHEALTH APPLICATION IS USEFUL

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	0
Agree	4
Strongly Agree	5

Overall, our participants agreed on the statement that Nutrihealth application is useful. Four of them chose "Agree, " and the rest of them chose "Strongly Agree" in response to this statement. Our participants were familiar with the use of mobile devices such as a smartphone. Malaysian Communications and Multimedia Commission (MCMC) [12] reports that in 2012, 13.5% of smartphone users in Malaysia is among elderly. It is clearly implying that Malaysian elderly have enough exposure and familiarity with technology.

TABLE V
NUTRIHEALTH APPLICATION IS EASY TO USE

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	0
Agree	2
Strongly Agree	7

Most of our participants agreed on the statement that Nutrihealth application is easy to use. Two of them chose "Agree, " and the rest of them chose "Strongly Agree" in response to this statement. Most participants involved in this study have their own smartphone and use the smartphone every day in their daily life. Participants did not encounter many problems to learn how to use the application.

TABLE VI
MY FAMILY THINK THAT I SHOULD USE THE NUTRIHEALTH APPLICATION

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	0
Agree	9
Strongly Agree	0

All of the participants chose to agree with the statement that their families think that they should use the Nutrihealth application: Nine of them chose to agree. In this experiment, our participants need to use the mobile application for 3 days. During that time, their family members will remind our participants to capture the image of their meals before they eat. There were family members of our participants that also monitor their parent diet using this application. So it clearly is seen that their family really support them to use this mobile application to make sure that their parent keeps a healthy lifestyle.

TABLE VII
NUTRIHEALTH APPLICATION HAS CONSISTENT QUALITY

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	3
Agree	6
Strongly Agree	0

Most of our participants chose to agree with the statement that Nutrihealth application has consistent quality: Six of them chose to agree in response to the statement. There were participants that chose neutral: three of them chose neutral. This is because they are using a phone that has lower hardware specification such as RAM. Other than that, there were participants that face not enough memory space problem. This kind of problems will affect the performance of the Nutrihealth application.

TABLE VIII
I WOULD LIKE TO USE NUTRIHEALTH APPLICATION IN FUTURE

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	0
Agree	6
Strongly Agree	3

All of our participants seem to agree to use the Nutrihealth application in the next few months: Six participants chose to agree, and three of them chose strongly agree in response to the statement. Three days' experiments are just not enough for them to monitor their health. It is because we need to improve in this application such as food database. There are meals that are not on the list. Participants intend to use this application for a few months after we update the database from time to time.

C. PART C: Persuasive Design

This part shows the feedbacks from the participants about the persuasive design principles that has been implemented in the Nutrihealth application.

TABLE IX
NUTRIHEALTH APPLICATION INTERFACE IS NOT CONFUSING

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	0
Agree	4
Strongly Agree	5

All of our participants in this experiment agree that Nutrihealth application Interface is not confusing: four of them chose to agree, and the rest five of them chose strongly agree. In order to make it not confusing, the interface design of this application has only the important element such as button and some description about the function of the button.

TABLE X
NUTRIHEALTH APPLICATION GIVE USEFUL INFORMATION ABOUT MYSELF

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	1
Agree	6
Strongly Agree	2

Most of our participants chose to agree to the statement that Nutrihealth application gives useful information about themselves: six of them chose to agree, two of them chose strongly agree, and one of them chose neutral. This application will calculate participant's BMI and suggest the suitable menu for them based on their ideal calories intake. They feel satisfied with the suggested menu provided by the application because it is Malaysian food and easy to find.

TABLE XI
NUTRIHEALTH APPLICATION USES EASY TERMINOLOGY

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	2
Agree	6
Strongly Agree	1

Most of our participants agree with the statement that Nutrihealth application uses easy terminology: Six of them chose to agree, one of them chose strongly agree, and the rest two of them chose neutral. This application is using the Malay language to make it easy for Malaysian elderly to read and understand the instruction given.

TABLE XII
NUTRIHEALTH APPLICATION HELP ME TO MONITOR MY DIET

	Elderly (n = 9)
Strongly Disagree	0
Disagree	0
Neutral	0
Agree	5
Strongly Agree	4

All of our participants agree with the statement that Nutrihealth application will help them to monitor their lifestyle: five of them chose to agree, and four of them chose strongly agree. During the experiment, participants need to upload their meals, and this application will update their calories intake every time they upload the meals. This features will help them to monitor their diet.

TABLE XIII
PARTICIPANT'S CALORIES INTAKE FOR 3 DAYS

	Day 1 (Kcal)	Day 2 (Kcal)	Day 3 (Kcal)	Ideal Calories (Kcal)
Participant 1	547	670	932	1193.01
Participant 2	906	432	865	1925
Participant 3	826	491	1065	1285.94
Participant 4	536	94	1374	1239.04
Participant 5	678	798	1220	1382.35
Participant 6	246	106	578	2310
Participant 7	576	897	1054	1317.69
Participant 8	152	476	809	1925
Participant 9	432	568	904	2240

Table 13 shows the calories reading for each participant in 3 days. Overall observation shows that the design potential to improve from the change in diet intake from day 1 to 3. There were participants that have lower calories reading on the first day. It is because of they still in the phase of

adapting and learning the application. On the following day, they used the application more often. One participant fasting on the second day which is Participant 4 (94 Kcal) that shows low intake on that day due to no food is taken during daytime. There were also participants that forgot to upload their meals on the first day. The participants that could not upload their meals because their meals did not exist in the database. We have visited them each day and assisted in the recording their meal intake, and that solved the problems. Even though there are limitations during the study, we still believe that the intervention with the use of mobile apps among the elderly provides insight for future research design and possibilities.

IV. CONCLUSION

The results of this study conclude that our participants liked the Nutrihealth application because it helps them to monitor their health. This application also causes our participants to be careful in choosing meals instead of monitor our participant's diet. They also can use it everywhere as long as they bring their smartphone. This is also the reason they prefer to use Nutrihealth application. Some of our participants expressed possible future improvements on the application. Some suggested that this application should update its meals. The meals provided by the application is not enough and will affect the calories intake results. To continue the study on persuasive mobile application development on a healthy diet for elderly based on persuasive design, a more diverse demography of population will be included such as adult citizens in Malaysia. These recommendations will be considered for improvement of our Nutrihealth application.

ACKNOWLEDGEMENTS

REFERENCES

[1] J. Who and F. A. O. E. Consultation, "Diet , Nutrition And The Prevention Of Report of a Joint WHO / FAO Expert Consultation," 2003.

[2] Ministry of Health, "Malaysian Dietary Guidelines," 2010.

[3] Fogg, B.J., "Persuasive technology: Using computers to change what we think and do. Morgan Kaufmann Publishers, San Francisco," 2003.

[4] Simons, H.W., Morreale, J., Gronbeck, "Persuasion in society. Sage Publications, Inc., Thousand Oaks," 2001.

[5] H. Oinas-kukkonen and M. Harjumaa, "A Systematic Framework for Designing and Evaluating Persuasive Systems," pp. 164–176, 2008.

[6] Joseph Tran, BS, Rosanna Tran, BS and John R. White Jr., PA, PharmD, "Smartphone-Based Glucose Monitors and Applications in the Management of Diabetes: An Overview of 10 Salient "Apps" and a Novel Smartphone-Connected Blood Glucose Monitor," 2012.

[7] Z. Lv, F. Xia, G. Wu, L. Yao, and Z. Chen, "iCare: A Mobile Health Monitoring System for the Elderly." 2010.

[8] W. Boontarig, G. Quirchmayr, W. Chutimasakul, and B. Papasratorn, "An Evaluation Model for Analysing Persuasive Systems in Mobile Healthcare," 2014.

[9] B. J. Fogg, "Persuasive Technology: Using Computers to Change What We Think and Do," vol. 4744. Morgan Kaufmann Publishers an Imprint of Elsevier Science," 2003.

[10] N. M. Ali, S. Shahar, Y. L. Kee, A. R. Norizan, and S. A. M. Noah, "Design of an interactive digital nutritional education package for elderly people," *Informatics Heal. Soc. Care*, vol. 37, no. December, pp. 1–13, 2012.

[11] H. M. Mohadis and N. M. Ali, "A Study of Smartphone Usage and Barriers Among the Elderly," *2014 3rd Int. Conf. User Sci. Eng. A*, pp. 109–114, 2014.

[12] H. Mohd Mohadis and N. Mohamad Ali, "Using Socio-ecological Model to Inform the Design of Persuasive Applications," *Proc. 33rd Ann ACM Conf Ext Abst Hum Factors Comp Sys*, vol. 18, pp. 1905–1910, 2015.

[13] V. Venkatesh, "Consumer A Cceptance and Use of Information Technology: Extending The Unified Theory," vol. 36, no. 1, pp. 157–178, 2012.

[14] B. Kijsanayotin, S. Pannarunothai, and S. M, "Speedie. Factors influencing health information technology adoption in Thailand's community health centers: applying the UTAUT model," 2009.

[15] D. Zimmerman, D. Ph, and T. Yohon, "Small-screen Interface Design?: Where Are We?? Where Do We Go?? Literature?: Small-screen Interface Design," 2009.