

MHealth for Decision Making Support: A Case Study of EHealth in the Public Sector

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Abstract—This paper seeks to explore factors that determine the acceptance of the MHealth application patients. The research relied on (UTAUT2) Unified Theory of Acceptance and Use of Technology to assess the level of acceptance of a new mobile health application by patients. The study involved conducting test surveys across medical hospitals in Jordan with the goal of collecting data from hospital visitors and their patients concerning their intention to use the new mobile health application. 98 questionnaires were collected and 44 valid responses drawn from them for onward data analysis. The UTAUT2 research model was the most appropriate one for conducting the evaluation on MHealth's user acceptance. Its results would support the government's goal of building m-health solutions that meet user needs. The model also enhances the roles of DSS in facilitating adoption of MHealth applications. This study provides a theoretical framework for pursuing future research work on the rates of adoption of m-health applications by patients.

Keywords—Mobile health application; UTAUT1; UTAUT2; trust factors

I. INTRODUCTION

Mobile technology is growing rapidly [1][2], prompting more healthcare organisations to consider mobile health technologies to be a feasible solution for monitoring patients' status. This development has formed the possible for converting healthcare system supply into a more available, reasonable, and active form [3][4][5]. The electronic health system (e-health system) used in the traditional setting are faulted for their reliance on wired connections and computers. As an improvement, mobile health uses wireless cellular communication to achieve mobility and flexibility [6][7]. It also has the advantage of portability and long-life battery power. Due to their mobility, portability, and flexibility of mobile technologies, they are preferred over traditional systems when seeking to enhance access to healthcare services. They also help to reduce the costs and time incurred in delivering healthcare [8]. These systems may also be used to create motivation amongst healthcare professionals to stick to professional habits by reshaping [9][10]. Mobile health system is gaining increased prominence as a favoured technology on health communication. Its importance goes beyond more communication by including aspects such as management [11], facilitation and delivery of health information through monitor, cell phones, wireless infrastructure, tablets, and sensors. Mobile healthcare technologies include many healthcare services and

applications such as site-based health services, mobile telemedicine, and pervasive information access to healthcare systems, and patient monitoring [12][13] [14]. They bring great benefits to both patients and physicians.

In addition the potential financial and medical additions of mobile health service area, the implementation of the use of MHA opposite tasks and walls at the social, technological, culture, governmental and governmental points, particularly in developing nations [15] [16] after interviews with Patients and reviewers and health organizations there are several barriers. one of the key notes that we observed is the lack of the cognizance about mobile health applications (MHA) [17][14], facilities and its benefits. Second, there are concerns with act of application. Third, patients do not neediness to change the routine of providing healthcare system, equal with the probable assistances of mobile health app [17] [18] [19]. Several patients sense that physicians are so busy and do not have period to use the app to follow up and remotely display them. Fourth, there is a unlimited mission with respect to the belief, extra than one patient do not belief any administration system.

Lastly, it is hard to accept mobile health app without there is community acceptance also official support. The acceptance of mobile health system depends on several factors beyond the technology's skills. These issues include the willingness of the patients, health professionals, and care contributors to adopt embrace new technology [20][21][22][23][24]. To some extent, it also depends on the level to which the management will provide the necessary support. It is vital to remember that any role of DSS is to help support the aims of the healthcare organizations.

When creating m-health system, an institution needs to have information on the potential for its users' acceptance. In this regard, they need to rely on proper research on the established factors that influence users to adopt or reject new mobile healthcare technology [25]. This is especially important in the modern healthcare setting, as most hospitals strive to encourage the public and their staff to embrace new interventions for health promotion as a way of reducing healthcare costs and enhancing the overall health standards.

The researchers from several disciplines have been reviewing computerized DSS for around 55 years [26][27][28]. DSS frameworks can be distributed into five types including: first-Model(driven DSS), second(Data-driven

DSS) [29][26], third Communications (driven DSS), fourth Document (driven DSS), fifth Knowledge (driven DSS).

- Model driven DSS emphasize admission to and handling of economic, or simulation models. Model-driven DSS use incomplete factors delivered by decision makers to assistance decision makers in investigating a state. Academics motivated on model management and on improving further diverse styles of models for use in DSS such as optimization, and simulation models.
- data-driven DSS give emphasis to admission to manipulation of a time series of internal establishment data and at times external , real-time data. Simple file systems accessed by query and recovery tools provide the most basic level of functionality.
- Communications-driven DSS- use system and communications technologies to enable and communication. In these systems, communication technologies are the dominant architectural factor. Tools used contain groupware. In overall, groupware, bulletin boards, audio and videoconferencing.
- Document-driven DSS- usages handling technologies to deliver document retrieval and analysis. Vast document databases may hold scanned documents, images, sounds, and video. Cases of documents that might be accessed by a document-driven DSS are rules and techniques, product specifications, corporate historical documents.
- Knowledge-driven DSS- can propose actions to managers. These DSS are person-computer systems with intensive problem-solving expertise [30][31]. The expertise involves of knowledge about an exact domain, considerate of problems inside domain.

A. Review of Decision Support System in Healthcare Sector

There are two main areas for making primary decisions in the healthcare setting. The first lower level area has to do with

diagnosis and treatment, patient management, finance management, inventory and record keeping The second higher level area is meant to position the healthcare facility in a competitive place relative to its competitors [32]. In this area, some of the functions handled include patient management and inventory management. This second higher level of decision making is mostly meant to benefit shareholders, while the lower level decisions is mainly targeted to improve the work of nurses and doctors. An example of a decision support system in the healthcare setting is the PRODIGY [33]. This DSS allows healthcare professionals to access evidence and knowledge on disease symptoms and conditions when delivering primary healthcare [34]. PRODIGY is an acronym for Prescribing Rationally with Decision support In General Practice Study. The system provides full text guidance, drug information, patients information leaflets, self-help contacts, and quick reference guides to pharmacists, nurses and patients. Other important information maintained by PRODIGY include finance information such as accounts receivable, track billing, accounts payable and payroll; patient insurance policy, insurance payment options, and insurance claims.

MedSphere also offers decision support systems that have various modules [35][10]. Their systems have modules that are integrated to deliver a comprehensive functionality. They capture important information on the patient's billing as they move from registration, diagnosis, prescription, admission and discharge. It also has modules for handling collection processing, Supply chain management, and other features. It gives instantaneous view on the financial state of the hospital at any given time [7]. DSS supports patient diagnosis, as it displays patients' background information and provides clinicians with knowledge on symptoms for various health problems and their recommended treatment processes [36]. As showed in Fig. 1, clinician can use DSS to determine proper drug usage, diagnose the health problem of a patient, and send reminders to other staff to administer drugs to hospitalised patients on time. Another example of such a DSS is known as Isabel. This system has a database of medical records for patients which are accessible over the web.

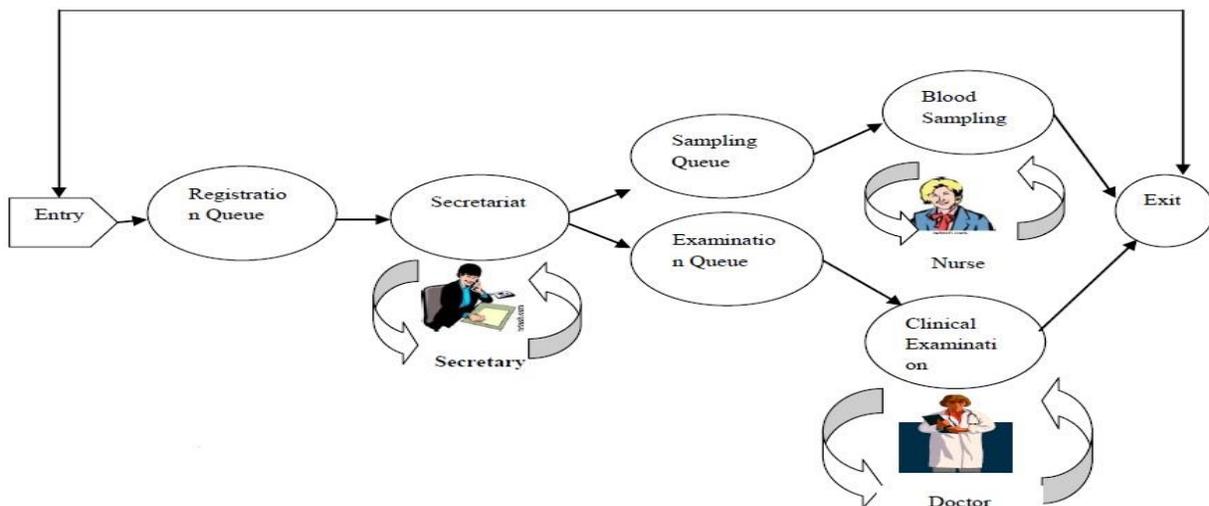


Fig. 1. DSS Progress Example [27].

II. LITERATURE REVIEW

A. UTAUT1

More research has been conducted on the technology acceptance models. Different models and theories propel these studies. The researchers of UTAUT model have identified and harmonized 8 different models and theories that form a comprehensive acceptance model. These theories are [11], [37]: Social Cognitive Theory-SCT-, Technology Acceptance Model -TAM-, Motivational Model -MM-, Theory Reason Action TRA-, and Theory of Planned Behavior- TPB, Innovation Diffusion Theory -IDT.

The unification of these studies make a summation of all the constructs from the eight models into four different determinants which help in predicting the usage, the intentions, and the specific moderators of all important relationships (Morris et al., 2003) [38]. Fig. 2 makes an illustration of the relationships inherent within the UTAUT [13][39]. This model is composed of 4 exogenous variables (EV) that are namely; performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC) and social influence (SI) [39]. These exogenous variables are mainly used in technology intention to the behavior and usage. Among these exogenous variables [38][37], there are four moderators which include age, gender, experience and voluntariness.

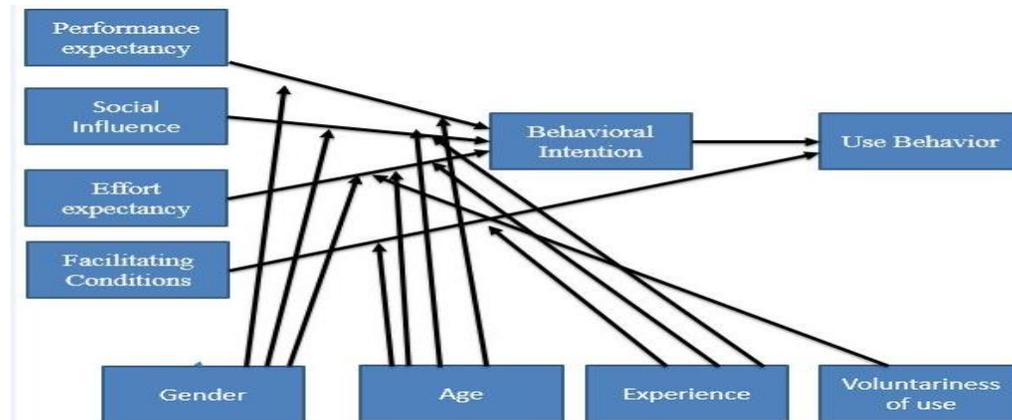


Fig. 2. UTAUT1 Model.

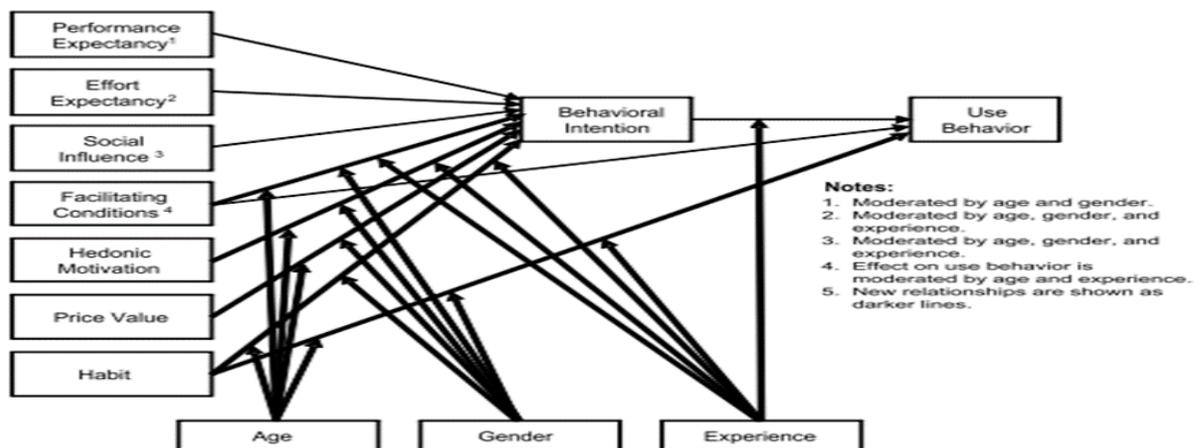


Fig. 3. UTAUT 2 Model.

B. UTAUT2

The study has extended the unified theory and the technology model by examining how technology is used and accepted by consumers as shown in Fig. 3. The goals of UTAUT2 align with those of UTAUT1 and the concepts of HM, PV and HT[40]. According to this study by Venkatesh, the user's demographic characteristics became the moderator variables[41][1][40] They included experience, age, and gender; and how they affected technology use.

C. Hedonis Motivation (HM)

It is described as the intrinsic motivation of a user of technology [42][43][13]. It is considered critical in constructing a model to determine use and acceptance of technology. HM can be compared to playfulness or the user's enjoyment of TAM as a factor that has intrinsic value.

D. Price Value (PV)

People are known to choose the products and services that benefit them more than price value. As such [44][45], one can define price value as conscious trade-off that people make between the money costs of acquiring a new application and the perceived benefits that they would derive from the application.

E. Mobile Health Application

EHealth-related information can be collected, stored, and exchanged effectively through a range of tools provided through various information and communication technologies (ICTs)[3]. Healthcare can harness these technologies to enhance their level of safety, quality and cost performance. MHealth is considered as one of the key applications in healthcare delivery, as it combines several functions such as telemedicine, electronic prescription, test ordering, emergency information and digital imaging. These elements help the healthcare professionals to obtain medical evidence in a reliable manner. Such evidence supports the healthcare organizations in delivering their clinical mandate. MHealth

application also enhances service delivery and organisational efficiency in the healthcare setting. Different healthcare stakeholders such as professionals, patients, general public and organizations can use the MHealth application[46]. Different studies indicate that MHealth applications bring great benefit to patients. One such benefit is that it raises the quality of care by providing easy access to important health data that a patient may need from different health service providers. Most MHealth applications are also modelled to support disease management programs that bring great benefit to patients.

Table I summarises related studies on the topic of user's intention to adopt new MHealth applications.

TABLE I. MHEALTH APPLICATION REVIEW

Author	Description	Origin	Method, sample size	Model	Results
[19]	Examines the user adoption of a new tablet application that aims to provide support for cognitive stimulation for the elderly	Paris	, survey , 15 senior users	Cognitive Therapy	good acceptability of the app's games that continues and improves with time
[47]	Applying an Acceptance Model to assess the adoption of M-Health Services by health related users in UAE	UAE	Survey , 144	(TAM)	model. PU, PEOU, TR and SE found directly influencing the intention to use M-Health system
[9]	Achieving privacy and security in MHealth applications	USA, EU	Review and Recommendations	Review and Recommendations	
[16]	Assessing the current state of the art in mobile health-related and clinical apps	USA, Europe,	brief survey of evaluation studies	evaluation, regulation and certification, quality	Interactions may require substantial effort.
[48]		Developing Countries	CASE STUDY	capacity for improved access	RECOMANDATIONS
	consumer's acceptance of mobile technology	Egypt and Yemen	302 survey	(TAM)	Positively Resistance to change, Technology anxiety factors
[12]	Creating a summary of 7 strategies for conducting evaluation and selection of health-related apps:		Interview .1	Case study	
[26]	Developing and performing user evaluation for a mobile DSS running on iOS known as OphthalDSS	Spain	Survey, 50 physicians answered	Quality, Ease of Use, Availability, Performance	Positively Quality, Ease of Use, Availability, Performance

III. RESEARCH METHODS AND RESULTS

A. Pilot Study for MHealth Application by UTAUT2

Quantitative research methods were used for primary research in this study. This approach helps to generate contextual information on user acceptance for MHealth applications across Jordan. It will also give background information on the use of UTAUT2 in the assessment of user acceptance for new technology [34][49]. The research will also use a correlational study design to determine whether the conceptual model has any relationships that can be interpreted as independent variables and dependent variables [6]. The

section below describes the detail of the phases used in the study. 9 constructs from the technology acceptance model were measured using 32 items by following the guidelines UTAUT2. The study also involved the collection of the necessary demographics on the number of users that had embraced the new M-health application across Jordan. The demographics were intended for use in comparing different levels of user acceptance for MHealth applications in hospitals across Jordan [50]. The study recognised that the adoption of information technology is largely connected to most business activities and services.

TABLE II. SAMPLES DEMOGRAPHIC

Variable	Description	Frequency	Percentage
Gender	male	28	63.6 %
	Female	16	36.4%
Age	21-30	6	13.65
	31-40	14	31.80%
	41-50	20	45.50%
	51-60	4	9.10%

TABLE III. VARIABLES

Variable Group	No. Items	Item	Min	Max	Mean	Std. Deviation
Performance expectancy	4	I would find MHEALTH (useful) in my job	2.00	5.00	4.0554	.89853
		Using MHEALTH (increases) my chances of achieving things that are vital to me	2.00	5.00	3.5455	1.22386
		Using MHEALTH aids me accomplish things more rapidly.	1.00	5.00	3.8081	.97145
		Using MHEALTH in my job	2.00	5.00	3.6818	1.39340
Effort Expectancy	4	Learning to operate MHEALTH app would be relaxed	1.00	5.00	3.8081	1.30600
		My interaction with MHEALTH app is clear	1.00	5.00	3.7708	1.42716
		I find MHEALTH app easy to use	1.00	5.00	3.5455	1.40500
		It is relaxed for me to develop expert at using MHEALTH application	1.00	5.00	3.7702	1.46828
Social Influence	3	Persons who are significant to me reflect that I should use MHEALTH application	1.00	5.00	3.2044	1.21052
		Persons who effect my behaviour think to use MHealth application	1.00	5.00	3.2201	1.27920
		Persons whose views that x value select that I use MHEALTH application	1.00	5.00	3.6601	1.16217
Facilitating condition	4	I have the resources essential to use MHEALTH	1.00	5.00	3.5909	1.05375
		I have the knowledge needed to use MHEALTH	1.00	5.00	3.9545	.89853
		MHEALTH is compatible with other tools I use	1.00	5.00	3.5213	1.00755
		get help from experts when I have problems using MHEALTH application	1.00	5.00	3.4440	1.29685
Hedonic Motivation	3	MHealth application is so fun.	1.00	5.00	3.0114	1.42413
		MHealth application is so enjoyable	1.00	5.00	3.0124	1.31590
		MHealth application is so entertaining.	1.00	5.00	2.8541	1.46311
Price Value	3	MHEALTH application is judiciously priced	1.00	4.00	3.4471	1.21677
		MHEALTH application is a not bad value for the money	1.00	5.00	3.8854	1.46015
		existing price, MHealth application provides a respectable value	1.00	5.00	3.6547	1.54863
Habit	4	use of MHEALTH application has become a nice and habit	1.00	5.00	3.4401	1.09801
		I am addicted to using MHealth app	1.00	5.00	3.8801	1.13294
		I must use MHealth app	1.00	5.00	3.3182	1.21052
		Using MHealth app has become natural to me	2.00	5.00	4.0014	1.15470
Behaviour	3	I plan to remain using MHealth app in the future	1.00	5.00	3.2014	1.17422
		I will continuously try to use MHealth app in my daily life	1.00	5.00	3.8824	1.34277
		I plan to continue to use MHealth app frequently	1.00	5.00	3.7547	1.24924
Intention to use	3	I frequently used MHEALTH app to understand health problem	1.00	5.00	3.4401	1.24924
		I often use MHEALTH app to serve patient	2.00	5.00	3.8792	1.21677
		I often use MHEALTH app to establish information about health issues problem	2.00	5.00	3.8821	1.20317

TABLE IV. CRONBACH ALPHA

Variables	N of (Items)	N of delete (items)	Cronbach C Alpha A(CA)
Performance P expectancy E (PE)	4	0	0.91
Effort Expectancy(EE)	4	0	0.901
Social Influence(SI)	3	0	0.875
Facilitating condition(FC)	4	0	0.876
Hedonic Motivation(HM)	3	0	0.952
Price value(PV)	3	0	0.932
Habit(H)	4	0	0.876
Behaviour(B)	3	0	0.941
Intention to use(IU)	3	0	0.917

The study identified 8 important success factors that researchers need to look out for when using the UTAUT2 model. These include Hedonic Motivation, Performance Expectancy, Social Influence, Effort Expectancy, Price Value, Habit, Facilitating Conditions, and Behavior. In light of this model, the researcher sought to use the Acceptance and Use of Technology approach to assess the perception that hospital visitors and patients have about the use of MHealth applications. More than 70 users participated in the survey that sought to examine their intention to use MHealth applications. The users were drawn from two major hospitals across Jordan[51][7][43][52]. The total number of valid responses collected from the survey was 44. This information is presented in Table II. Most of the valid responses were submitted by women (63.6%) rather than men (36.4%). Table III presented the min and max and mean of valid variables. And Table IV showed the Cronbach Alpha values.

B. Reliability Test

A reliability test was conducted in this study to measure the validity or acceptability of the measures. Cronbach's alpha test was used to determine the degree of internal consistency in the data. It sought to ascertain that the data used in the study had an appropriateness value of above 0.7 (Sekaran 2003). The results in this test indicate that the data met the basic threshold for internal consistency and the other factors used in the study were reliable.

IV. CONCLUSION AND LIMITATION

More developing countries continue to adopt m-health applications as a critical technology that would drive a positive change in their healthcare services delivery approach. It is required to know the questions that affect related health users to approve or reject mobile health system. This research presented a model for MHA acceptance founded on UTAUT2 and explored the rationale of technology adoption for users in the mobile health system. This model united cultural, social, technological, political, and structural sides. DSS is important in conducting medical diagnosis, as it documents information on health problems and patients' background information that can be used by clinicians to quickly identify a patient's specific ailments. Limitation of this study this study have been conducted in two Jordan hospitals only. Researchers only measured trust factors and UTAUT factors. This sets a foundation for future research on patients' adoption of MHealth applications.

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