

MoHTAM: A Technology Acceptance Model for Mobile Health Applications

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Abstract— In spite of the advancement and variety of available mobile based applications, there is an eminent need to investigate the current position of the acceptance of those mobile health applications that are tailored towards the patients' medical information management and access.

This paper explores and analysis the technology acceptance of the use of smart mobile phones from users' perceptions, viewpoint, and experience. The paper will focus on studies of the factors affecting the intention to use the smart mobile phone in the medical domain.

Our proposed Mobile Technology Acceptance Model (MoHTAM) assessed the significance of the correlation between technology design, perceived ease of use, perceived usefulness as independent factors and the intention to use m-Health services as the dependent factor.

The correlation coefficient analysis indicated that there is a significant relationship between the major constructs. Rigorous analytical testing confirmed that there is a direct relationship between social, cultural and technological constructs with intention to use m-Health applications. The model indicated that a well-informed technology design will increase the intention to use m-Health application, and perceived usefulness is more significant to the intention to use m-health applications than the perceived ease of use.

These findings indicated that intention to use mobile health informatics is formed by the perceptions of the user of m-Health technology design approach, especially in relation to the navigation and the data presentation on the mobile device.

Keywords: Health informatics, Technology acceptance, perceived usefulness, Smart mobile phones.

I. INTRODUCTION

The well-known restriction policies to access patients' records still remain a preeminent issue [16]. Patients travel around the globe to receive medical attention. Hospitals are not always keen to release medical information without the consent of the patient, and the hospital always hold the ownership of the medical information.

Recent advancement in digital and wireless mobile devices has created new opportunities to access information in a very diverse way and with minimal geographical constraints.

Mobile technologies do not only include mobile phones but all digital devices that are cabled or wireless. The focus of this research on mobile technology is in relation to what are commonly called smart mobile phones, such as iPhone, blackberry and androids.

The noticeable competition between the smart phone manufacturers led to the emergence of a new generation of mobile devices; that are considered to be mini computers. They have high computational and processing capabilities; that allow them to run and handle applications in a fashionable and appealing way to the users.

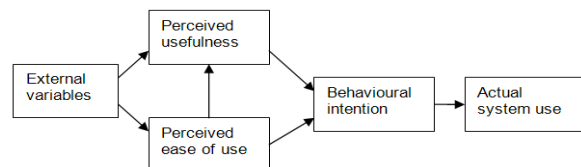
Accessing patient medical records outside the hosting authority remains an obstacle that needs to be addressed. Patients now travel around the globe to receive medical attention. There is a need to allow individuals to have access to their medical records anywhere anytime. ICT can provide a tangible solution to personal medical data access, which will help overcome the issues of corporate to corporate personal medical data movements [14,15].

This paper introduces a technology acceptance model for smart mobile phones (MoHTAM), which is intended to be used in the medical domain, specifically patient's medical information management, such as medical health record access, appointment management, and prescription management using mobile devices.

This research extends a previous study named 'e-HTAM' [1] conducted by the authors, where they adapted Davis' TAM [2] to investigate the suitability of TAM in the field of e-Health.

The Technology Acceptance Model (TAM) is one of the most cited models [7], when it comes to studying user acceptance and use of technology. TAM (figure 1) was developed to explain the behaviour controlling computer-usage [2,11].

Figure 1: Davis' Technology Acceptance Model [11]



TAM [2,11] is an Information System theory that models how users come to accept and use a technology. The e-HTAM model described in the earlier paper 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 Perceived Usefulness (PU) and Perceived Ease of Use (PEU) of the technology. A high level of PU and PEU is more likely to induce positive perceptions. The relation between PU and PEU is that PU mediates the effect of PEU on attitude and intended use.

The findings published in this current paper is a part of a wider research study, where the objectives are to research, design and implement medical applications, that can be accessed through smart mobile phones. Those applications are intended to be culturally sensitive.

To achieve those objectives, the research reported here first conducted a pilot study to investigate and assess factors that might affect the acceptance of Mobile phone based health informatics. The data that were collected have been analysed to build the technology model that will be used to assess the concept of m-Health acceptance.

By m-Health the researchers mean the mobile health data access and management, particularly, medical health record access, appointment management, and prescription management using mobile devices.

The intention of this paper is to introduce a mobile health informatics framework that is patient driven. One of the benefits of this framework is that it is a patient centric approach, where the patient will have access to his or her medical records and can send them or authorise access without consulting the hospital where the medical information is stored. This will allow the medical information to be mobile and accessed anytime anywhere. The concept of anytime anywhere will speed up the medical decision process.

The research vision is to establish a framework that will allow the mobility of the patients' medical data, and make the process of exchanging patients' medical records free of restrictions, as it will be based on the patient's permission.

II. RELATED WORK

In a previous questionnaire study, Mohamed et al [1] assessed the effect of the Technology Acceptance Model's [2] major constructs Perceived Ease of Use (PEU) and Perceived Usefulness (PU) on intention to use electronic health services; they have also investigated the position of other social, cultural and technical factors. The study constructed a model representation that is suitable to be used to study and assess the acceptance of patients' centric electronic health applications. The Model that has been constructed is known as e-HTAM.

e-HTAM [1] has explained the factors affecting the behavioural intention to use web based health services and indicated that there is a significant correlation between technology design and intention to use e-Health web based services, where the correlation was reported as $r = .275$. This suggests that the technology design to some extent influence the intention to use e-health services. The model also showed that both perceived usefulness and perceived ease of use were also influential, as the correlation was reported as $r = .420$ and $r = .438$. Other sociocultural factors such as Tangibility, Trust, Subjective norms, and Uncertainty avoidance were all reported as significantly correlated with the intention to use e-Health services.

e-HTAM was based on a sample of 50, which to some extent affected the overall model in terms of its reliability and consistency. The e-HTAM questionnaire reported α of .651 Cronbach alpha [4] reading. Although .651 cronbach α reading is considered to be marginally acceptable, the majority of statistical experts set the cut off line by $\alpha \geq .7$.

Haslina et al [12] discussed issues surrounding the acceptance of Electronic Medical Record (EMR), where they have stressed the importance of acceptance study in the field of EMR (Electronic Medical Record). 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 [12], and found to be of great 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 [19] examined factors that may influence managers in the medical adoption of 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 "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 strong influence when it comes to technology adoption [7,9].

III. THE STUDY DESIGN AND RESULT ANALYSIS

This paper introduces a technology acceptance model for smart mobile phones (MoHTAM), which is intended to be used in the medical domain. This questionnaire study extends previous research conducted by the authors 'e-HTAM' [1], where they adapted Davis' TAM [2] to investigate the suitability of TAM in the field of e-Health.

In order to address issues reported in e-HTAM [1], a second phase of the pilot study was conducted to empirically assess the acceptance of the use of the smart phone devices (m-Health) in the field of medical informatics. It was also designed to report on the level of m-Health acceptance and how it addressed the overall model consistency and reliability of e-HTAM [1].

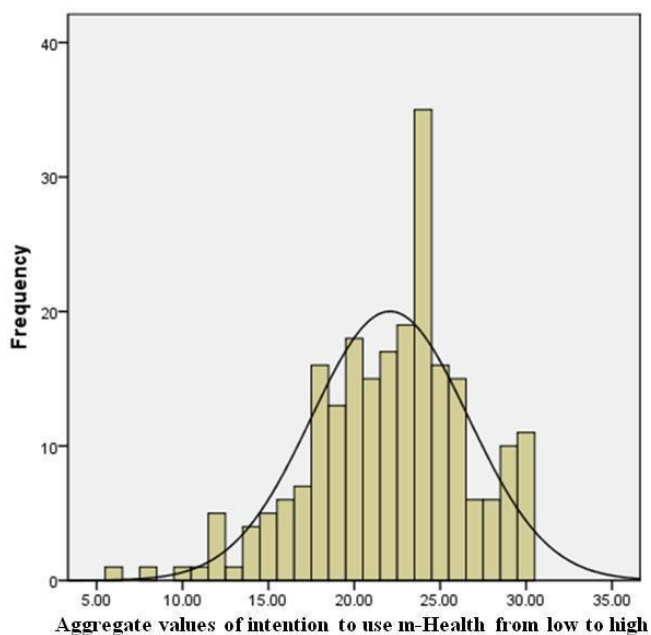


Figure 2: mHealth acceptance data distribution

Phase two of the pilot study was conducted in the UK and the UAE¹. 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. For the purposes of integrity and data validity the authors opted to offer translated questions to UAE residents.

MoHTAM incorporated mobile health design factors and other technological and sociocultural factors. The pilot study used in e-HTAM [1] was revised and enhanced to incorporate mobile phone health informatics acceptance.

This pilot study was conducted over a one month period, in which 150 UK respondents were asked to participate of whom 116 responded and 150 UAE respondents were asked to participate of whom 113 responded (total N = 229)

The MoHTAM questionnaire employed a Likert 5 points response scale [3], ranging from strongly disagree to strongly agree.

The statistical analysis of the collected data indicated that there is a significant correlation (figure 3) between technology design, perceived usefulness, perceived ease of use and intention to use mHealth services.

As can be seen from figure 3, significant results were obtained for the major model constructs except Power Distance and Tangibility; it also show the significance results for TAM constructs (PU and PEU) correlation with intention to use e-Health web based services.

As can be seen from figure 2, the data distribution is negatively skewed, which suggest that the score is clustered to the right hand side of the graph, which show a reasonable degree of approval among samples toward intention to use m-Health services.

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Mo-HTAM constructs relationships were measured using Pearson's correlation; all tests of significance were reported as 2-tailed. Intention to use m-Health significantly correlated ($r = .522, p = .000$) with intention to use e-health services. This indicates that creating accessible mobile based e-Health services can lead to increased intention to use m-health services.

The results indicate that PEU ($r = .260, p = .000$), which suggest that Perceived Ease of Use can be corresponded with freedom from efforts and anxiety, which is more of a concern for those with high uncertainty avoidance value. According to Venkatesh [2] if a technology is easy to use, it would be enjoyable, which in turn increases the intention to use. These survey results suggest that increasing PEU is related to an increased intention to use e-Health services, as the correlation is significantly high ($r = .506$).

Davis et al [2] defined Perceived Usefulness as "The degree to which a person believes that using a particular system would enhance his or her job performance." People 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 [2,9,10]. Acton et al [10] 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 [2,10] as PU was found to be significantly correlated to intention to use m-Health services ($r = .521, p = .000$).

The 12 constructs of the model which affect and constitute the scale were subjected to Principal Components Analysis (PCA) using SPSS. Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .209 and above. The Kaiser Meyer-Olkin value was .834, exceeding the recommended value of .6 (Kaiser 1970, 1974) and Bartlett's Test of Sphericity (Bartlett 1954) reached statistical significance, supporting the factorability of the correlation matrix.

IV. MODEL REFINEMENT AND RELIABILITY TEST

This study employed TAM standard constructs [2,11] to investigate its applicability in the field of m-Health. The proposed model incorporated technological factors (m-Health technology design), and other social and cultural such as subjective norms, tangibility and Hofstede's [17,18] cultural dimensions into the model, as they are expected to have a significant effect on Intention of use.

Prior to conduct the reliability test the first author checked that the number of cases is correct (in the case processing summary table) and that the number of items is correct (in the reliability statistics table). The inter-item correlation matrix for negative values was also checked, as all values should be positive, which indicate that the items are measuring the same underlying characteristic. A Cronbach Alpha test [4] was performed to test the stability and consistency of Mo-HTAM constructs.

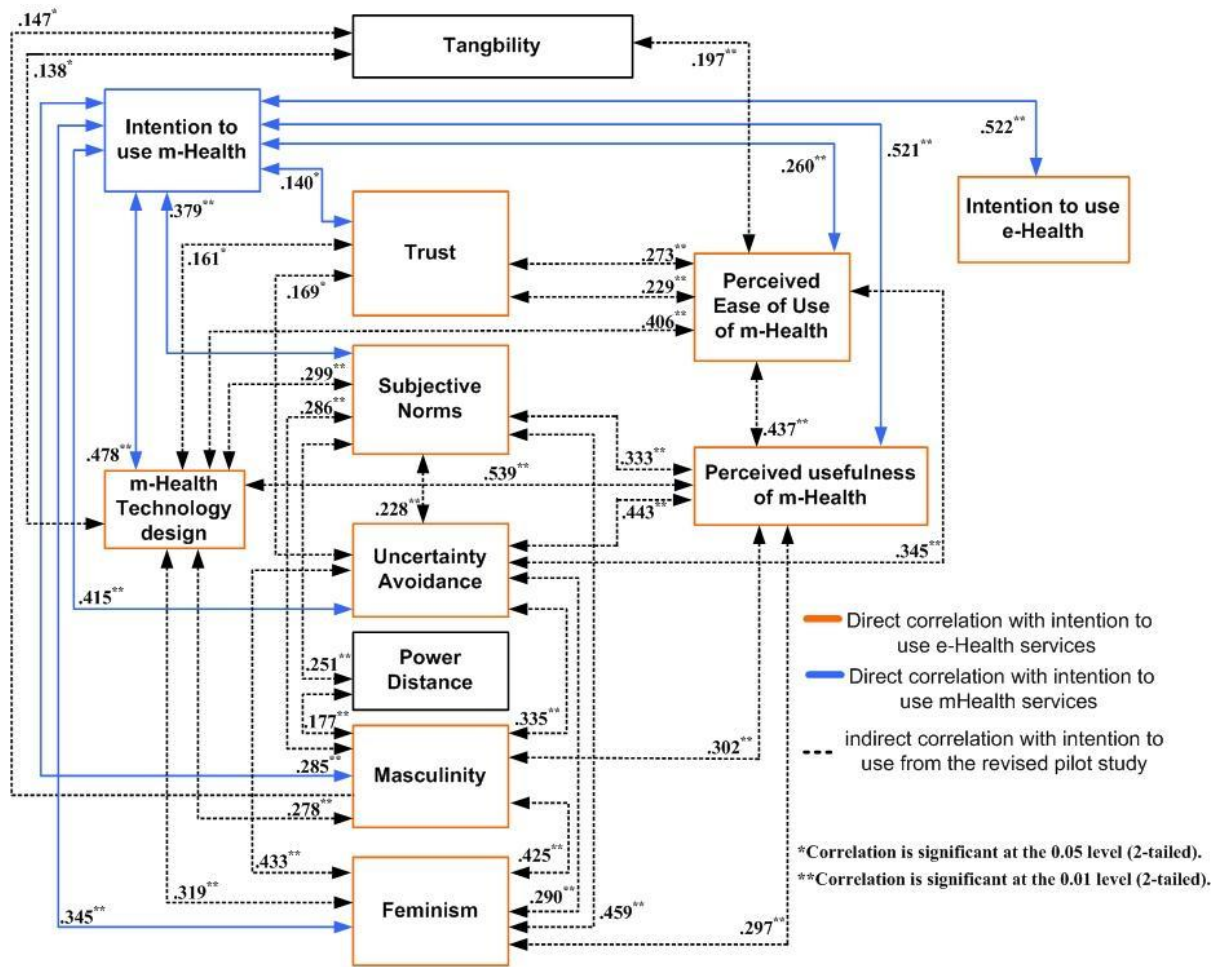


Figure 3: MoHTAM constructs correlation association diagram

	Cronbach's Alpha if Item Deleted
Intention to use e-Health	.750
Intention to use m-Health	.753
Masculinity/Feminism	.778
Power Distance	.790
Perceived ease of use	.771
Perceived Usefulness	.740
Subjective norms	.778
Tangibility	.803
e-health Technology Design	.752
Trust	.788
Uncertainty Avoidance	.766
Collectivism/individualism	.775

Figure 4: Cronbach alpha if item deleted

Cronbach Alpha test was performed to test the stability and consistency of the instrument. According to Pallant [5] a good reliability test should produce at least a value of above 0.70. The reliability of the proposed model constructs was assessed by Cronbach's alpha test (α). The results show that all constructs had an acceptable level of internal consistency of 0.793, which suggests a good internal consistency and reliability for the MoHTAM scale with the current sampled population.

Although the model scored .787 overall, values above .8 are preferable. Inspecting Cronbach alpha test total item statistics, indicates that there is a possibility of enhancing the Cronbach alpha reading. The Tangibility total correlation was reported at .054. As Tangibility is found to have no direct reported correlation with intention to use m-Health (see figure 3), the authors opted to delete this item from the scale (as suggested by the reliability test, see figure 4) to enhance the overall Model stability and consistency. Removing Tangibility from the scale increased the overall Cronbach alpha test value to .802 which make the Model stability and consistency rated as "very good".

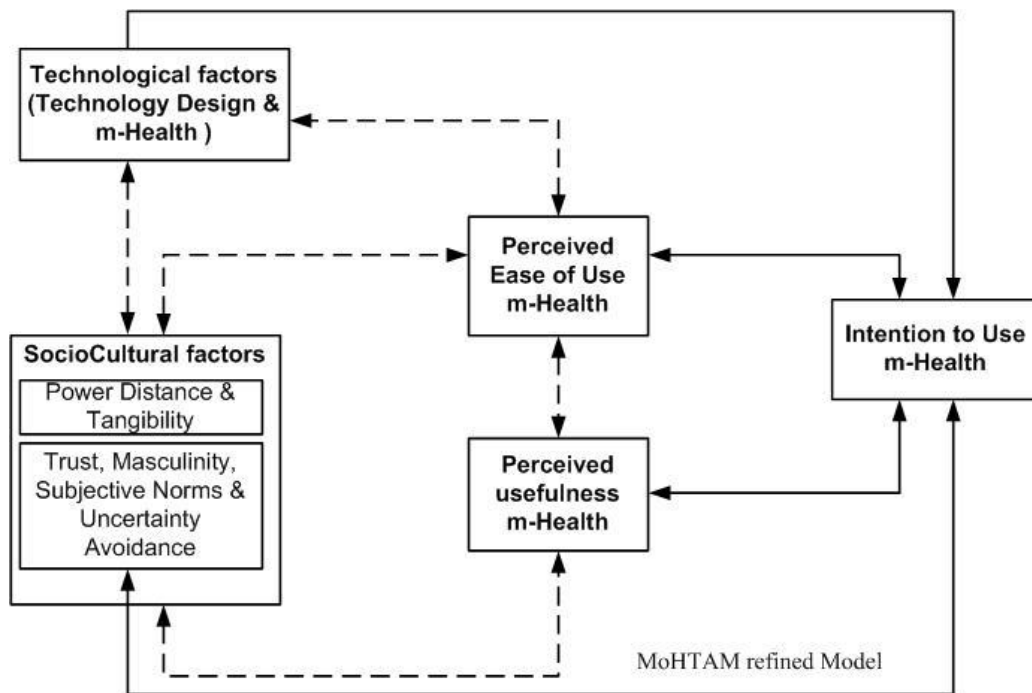


Figure 5: MoHTAM Refined Model

The Cronbach a value of .812 at the standardised items or collectively at .803 addressed the issue of the reliability reported in e-HTAM [1] where Cronbach alpha value was reported at .651.

The model refinement conclusion has been represented graphically in Figure 5.

CONCLUSION

This paper has presented a model for m-Health applications acceptance (MoHTAM) which has adequately explained the concept of m-Health applications acceptance. MoHTAM incorporated social, cultural and technological constructs, and assessed the influence of the characteristic behaviour of the participants sampled and how they affect the perception and the intention to use m-Health applications.

The correlation coefficient analysis indicated that there is a significant relationship between the major constructs. Rigorous analytical testing confirmed that there is a direct relationship between social, cultural and technological constructs with intention to use m-Health applications. The model indicated that a well-informed technology design will increase the intention to use m-Health application, and perceived usefulness is more significant to the intention to use m-health applications than the perceived ease of use.

The Mo-HTAM study concluded that intention to use mobile health informatics is formed by the perceptions of the user of m-Health technology design approach, especially the navigation and the data presentation on the mobile device. The reliability and consistency test indicated that MoHTAM is a very reliable model.

Future work will use the knowledge learnt from this questionnaire research to design a well-informed mobile health application, which will allow the model to study the gap between the intention to use m-Health application and

the actual system use of m-Health applications in the medical domain.

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