Does e-Health technology design affect m-Health informatics acceptance?
A case study

Abdul Hakim H. M. Mohamed[1], Hissam Tawfik[1], Lin Norton[1], Dhiya Al-Jumeily[2]

[1]Liverpool Hope University, [2]Liverpool John Moores University

Mohamed@hope.ac.uk

Abstract – **This paper explores and analysis the influence of e-Health technology design on intention to use m-Health informatics, from users' perceptions, viewpoint, and experience.**

This study assesses the influence and the relationship between e-Health technology design as the independent variable (predictor) and the intention to use m-Health as a dependent variable.

The results indicated that there is a direct significant relation between e-Health technology design and intention to use m-Health informatics. The results also confirmed that intention to use m-Health informatics is influenced by the perceptions of the user of e-Health technology in terms of the design approach, especially in relation to the navigation and the data presentation. This suggests that a well-structured e-Health technology design will increase the intention to use m-Health informatics.

Keywords: **e-Health technology design, m-Health informatics, Technology Acceptance**

I. INTRODUCTION

The advancement of wireless mobile devices advancement has re-shaped the way people access information in a very versatile way and with minimal geographical constraints.

Mobile technology is not limited to mobile phones but it includes other digital mobile devices. The focus of this study investigates and assesses e-Health technology design as an influential factor that could affect m-Health informatics acceptance

m-Health informatics can be considered to refer to the use of e-Health medical data, appointment booking and repeat prescription ordering through smart mobile devices, such as iPhone, blackberry and androids.

One of the motivations behind conducting this research is the fierce competition in the mobile device market, which has led to the production of powerful and portable mobile devices, such as iPhone, blackberry and androids. The versatility of these devices has enabled them to handle and run applications in an appealing and fashionable way. It's anticipated that the use of mobile informatics in the health applications will increase in the future. This study aims to answer the following question: "Does e-Health technology design affect m-Health informatics acceptance?"

The interaction design [18,19,20] of m-Health informatics forms the user perceptions of either accepting or rejecting the technology, hence the ease of use and usefulness are crucial elements to be considered during the design stage. The ease of use of the technology and the

usefulness of the contents usually dictate the technology acceptance from a user viewpoint [18]

This study employed Davis et al [2,3] technology acceptance constructs (figure 1), namely Perceived ease of use (PEOU) and Perceived usefulness (PU), to study their implication on accepting m-Health informatics in the United Arab Emirates (UAE).

TAM (Technology Acceptance Model)[2,3] is an Information System theory that models how users come to accept and use a technology. They suggests that when users are presented with a new software package, a number of factors influence their decision about how and when they will use it, notably PU and PEOU of the technology. A high level of PU and PEOU is more likely to induce positive perceptions. The relation between PU and PEOU is that PU mediates the effect of PEOU on attitude and intended use.
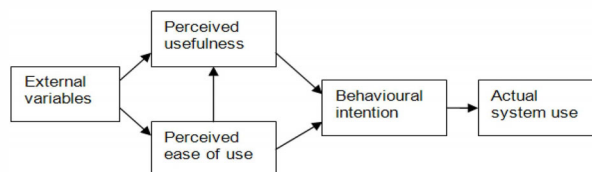

Figure 1: Davis' Technology Acceptance Model [2]

The applications of TAM in e-Health research could be read as a means to assess and determine the role of sociocultural and technological factors affecting the adoption and dissemination of e-Health [1]. The Technology Acceptance Model (TAM) specifies positive relationships between system design features, perceived usefulness, perceived ease of use, attitude toward using, and actual usage behaviour [2,3]. Overall, the TAM provides an informative representation of the mechanisms by which design choices influence user acceptance, and should therefore be helpful in applied contexts for forecasting and evaluating user acceptance of information technology (IT), as shown in Figure 1

II. RELATED WORK

Haslina et al [6] discussed issues surrounding the acceptance of Electronic Medical Record (EMR), where they have stressed the importance of acceptance study in the field of EMR. They argued that there is a need for a social framework for EMR acceptance. Factors such as user behaviour, perceived ease of use, perceived usefulness,

information quality and interface were all investigated [6], and found to be of concern. This highlighted the need for an investigation into the acceptance of EMR among doctors, nurses, clinicians and patients before EMR can successfully be implemented.

Wilkins [7] examined factors that may influence managers in the medical adoption of Electronic Health Record EHR. Wilkins adopted TAM as a theoretical foundation for the study. Managers in the health sector in Arkansas, USA, were queried to assess the weight of perceived ease of use, perceived usefulness and behaviour intention. Wilkins' results indicated that there was a difference between IT managers who had adopted components of electronic health record systems compared to those who did not use EHR. It was evident that respondents who had adopted EHR components felt that EHRs would be beneficial in their work. One of Wilkins' questions was "Is there a difference in the perceived usefulness of EHRs between health information managers that have adopted EHRs and those that have not adopted EHRs?" Results indicated that electronic health record decision making and task completion is easier and quicker, which will impact positively on productivity. The same sample also responded to the question: "Is there a difference in perceived ease of use of EHRs between health information managers that have adopted EHRs and those that have not adopted EHRs?", the majority stated that electronic health records will make the process of handling the medical record easier to navigate, understandable and clear. One of the weaknesses of Wilkins' study is that it was conducted in only one state in the USA. For greater generalisability, the research needs to be carried out in other American states and across Europe. Wilkins' findings can further be enhanced by incorporating sociocultural factors and subjective norms in an organisational context, as there is clear evidence that they do have a strong influence when it comes to technology adoption [8,11].

In other related work, Wu et al [12] proposed a TAM that incorporated self-efficacy, compatibility, training and technical support to investigate what determined healthcare professional mobile healthcare systems (MHS) perception and acceptance in the healthcare domain.

They argued that healthcare professionals' intention to use the services is positively influenced by the perceived ease of use and perceived usefulness, and perception of MHS ease of use does influence the professional's perception of MHS usefulness.

The results also confirmed that compatibility directly influence behavioural intention to use the services, perceived ease of use, perceived usefulness, and MHS self-efficacy.

These findings indicated that neither training nor technical support were found to be significant on either perceived ease of use or perceived usefulness, which is to some extent supported by the current literature [13, 14, 15].

Wu et al [12] study would benefit from the consideration of the impact of the cultural and social, such as Trust, Subjective norms, Tangibility, and Uncertainty avoidance [1].

III. THE STUDY DESIGN AND RESULT ANALYSIS

In order to study the impact of PU and PEOU on m-Health informatics, a survey was conducted to empirically investigate and assess the of m-Health informatics acceptance.

The participants were students in higher education, medical practitioners, ministry of health staff and universities staff. The data were collected through a paper based and online questionnaire. 300 participants were invited to participate, of which 229 completed the survey questionnaire.

The survey questionnaire employed a Likert 5 points response scale [5]. This study was conducted over a month period, in which 300 respondents were asked to participate of whom 229 responded (45% students). The statistical analysis of the collected data indicated that there was a significant correlation (figure 2) between technology design, perceived usefulness, perceived ease of use and intention to use m-
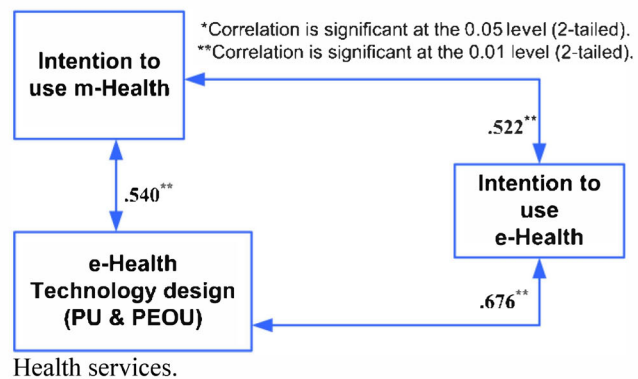

Health services.

Figure 2: Correlation association diagram

The correlation between e-Health technology design constructs (PU & PEOU), intention to use e-Health services and intention to use m-Health informatics were measured using Pearson's correlation; all tests of significance were reported as 2-tailed (non-directional). Intention to use m-Health informatics significantly correlated (r= .522, p=.000) with intention to use e-Health services.

This indicates that creating accessible and useful e-Health services can lead to increased intention to use m-Health informatics. Davis et al [2,3] defined Perceived Usefulness as "*The degree to which a person believes that using a particular system would enhance his or her job performance*".

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.169	1.974		1.605	.110
	eHealthTechnologyDesign	.284	.029	.540	9.658	.000

a. Dependent Variable: mH

Figure 3: Regression coefficients table

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.540[a]	.291	.288	3.85175

a. Predictors: (Constant), eHealthTechnologyDesign

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1383.973	1	1383.973	93.285	.000[a]
	Residual	3367.765	227	14.836		
	Total	4751.738	228			

a. Predictors: (Constant), eHealthTechnologyDesign
b. Dependent Variable: mH

Figure 4: Regression output table (Model summary & ANOVA)

The users assess the results of their behaviour and action in terms of perceived usefulness and establish their choice of behaviour on the desirability of the usefulness [2,8,16]. According to Venkatesh et al [17] if a technology is easy to use, it will be enjoyable, which in turn, increases the intention to use. The results of this research indicate that the more useful and easy to use m-Health informatics is perceived to be, the more likely it is that users will accept and use them. The m-Health services that provide higher quality of information would result in a greater perceived usefulness from the users. Acton et al [16] found that perceived usefulness had a strong direct effect on usage of personal computing, which suggests that perceived usefulness is the most important factor affecting user acceptance. This survey confirms the findings of related previous related studies [1,2,3,6,7,12] as e-Health technology design constructs (PU & PEOU) was found to be significantly correlated to intention to use m-Health informatics (r = .540, p=.000) and intention to use e-Health services (r=.676, p=.000).

The Kaiser Meyer-Olkin value was .834, exceeding the recommended value of .6 [4] and Bartlett's Test of Sphericity [4] reached statistical significance (803.545).

The reliability test to the constructs of the proposed model constructs was assessed by cronbach's alpha test (α) The results show that all constructs had acceptable level of internal consistency (0.803), which suggesting a good internal consistency reliability for the Model scale with this sample.

A model emerged as a result of the regression analysis [4], the proportion of the variance accounted for by the model, the significance of model and the significance of the predictor variable, is explained as: (F4,42=93.285, p < 0.0005. Adjusted R square = .288. Significant e-Health technology design .540 p < 0.0005), (see figures 3 & 4, appendix 1).

This supports the hypothesis that e-Health technology design is a significant predictor of m-Health informatics acceptance, as the p value is <0.0005, and e-Health technology design does affect the m-health informatics acceptance.

IV. CONCLUSION

This study investigated and assessed the influence of the e-Health technology design constructs (Perceived usefulness and perceived ease of use) on m-Health informatics acceptance. The e-Health technology design was used as a predictor variable.

The Pearson correlation coefficient was employed to study the relationships between the constructs. The correlation analysis yielded significant positive correlations between e-Health technology design, intention to use m-Health informatics and intention to use e-Health services. The reliability and consistency test results of the constructs proved to be reliable.

The regression analysis demonstrated that e-Health technology design can predict and influence the intention to use m-Health informatics.

The results indicated that technology design significantly influences the intention to use m-Health informatics, and perceived usefulness is more significant to the intention to use m-Health informatics than the perceived ease of use.

The study concluded that intention to use m-Health informatics is formed by the perceptions of the user of e-Health technology design approach, especially the navigation and the data presentation on the mobile device.

The results obtained by this study will be used in future research study to design a well-informed mobile health

application, which will facilitate to study the gap between the intention to use m-Health application and the actual use of m-Health informatics.

REFERENCES

[1] Mohamed, A. H. H. M.; Tawfik, H.; Norton, L.; Al-Jumeily, D. (2011) "e-HTAM: A Technology Acceptance Model for electronic health" Innovations in Information Technology (IIT) conference, UAE. pp.134-138, 25-27.

[2] Davis, F.D. (1989) "Perceived usefulness, perceived ease of use, and user acceptance of information technology". MIS Quarterly, 13 (3)

[3] Davis, F.D. and Venkatesh, V. (2004) "Toward Preprototype User Acceptance Testing of New Information Systems: Implications for Software Project Management". IEEE Transactions on Engineering Management, 51 (1).

[4] Pallant, J. (2007) SPSS Survival Manual. A step by step guide to data analysis using SPSS for Windows third edition. Maidenhead, Berkshire: Open University Press.

[5] Dawes, J. (2008) "Do Data Characteristics Change According to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales". International Journal of Market Research 50 (1): pp. 61–77.

[6] Haslina, M. and Sharifah, S. (2006) "Electronic Medical Record Evaluation Using Task Analysis Technique," presented at Proceedings of the 11 the International Symposium on Health Information Management Research, iSHIMR 2006, USM, Kelantan, Malaysia, 2006.

[7] Wilkins M. A. (2009) Factors Influencing Acceptance of Electronic Health Records in Hospitals. Perspect Health Inf Manag. 2009; 6(Fall): 1f. Published online 2009 September 16.

[8] Mathieson K., Peacock , E. Chin, W. (2001) Extending the technology acceptance model: the influence of perceived user resources, ACM SIGMIS Database, v.32.

[9] Hofstede, G (1980) "Culture's Consequences; International Differences in work related values", Sage, Beverly Hills.

[10] Hofstede, G. (2001) Culture's Consequences: Comparing Values, Behaviours, Institutions and Organizations across Nations, 2nd Ed., Sage Publication, Thousand Oaks, CA.

[11] Chuttur M.Y. (2009) "Overview of the Technology Acceptance Model: Origins, Developments and Future Directions", Indiana University, USA.

[12] Wu, J., Shen, S., Lin, L., Greenes, R., and Bates, D. (2008) Testing the technology acceptance model for evaluating healthcare professionals' intention to use an adverse event reporting system. Int J Qual Health Care.

[13] Kim, D., Chang, H. (2007) Key functional characteristics in designing and operating health information websites for user satisfaction: an application of the extended technology acceptance model. Int J Med Inform.

[14] Lanseng, E., Andreassen, T. (2007) Electronic healthcare: a study of people's readiness and attitude toward performing self-diagnosis. Int J Serv Industry Manag.

[15] Aggelidis, V., Chatzoglou, P. (2009) Using a modified technology acceptance model in hospitals. Int J Med Inform.

[16] Acton, T., Golden, W., van der Heijden, H. (2005). "Effects of see-through interfaces on user Acceptance of small-screen information systems." ECIS.

[17] Venkatesh, V. and Davis F. D. (2000) "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies", Management Science, Vol. 46. No. 2, pp. 186-204.

[18] Paul, C., Anna L. C. (2008) Research Methods for Human-Computer Interaction, Cambridge University Press, New York, NY.

[19] Nielsen, J. (1993) Usability Engineering, Morgan Kaufmann Publishers Inc., San Francisco, CA.

[20] Borchers, J. O. (2001) A pattern approach to interaction design. AI Soc. 15(4): 359-376.

Appendix 1: P-P Plot of intention to use m-Health informatics (DV) and e-Health technology design (IV)

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: mH
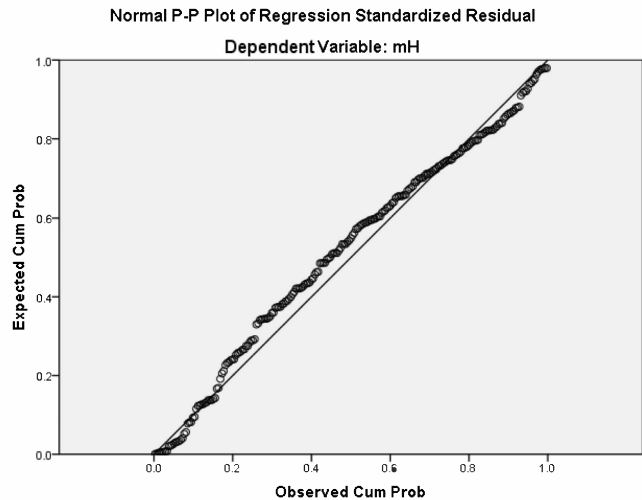
Appendix 2: Sample questions for intention to use m-Health informatics and e-Health technology design

I can search the internet for health information or services easily
I would use the internet to obtain health information from the internet
I intend to use internet based health information or services frequently whenever it is available
The internet based health information or services websites that I have visited or used were easy to use
I would use the internet to book my medical appointment, if it is available
I prefer the use of multimedia (voice, image and video) to provide an idea of how to deal with the medical services that is available on the Internet
I prefer to use websites that provides detailed information about the disease which I inquire about, rather than sites provide general information
I will not be visiting websites that provide useless or inaccurate information
I will not be visiting websites that contains information difficult to understand
I will not be visiting websites that is difficult to navigate between it is pages
The Internet is not safe and I do fear of stealing my personal and financial information
The Internet is safe and I do not fear of stealing my personal and financial information in the health related websites.
I prefer to use web sites that enable me to interact with health professionals or doctors
I prefer to use websites that enable me to control the way the information is displayed and be able to change the colour and size of the font to suit me
I think that the colour of the web page is important to visit the site and interact with it
I think that the layout of the web page is important to visit the site and interact with it
I prefer to visit websites that would enable me to control it is format and layout
I would prefer to see a doctor and talk to him/her face to face instead of using the Internet to connect or talk with him/her
Dealing directly with the doctor provides me with better service than communicating with him/her via the Internet
Dealing directly with the doctor provides me with better services than communicating with him/her through the applications installed in the mobile phone
The Internet is easy to surf
It is easy to find medical information through the Internet
I intend to use the Internet to search for information or health services whenever it is available
I will book my health or medical appointment through internet enabled mobile phone or device whenever this service is available
I'm going to access medical information through internet enabled mobile phone or device whenever this service is available
Mobile phones are easy to use
Smart mobile phones (iPhones, Android, BlackBerry …etc.) are easy to use
e-Health or medical services available through the Internet should receive more support and attention from the government to evolve properly