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Factors affecting acceptance and adoption of mobile health application (MHA)

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Abstract—*Health systems using modern Technologies i.e. Mobile Health Application (MHAs) have a deep impact on the standards of hospital services and reducing healthcare costs. The use of MHA in a society is directly proportional to the awareness and education of the society. The factors that affect MHA acceptance has been analyzed in this study usingUnified Theory of Acceptance and Use of Technology (UTAUT) framework[1]. The UTAUT model is a new tool for evaluating the integration/adoption of MHAs. We tend to formulate the propensity to using the MHA system and behavioral exercise of healthcare professionals using empirical studies and the use of the UTAUT2 model. Trust of data most important in health sector, themain aim of this research is to check and test the factors which effect the assimilation and acceptance of the MHA by the healthcare providers. The target area of this research is Jordanian hospitals using MHA. The data used in this research is gathered from healthcare professional working in hospitals of Jordan using MHA. The work presented in this research gives a clear view of which elements effect the acceptance and adoption of MHA[2][3].*

Keywords – *Mobile HealthApplication, e-Healthcare,*

I. INTRODUCTION

The Mobile Health Application (MHAs) is the collective body of diverse info instruments, which include: test systems, e-prescription, emergency management, Decision Support Systems (DSS)[4][5], digital imagery and telemedicine), that should have positive impact on healthcare professional's decision-making processes. Through the integration of the MHA, daily hospital operations and practices could be safer. A review of literature proves that there are many benefits of MHA for the patient Benefits include, increased quality of health care, due to easily accessible healthcare-related data, this could significantly improve coordination among healthcare professionals[6], positively increase efficiency of primary health care, empower and encourage patient's active participation in decisions relating to health care [7][3] and may be used for proper transfer of Data on suggested precautionary health care, through primary-care channels [5][8]. Moreover, it is a device which encourages technology transfer and knowledge exchange, as well as help in the decision making based on up to date Data about its patients [9]

II. CURRENT KNOWLEDGE OF MHA ACCEPTANCE

MHA is usually implemented in a lot of high-income countries. An example of which is the "USA Institute of Medicine", which described theMHA as "an important technology" for "eHealth" [3]. Despite this, however, MHA is still not as widely accepted even by healthcare professionals practicing in the US,Canada and United Kingdom [6]. An increasing number of studies on MHA and acceptance shows that integration projects are often withdrawn soon after the research stage. Common causes associated with the low acceptance of MHA

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include lack of initial/start-up funds, lack of monetary benefits, subpar technology, non-prioritization, and even opposition from healthcare providers and professionals.MHA integration and acceptance needs large capitalization and investment in time and effort, but the radical change to hospital work and service is clear [9]. The impressions on the MHA usually vary between health professional groups, which makes MHA's acceptance by the medical community even more complex within a pluralist eHealth regime.

III. RELATED WORK

A. The Unified Theory of Acceptance and Use of Technology (UTAUT)

For two decades, researchers held seminars and lectures to encourage acceptance. Several models and theories have been used to forward these studies in different locales for various areas of the study[9],[10]. The findings and conclusions from these studies differ. Proponents of the UTAUT model uniformed eight theories which is namely: Technology acceptance model (TAM), Theory of reason Action (TRA), Motivational model (MM), combined TAM and TPB (C-TAM-TPB), Theory of planned behavior (TPB), Model of PC Utilization (MPCU)[11], Social Cognitive and Innovation Diffusion Theory (IDT) Theory (SCT) Bandura (1986). The UTAUT adds up different sides of all the concepts from the above-mentioned theories into four elements, which says that intention, usage, and four (4) key constructs are the key factors to their interrelationships [10]. Figure 1 display the dynamics of the UTAUT model. The UTAUT Model forms four constructs, namely: Social Influence (SI), Effort Expectancy (EE), Facilitating Conditions (FC) and Performance Expectancy (PE)[12]. Certain studies under the UTAUT model also consider Endogenous Variables (EV)[13], which refer to those which influence behavior and intent to use the technology[14]. There are four other factors to consider, namely: age, experience, gender, and voluntariness. PE means the degree by which an individual considers the benefit and performance of the technological system[15][16]. The degree by which the MHA system can be easily used is a key factor and indicator, which plays a role to figure out the "Behavioral Intention to use" technology and its EE. A person's perception of how important a new system is functioning as a significant indicator to determine technological intention to use[17][18]. Means the propensity to believe that the technology will play a vital and effective function in the organizational and technical structure[19].

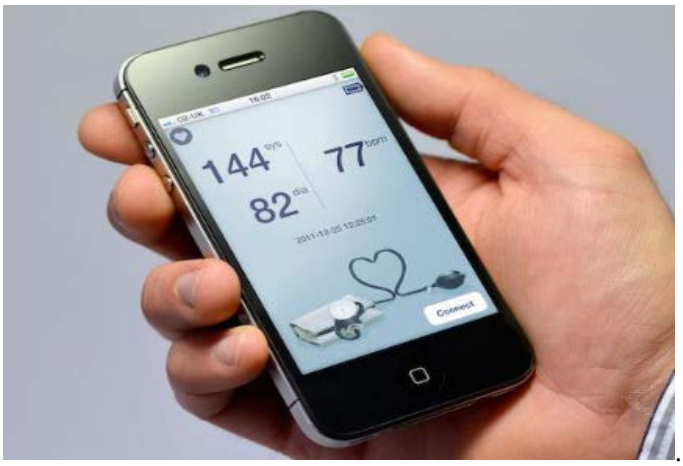

Figure 1: Mobile Health Application example

Employing the UTAUT model in this study is justifiable and sensible due to its worldwide and integrative features, which incorporate a multitude of explanatory variables from the primary theoretical models used in

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analyzing and defining technology acceptance and use. More specifically, [10] it involves an exhaustive analysis of relevant works and proposes an amalgamated framework which combines the public influences on the core concepts[20]. Thus, we can surmise and expect that such theory which employs and adopts such contributions from other models will be the better choice for analyzing and defining technology acceptance and use [9][21].

B. UTAUT2

[4] Advances the UTAUT, to accurately analyze adoption and usage of technology from a buyer's point-of-view. It introduces three new concepts, namely Hedonic Motivation (HM), Price Value (PV) and Habit (HT)[22][23]. Demographic attributes of users were also considered, namely: experience, age, and gender, which may affectBehavioralIntention (BI) and use of technology. Findings were obtained from the employment of 2-pronged web-based surveys. It took four months to collect 1,512 responses. As compared to UTAUT, the added factors considered in UTAUT 2 resulted in a greater variance in BI.

1) Hedonic Motivation (HM)

The motivation obtained by getting fun, enjoyment, or pleasure from the use of technology is called hedonic motivation. It is considered as key concept to define technology reception and usage. HM is akin to Perceived Enjoyment[24], and “playfulness” is like TAM, in functioning as an element of intrinsic motivation[25]

2) Price Value (PV)

Generally, people choose to avail the products/Data if they see that the benefits derived therefrom are greater than the actual cost of purchasing the product/data, this is known as price value. It can be further defined, in the context of the theory[26], as learner’s mental exchange between the economic cost and paybacks of using the technology[27],

3) Habit (HT)

Habit is considered as a robust indicator of upcoming technological use [14][28]. Habit is characterizing as the degree by which persons are inclined to actin a routine like a manner

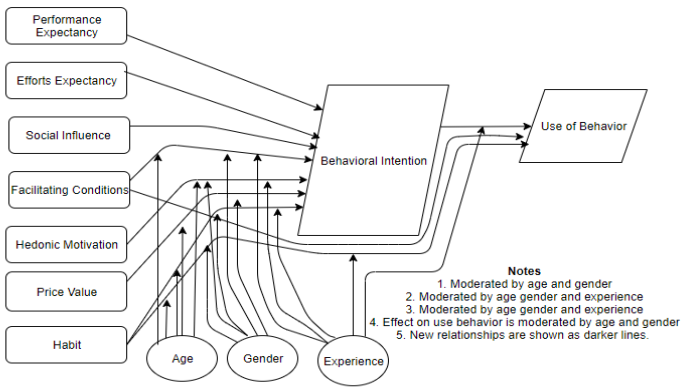

Figure 2:UTAUT (2)

Data and Communication Technologies (ICTs) include an assortment of beneficial implements for collecting, storing, and exchanging eHealth-related data [1][29]. Thus, there is proof that ICT can advance quality, security,

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and cost-efficiency for processing of healthcare data. The Mobile Health Application (MHAs) is considered essential for effectively employing ICTs within the healthcare community. It gives way for the amalgamation of innumerable medical orders[30], and procedures (e.g. electronic prescriptions, emergency data, ordering of tests, telemedicine, digital imaging, etc.), which can streamline Data collection, storage, and processing, and greatly improve on the decision-making of hospitals. The use of such Data is essential in daily clinical practices, and this can be improved and made more efficient using MHA [38][31]. There are high hopes and expectations that patients, healthcare professionals, organizations, and the general public will receive help from the use of MHA. A review of literature proves the many benefits of MHA for patient [15][32].

A primary benefit cited is the improvement in “quality of care”, after the patients and their health care providers could access their relevant health data. [16][7].

Through relevant disease management programs [17], the MHA can help and empower citizens to actively take part in the decision-making process for policies concerning health.

The MHA helps in knowledge exchange and technology transfer, as well as in the decision-making process of and amongst healthcare specialists by giving access to germane and up-to-date Data of their patients[4][33].

C. Trust and technology

Technology and computer innovations have changed the face of globe. Technology is massively used in the Data and communication zone especially in knowledge transactions[34],[35].[25]Technology is directly related to the progress and prosperity of a country[36]. It changes the life style of many societies and has a great impact on human life. Technologies weather its online or offline has their own importance.

Figure 3: Trust in Digital Technology

The online technology plays a role of intermediate in some industries. People are taking help from technology in every field of life i.e. as a tool for studying, doing online jobs, online marketing and bridging the borders[37][38]. Therefore, it is concluded that technology is fixed with human life in majority of activities. In recent years'e-commerce, e-health and e-government which is called Internet of Things (IoT) in the language of IT gain very much attention from researchers. Dueto technologya lot of human resources are saved and ease in working is produced, that motivates many researchersto uncover the elements that play critical role in technology acceptance[39][40][32].

IV. The Contribution

Trust in data(TD)

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Trust in Data (TD) signifies the level of trustworthiness of Data acquired entrenched in online milieu. Chopra and Wallace (2003) classified TI as a significant trust found in e- environments, mainly apparent via Data quality indicators, for example, accuracy, currency and coverage[41]. The quality attributes of e-government systems Data provision as utmost important in the development of trust in e-health. In addition, the quality of Data is an important and meaningful determinant towards the readiness to utilise e-government services. Hence, trust in MHA system will rely mainly on the trust, which the user is able to show in the Data that is accessible to them.

V. Dimensions

The dimensions of (TD) emphasise on:

i. **Data Reliability:** To validity, completeness and reliability of Data provided.
ii. **Data Adequacy:** The adequacy of Data provided which is drive-specific.
iii. **Data Relevance:** The relevancy of Data provided which is purpose-specific.
iv. **Data Understand ability:** The comprehensibility of the Data provided.
v. **Data Accuracy:** The accuracy of Data provided.
vi. **Data Currency:** The currency of Data provided.

TI plus its dimensions are enabled via suitable Data architecture, which is sustained, by incorporating Data as well as database systems. For Data to be trusted, its consistency across the board in every government agency system is a mandatory requirement. Specifically, in targeting for the achievement of validity and reliability in the Data availed, supplementary technical processes and measures accuracy and currency of Data are necessary. These implicate the engagement of Data quality control measures in the MHA system, which are uploaded manually, derived from other systems. The standard system assures validity, completeness and accuracy of data. in addition to this, Data currency could be tracked by enforcing systems in the form of timestamps to determine the last modification made. Data adequacy, relevance and comprehensibility, which are other trust dimensions in data, are more personal and reliant on user perspectives. Furthermore, a suitable interface design and arrangement of Data will establish these dimensions. Ultimately, the constant screening and evaluation on the quality of Data will promote the progress in trust of data.

VI. Research Hypothesis

MHAs and UTAUT2

The UTAUT model has been used widely for analyzing and forecasting MHA espousal and approval. This is presented in Table 1. In the case of the Jordanian Hospitals, the staff of hospital will likely find the MHA system helpful and useful. It can help them to execute their tasks and responsibilities effectivelyand efficiently. PE, EE, Social Influence, HM, PV, and HT will have direct effects on the BI to use of MHA, by medical professionals and staff. Consequently, higher levels of intention of use will result in increased adoption of the MHAs. H1. Performance expectancy is correlated with a positive manner to utilize the MHA System. H2. Effort expectancy is likewise correlated optimistically to BI of the MHA system. H3. Similarly, positive social influence means it will be more likely that the MHA system will be adopted. H4. The same rings true for facilitating conditions. H5.

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Hedonic motivation is certainly linked for with the aim of using MHA system. H6. Price value is also correlated in a progressive manner to the propensity to use MHA system. H7. Likewise, Habit positively influences BI to use MHA system. H8. Trust in Data is particularly associated for using the MHA system[42].

VII. DATA ANALYSIS AND RESULTS

SPSS version 18 and SMART-PLS 2.0 is used for statistical analysis is in this research. The resultis comprised of nine major sub-sections.

D. General statistics and Frequancies

The table 1: represent the general statistics of all demographic variables like gender, age, education level etc.

Table 1: sample profile

Group	Frequency	Percentage
Gender		
Male	69	25
Female	209	75
Age-groups		
< 35	77	27
= > 35 < 50	107	38
> 50	94	34
Education level		
Master or PhD	15	5
Degree	138	49
Diploma	115	41
Secondary school or below	10	3
Type of Hospital		
Princess Badeah	178	56
Princess Rahmah	130	44
Function		
Physician	12	4.
Nurse	174	63
Pharmacist	18	6
Laboratory	20	7

Over 378 received questionnaires, 209 responses were received from female (75%) and 69from male (25%) participants. Therefore, females mostly dominated the sample of this study. In determining the age of the respondents, 27.7% of them were less than 35 years, 38.3% are between 35 to 50 years old and 34% of them were more than 50 years old.

The respondents were also asked in the questionnaire to mention their educational level. As a result, 49.6% of them possessed degrees, 41.1% have diplomas, 5.7% have master or PhD level education and 3.5 have secondary school or below.

In specifying the type of hospital, 56% were from Princess Badeah and 44% were from Princess Rahmah. In specifying the profession of the respondents, 63.1% of them were nurses, 19.1% were administrative staff, 7.1% were laboratory technicians, 6.4% were pharmacists and 4.3% were physicians.

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The respondents were questioned abouttheir experience. As a result, 52.5% of them have 3 to 12 months of experience, 34% have 1 to 2 years and 13.5% have above 2 years' experience.

Finally, in specifying the daily use of MHAs, 40.4% used between one to four hours, 29.8% used between four to 10 hours, 22% used less than one hour, and 7.8% used above 10 hours daily.

E. Measurement Model (CFA) –SEM

The ConfirmatoryFactor Analysis (CFA) called measurement model, is used to check whether the construct measure and researcher understanding about the nature of construct are consistent. this model could therefore be characterize in a way which veiled variables are determined in terms of unveiled variable[43]. According to [44]to ensure accuracy operationalization of constructs is a very important step. To assure the theoretical accuracy the authors have adoption ofcertain well-establishedscales.

Although there are a number of scales available in literature still the authors face issue of shortfall of already established scales, they develop their own new scales for to entertain new situations, all these considerations the bases for Reanalysis is in the selection of items to measure the constructs[44].

Each of the construct in CFA model was checked for validity and reliability. The validity and reliability are measured using special test in SPSS called Cronbach's alpha, if the value of this test is less than .70 it is considered that the construct is not reliable if this value is above .70 then the construct is reliable and valid.

The development of measurement model is elaborated in the next section. By using SMART-PLS 2.00. the convergent validity and discriminant validity are tested.

F. Convergent Validity

The results depicted in Table 6 represents the Cronbach's alpha and convergent validity for the measurement model.

Table 2: Results of Convergent Validity for Measurement Model

Construct	Item	Factor Loading	Average Variance Extracted (AVE)[a]	Composite Reliability (CR)[b]	Internal Reliability Cronbach Alpha
Behavioral intention to Use MHAs (BI)	BI1	0.836	0.804	0.925	0.878
	BI2	0.805			
	BI3	0.854			
Performance Expectancy (PE)	PE1	0.866	0.728	0.915	0.876
	PE2	0.843			
	PE3	0.851			
	PE4	0.819			
Effort Expectancy (EE)	EE1	0.839	0.747	0.922	0.886
	EE2	0.840			
	EE3	0.916			
	EE4	0.859			
Social Influence (SI)	SI1	0.836	0.692	0.871	0.777
	SI2	0.805			
	SI3	0.854			

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Facilitating Conditions (FC)	FC1	0.866	0.714	0.909	0.866
	FC2	0.843			
	FC3	0.851			
	FC4	0.819			
Hedonic Motivation (HM)	HM1	0.890	0.767	0.908	0.848
	HM2	0.901			
	HM3	0.835			
Habit (HT)	HT1	0.806	0.618	0.866	0.794
	HT2	0.735			
	HT3	0.806			
	HT4	0.797			
Privacy in Data	TI1	0.806	0.702	0.792	0.862
	TI2	0.735			
	TI3	0.601			
	TI4	0.772			
	TI5	0.806			
	TI6	0.797			

As shown in Table, above all the values of loading factors are above the cut-off 0.6 this cut-off is recommended by Hair (2006) which is 0.667 to 0.916.

Now each of the construct was checked for reliability after the unit-dimensionality of the constructs was achieved. Average Variance Extracted (AVE) is a measure of the amount of variance that is captured by a construct in relation to the amount of variance due to measurement oferror In the table 6 we also show the AVE, its cut-off is from 0.586 to 0.832 defined by Hair (2006) all our values lies in the range. The range for Composite Reliability is from 0.866 to 0.934 recommended by Bagozzi and Yi (1988). It shows the level of which the construct shows the latent our values exceeded the value .06 suggested by Bagozzi and Yi (1988)[45].

The value of Cronbach's alpha or internal Reliability or internal consistency, which refer the degree to which a measure is error-free. It ranged from 0.777 to 0.921 which were above the cut-off of 0.7 as recommended by[46]

Table 3: Examining Results of Hypothesized Causal Effects in Structural Model 2

Hypothesis	Path-Shape	Path - Coefficient	Standard-Error	T--Value	P--Value	Hypothesis-Result
H1	PE BI	0.133***	0.028	5.20	0.000	Support
H2	EE BI	0.088**	0.025	3.55	0.001	Support
H3	SI BI	0.133***	0.027	5.33	0.000	Support
H4	FC BI	0.043	0.023	1.89	0.061	Rejected

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H5	HM BI	0.131***	0.024	5.45	0.000	Support
H6	HT BI	0.125***	0.027	4.69	0.000	Support
H7	TI BI	0.138***	0.025	5.74	0.000	Support

P-value*< 0.05, P-value**< 0.01, P-value***< 0.001

There are seven different paths tested for P-value all the paths such as PE, EE, SI, HM, HT, TS on BIto Use MHAs BI the p-value for all the paths except one were statistically significant as their p-values were below 0.05. Thus, the hypotheses H1, H2, H3, H5, H6, and H7were supported. While there is only one path called FC on BI to Use MHAs (BI) was not found as statistically significant because its p-value lies above the standardized significance level of 0.05. Thus, the hypothesis was supposed to be rejected.

VIII. CONCLUSION

The current study attempted to explore the factors influence the MHAs acceptance in Jordanian hospitals government and the link between trust in data, and Behavioral Intention to use MHAs in Jordanian hospitals and thus it opened the door for the possibility of more research. The most significant contribution of the present study is that to the UTAUT2 theoretical knowledge.

The study's model is an extension of the UTAUT2 model comprising of external factors and behavioral Intention to use MHAs. The findings are expected to improve the theoretical knowledge on the topic particularly its relation to UTAUT2 and the application in the Jordanian health domain. The study also improved the classic UTAUT2 by introducing Trust in Data Factor and behavioral Intention to use based on a social perspective. The present study contributed to the literature concerning health informatics and particularly to the healthcare professional model of MHAs acceptance in the context of Jordanian government hospitals. In addition, the study also contributed to the Jordanian Ministry of Health (MOH) for its invaluable evaluation of the healthcare acceptance of MHAs in Jordanian hospitals or for that matter, in which EMRs use has been mandated. The research outcome can be utilized to improve the existing MHAs and these can be used in the evaluation, utilization, and identification of factors influencing MHAs acceptance in Jordanian public hospitals.

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