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Factors Influencing the Adoption of Clinical Informatics Tools among Medical Doctors in South Africa

Kehinde Aboyami Owolabi[1], Aderibigbe, Nurudeen Adeniyi [2], Evans Neil D[3]

Abstract

The adoption of clinical informatics tools is not encouraging in many developing countries and a better understanding of the factors that influence their integration is expected to promote their effective utilisation. To shed more light on this phenomenon, the study employed the use of Universal Theory of Acceptance and Use of Technology (UTAUT) to identify the factors that influence the use of clinical informatics tools. The study employed a positivism research paradigm anchored on survey research design. Simple random sampling technique was used to select one hundred and five medical doctors in a tertiary hospital in South Africa. Data were collected with the use of a structured questionnaire. Structural equation modelling was used to analyse the data collected. Findings from the study reveal that effort expectancy was related to behavioural intention to use clinical informatics (β = 0.41, p< 0.05). Also, performance expectancy was related to behavioural intention to use clinical informatics (β = 0.47, p< 0.01). The study therefore recommends that the hospital management should create conducive environment that will promote effective use of clinical informatics tools and organise training programmes for effective use of the tools. The study also sees the need for technology producers to make the tools more user-friendly.

Keywords: Adoption, clinical informatics, medical doctors, UTAUT and South Africa

Introduction

The adoption of information and communication technology is a way of accessing the uptake of technology, which is related to acceptance and desire to use technology in a functional organisation (Prince & Lau, 2014). Acceptance in this direction can be described as the realisation and willingness or unwillingness to use information and communication technology (Venkatesh, Thong & Xu, 2012). Use is related to adoption in that it is informed and often preceded by adoption. Various factors promote the adoption of information and communication technology, which include rate of investments in infrastructure development, provision of various motivational incentives to user groups, and effective policies that will encourage usage (Lluch, 2011). Based on this, the adoption of clinical informatics tools among medical doctors is

[1] Principal Librarian, Nimbe Adedipe Library, Federal University of Agriculture, Abeokuta , Ogun state, Nigeria
Email: yomiowolabi2000@yahoo.com

[2] Senior Librarian, Nimbe Adedipe Library, Federal University of Agriculture, Abeokuta , Ogun state, Nigeria
Email: rabshittu@yahoo.com

[3] Senior Lecturer, Department of Information Studies University of Zululand South Africa
Email: evansn@unizulu.ac.za

necessary in promoting effective healthcare delivery. Owolabi, Evans and Ocholla (2016) categorised clinical informatics tools into the following: electronic medical records, computerised physician order entries, computerised decision support systems, and diagnosis imagery archives.

The importance of clinical informatics tools to medical doctors, in decision making, cannot be ignored. However, the successful integration of clinical informatics tools in effective healthcare facilities has been found to depend on the extent to which the tools are acceptable. Nwagwu and Adio (2013) note that the adoption of clinical informatics tools assists medical doctors in making accurate judgment about patients, conducting medical examinations and making diagnoses. The various reasons medical doctors are in need of information were identified by David (2009). These include seeking patients' information, particularly on treatment, medical history and diagnosis methods. It has been observed that adequate and effective healthcare delivery need intensive and efficient information flow between different units and departments in hospitals. Acceptance of clinical informatics tools has a role to play in medical doctors' access to accurate information that will promote evidence-based medicine.

Flynn-Dapaah and Rashid (2010) argue further that clinical informatics tools are increasingly being used in different aspects of healthcare, like healthcare delivery, administration, and communication. For many years, many international organisations, such as Melinda Gate Foundation, Rockefeller Foundation, Rotary International and World Bank have sought to introduce effective access to clinical informatics by donating the tools to many countries in Africa, and encouraging their use in developing countries (Flynn-Dapaah & Rashid, 2010). To achieve this, the World Health Organisation adopted a resolution for clinical informatics and e-Health strategy, in member countries, which led to the establishment of the Global e-Health Observatory, with the mandate to monitor the adoption and use of clinical informatics tools in various healthcare facilities in developing countries (WHO, 2013).

Many factors can be associated with the adoption of clinical informatics tools. Nwagwu and Adio (2013) suggest that access to clinical informatics tools by medical doctors can be examined in three contexts: individual context, technological assessment and implementation evaluation. They further argue that the individual context is related to issues about computer confidence, computer usage, computer anxiety, ICT competency, computer self-efficacy and attitude towards the use of computer. The technological consideration, on the other hand, is about the perception of medical doctors about technology and its role in medical practices; and lastly, the implementation stage refers to professional environment of medical doctors.

Clinical informatics tools are vital means through which doctors have access to relevant sources that aid them to get timely, reliable and accurate information for effective diagnosis and treatment. Clinical informatics tools, in their far-reaching capabilities, have brought many positive changes to the treatment and diagnosis of patients and medical education, due to their roles in the improvement of the quality of healthcare delivery. Odini and Omuoke (2014) acknowledge that many hospitals in Africa are facing a lot of challenges in providing quality, efficient and accessible healthcare to patients because of poor adoption of clinical informatics tools.

However, Ani (2014) notes that African country is known to be poor when it comes to the acceptance of ICT infrastructure and that ICT infrastructure is least developed in their hospitals. This shows that hospitals in African countries have inadequate acceptance and use of clinical informatics tools compared with developed countries. Owolabi, Evans and Ocholla (2017) argue that poor acceptance of clinical informatics tools has led to high increase in medical errors.

Makary and Daniel (2016) reveal that 142,000 people died worldwide, in the year 2013, due to medical errors, compared with 94,000 recorded in 1990. In another study conducted in the United Kingdom, it was estimated that 850,000 medical errors occur annually, which cost over £2 billion (Edwards, Felix, and Lambert, 2010).Extant literature indicates various causes of medical errors to include poor adoption of clinical informatics tools (Turusa & Coleman, 2018). Africa is lagging behind in healthcare services. For example, life expectancy at birth in year 2017 was 54 in Africa, 66 in Eastern Mediterranean and 75 in Europe (Center for the Study Intelligence, 2017). Much of this gap, which has widened, is partly a consequence of the poor adoption of clinical informatics tools in healthcare facilities (KPMG, 2018).

Research objectives

The broad objective of the study is to examine the factors influencing the adoption of clinical informatics tools among medical doctors in South Africa. To achieve this objective, the following specific objectives have been pursued:

(i) To determine the influence of facilitating condition on the adoption of clinical informatics tools among medical doctors in South Africa.
(ii) To find out the influence of effort expectancy on the adoption of clinical informatics tools among medical doctors in South Africa.
(iii) To determine the influence of performance expectancy on the adoption of clinical informatics tools among medical doctors in South Africa.
(iv) To identify the influence of social influence on the adoption of clinical informatics tools among medical doctors in South Africa.

Research hypotheses

This study investigates factors affecting the adoption of clinical informatics tools among medical doctors in South Africa. Adopting the original UTAUT model developed by Venkatesh, Morris, Davis & Davis (2003), the study considers facilitating condition, effort expectancy, performance expectancy, social influence and behavioural intention as the main variables in assessing factors affecting the adoption of clinical informatics tools. The model showing factors affecting the adoption of clinical informatics tools is shown in Figure 1:

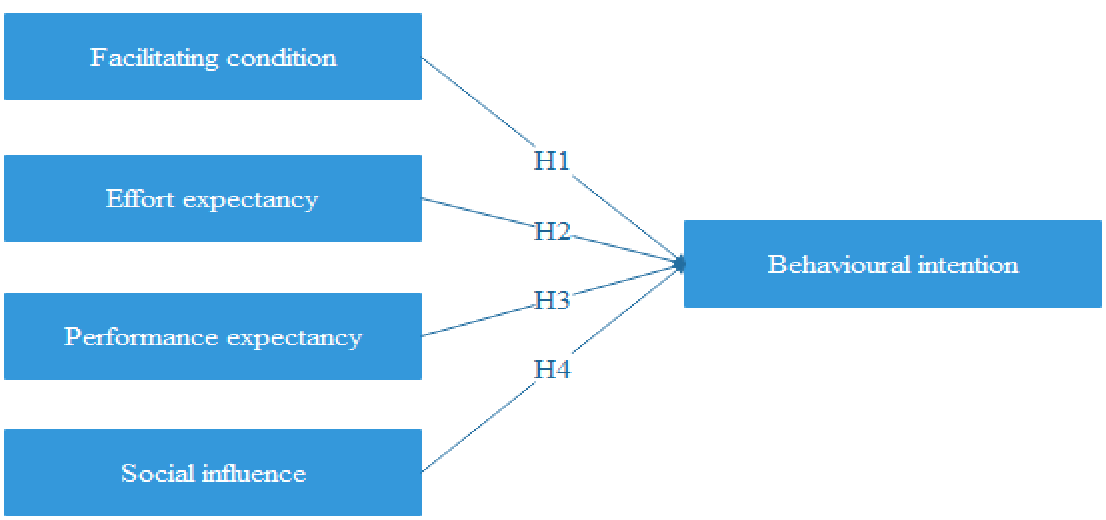

Figure 1: Adoption of clinical informatics tools model.

H_1. Facilitating condition will not positively influence the adoption of clinical informatics tools among medical doctors in South Africa.

H_2.Effort expectancy will not positively influence the adoption of clinical informatics tools among medical doctors in South Africa.

H_3.Performance expectancy will not positively influence the adoption of clinical informatics tools among medical doctors in South Africa.

H_4.Social influence will not positively influence the adoption of clinical informatics tools among medical doctors in South Africa.

Literature review

Various studies have revealed the position of clinical informatics tools adoption in both developed and developing countries. Verbeke, Karara, and Nyssen, (2010) for example, note that many doctors in hospitals in Africa, lack access to clinical informatics tools. It has been observed by Bean, Davis and Valdez (2013) that there are many factors that contribute to the gaps in the adoption of clinical informatics tools by medical doctors. Some of these problems are: nature of hospitals, computer skills and environment.

The United State of America's Department of Health and Human services note that, adoption of clinical informatics tools is a means to improving the health and healthcare of the underprivileged (Moududdin & Moore, 2008). This suggestion is based on the department's discovery that, the adoption and use of clinical informatics tools provide medical health information. Kommalage and Gunawardena (2008) compare clinical informatics tools adoption between developed and developing countries and the result reveals that developed nations have invested more in integrating the tools into their healthcare systems than the developing countries. This makes it possible for their medical doctors to have access to latest clinical informatics resources.

Olasina and Popoola (2014) report a survey of medical doctors' adoption of clinical informatics tools in America, Europe and Asia. The survey reveals that 80% of healthcare facilities had adopted the use of various types of clinical informatics tools. Houshyar *et al.*, (2012) report that at Vienna Medical School, 94 per cent of medical students had adopted computers for medical use. A study carried out in New Zealand and Denmark reveals that 99% of medical doctors adopted the use of clinical informatics tools for diagnoses and treatment of patients and they also use the resources to record clinical consultation records (Protti, Bowden and Johansen, 2008). In another development, Gatero (2011) conducted a study on the adoption of ICT by medical doctors at Kenyatta National Hospital, Kenya. The study revealed that very few medical doctors had adopted the use of clinical informatics tools.

Adoption of clinical informatics tools among medical doctors in the European countries has been assessed to be relatively adequate. European Commission (2008) surveyed clinical informatics tools' adoption among medical doctors across Europe and found that about 70% of the medical doctors had adopted the use of clinical informatics tools and 66% of them used the resources in their hospitals for medical consultations. Denmark medical doctors have the highest adoption rate of clinical informatics tools (91%) and have various forms of clinical informatics tools in their healthcare facilities, while Romania has the lowest (5%). The disparity in adoption and use of the tools has been attributed to the fact that Denmark has the highest broadband connections with high-speed internet connectivity, coupled with adequate funding of health institutions by the government.

In another development, Salman and Ahamed (2013) conducted a study on medical doctors' adoption of clinical informatics tools in Pakistan. Majority of the doctors admitted that they did not have access to such tools. The study reveals that adoption to clinical informatics tools is "location divide", that is, some hospitals in the remote rural areas of the country, as well as the medical doctors working in them, have no access to clinical informatics tools. Contributing on this, Safdari, Jebracity, Rahimi and Doulani (2014) maintain that medical doctors need to adopt the use of clinical informatics tools in order to have access to information for clinical guidelines, drug reference, clinical calculations, patients' demographic information and scientific evidence, at the point of care, every time. Therefore, to get such information needed in the field of medicine, adoption of clinical informatics tools appears to be very important because they are technologies that have operating systems and the capacity to provide evidence-based medicine and support medical doctors in decision making.

Furthermore, Coleman, Herselman and Corade (2013) conducted a study on the use of ICT to support doctors in rural areas of South Africa and they state that, acceptance of ICT has led to an increase in the promotion of healthcare for rural and marginalised people of South Africa. Arvanities and Loukis (2016) conducted a study involving 743 hospitals in 18 European countries to find out the level of adoption of clinical informatics tools. The study identifies the adoption of four types of clinical informatics tools but reveals that computerised physicians order entry, diagnosis image archiving and electronic medical records are acceptable to medical doctors. The study further reveals that access to these tools has had positive impact on the job performances of the medical doctors. The reason for this may be the types of clinical informatics tools used and the support they received from the use of the tools.

Clinical informatics tools have made medical knowledge accessible to patients. Patients use clinical informatics tools to have a better understanding of their medical conditions. Karsenti and Charlin (2008) observe that the Internet has brought changes to medical practice, as medical knowledge is now becoming accessible by everybody around the globe. Medical knowledge is no longer the monopoly of medical doctors. Bello *et al.* (2004), in their study at Obafemi Awolowo University, Ile-Ife, Nigeria, reveal that only 26% of the medical doctors have access to computers. The analysis showed a low level of use of ICT by medical doctors in Nigeria. Clinical informatics tools provide the opportunity to revolutionise healthcare system, by enabling innovations in work practice and changes to professional roles and responsibilities; resulting in new models of care delivery (Li, Talaaei, Seale, Ray & Maclnye, 2012).

Likewise, Chinghai and Holt (2010) point out that adoption of clinical informatics tools provide equal opportunities for effective healthcare delivery system, particularly for people living in rural areas in Africa. The adoption of clinical informatics tools has brought about the promotion of evidence-based medicine (Haux, 2006). In addition, adoption of clinical informatics tools is believed to promote quality assurance, and at the same time, enhance effective public health service delivery, particularly in developing countries (Mudaly, Moodley, Pillay & Seebregts, 2013). The acceptance of clinical informatics tools, in healthcare environment, has reportedly led to various benefits and increased effective diagnosis and treatment. Olasina (2014) notes that in the era of information age the adoption of clinical informatics tools by medical doctors is imperative for effective medical care. This implies that adoption of clinical informatics tools has changed the ways medicine is being practiced, as it improves the training and capacity building of medical practitioners.

Over the years, studies reporting the need for the adoption of clinical informatics tools in healthcare (Grayand& Verda, 2011; Shifeewand Zolfo, 2014), show that the adoption of clinical informatics tools will promote adequate follow-up to monitor patients' conditions. Several studies indicate that the adoption of clinical informatics in healthcare systems of developing countries, such as South Africa, will significantly transform medical practices to what obtains in developed countries (Bukachi & Pakenhamo-Walsh, 2007). This suggests that the adoption of clinical informatics toolsin healthcare delivery system has the potential to strengthen human resources for healthcare and at the same time, increase access to healthcare and promote quality health services. In the same vein, the adoption of clinical informatics tools in healthcare facilities will serve as a tool for improving medical services. Furthermore, Moahi (2009) argues that the adoption of ICT in hospital environments will determine medical doctors' accessibility and utilisation of healthcare facilities for their medical practices. The adoption of clinical informatics tools can increase the quality of healthcare, not only in rural hospitals, but also in urban ones.

Theoretical framework

Studies on individual or professional adoption of information and communication technology are one of the established streams of information systems research (Venkatesh, Davis, & Morris, 2007). However, Venkatesh *et al.* (2003) proposed a more robust theory for better understanding acceptance and adoption of information and communication technology. The theory builds upon the existing theories on acceptance theories. The research employs this lasted theory in order to validate the factors that promote adoption of clinical informatics tools among medical doctors. Musa (2006) notes that UTAUT theory needs to be used in developing countries in order to find out various factors that will promote ICT usage. Kaba, Diallo, Plaisent, Bernard, and N'da (2006) argue that in most African countries, users are not put into consideration in ICT adoption processes. There are many factors that promoted the use of UTAUT in this study. First, the theory has high explanatory power of about 70%, which is okay for technology acceptance studies, and it is more effective and relevant than previous models (Wu, Tao & Yang, 2008). In addition, the model examines people's intention to adopt the use of information and communication technology. In this case, the model was expected to be very useful in examining medical doctors' behavioural intention to use clinical informatics (Owolabi, Mholongand & Evans, 2017).The theory has extensive components which can predict when an individual in different professions, such as medical doctors can develop the intention to adopt and use ICT (Oye *et al.*, 2014).

Yoo, Han and Huang (2012) argue that UTAUT theory is very useful in determining medical doctors' level of adopting information and communication technology. The UTAUT provides a simplified path towards understanding the above concerns and how individuals would embrace a new technology or the choice of using it, as it suits their daily work activities. It is for this reason that UTAUT was selected as the most suitable theory to help understand the adoption of clinical informatics tools among medical doctors. The key constructs of the theory are performance expectancy (PE), social influence (SI), facilitating conditions (FC) and effort expectancy (EE). Performance expectancy is basically about the perceived benefits users will derive in the adoption of a new technology. Cohen, Bacihon and Jones (2013) note that performance expectancy is the benefits a user believes will be gained from using information and communication technologies.

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In another development, Venkatesh *et al.* (2003) describe performance expectancy as the degree to which an individual believes that using ICT would be of assistance in achieving better results. Extant literature reveals that performance expectancy indicates perceived advantages users believe they will derive from using a technology, in order to be more productive, and at the same time, increase their job performance. Based on performance expectancy construct, it is believed that medical doctors would adopt the use of clinical informatics tools with the anticipation that they will assist them in performing their clinical works. The adoption of clinical informatics tools in hospitals is likely to be based on the belief that the tools will be of various advantages to medical doctors, particularly in making clinical decisions and enhanced productivity. Tamblyn *et al.* (2006) posit that medical doctors' adoption of clinical informatics tools has the potential to improve medical doctors' productivity, job performance, and the quality of diagnosis and treatment of patients.

Effort expectancy is "the degree of ease associated with the use of a system" (Venkatesh *et al.*, 2003). It can be said that effort expectancy is related to "perceived ease of use". This is one of the constructs of effort expectancy. Other constructs are: perceived ease of use (TAM/TAM2), complexity (MPCU) and ease of use (IDT) (Venkatesh *et al.*, 2003). Owolabi (2016) maintains that effort expectancy shares a lot of similarities with TAM's perceived ease of use. Effort expectancy suggests desired expectation that ICT can be used with minimal or no effort and complexity. The issue is that a technology should be easy to use. Owolabi, Evans and Ocholla (2017) note that when there is lower effort expectancy in clinical informatics' tools usage, the usage of the tools may be low, especially when the tools are not easy to use. They go further to stress the need for adequate training in the use of a technology to ensure its effective use of the technology. Zhang *et al.* (2010) note that effort expectancy had a great influence on clinical informatics tools adoption. Supporting this, Alumelhen (2015) argues that medical doctors' impression of clinical informatics tool is one of the factors that determine its use.

Social influence is another UTAUT constructs that influences the adoption of clinical informatics tools among medical doctors. Venkatesh and Davis (2000) describe social influence as the extent to which an individual believes that the usage of ICT by other people can determine if he or she will accept to use the technology. It can be said that social influence is the extent to which an individual allows his or her opinion to be influenced by the attitude of others. Owolabi (2016) notes that social constructs are related to TRA, TRA, TAM, TPB and C-TAM-TPM, and it can also be traced to MPCU and DOI, as social factors. Studies have shown that, an individual's intention to use a new technology can be influenced by the views, opinions and perceptions of the people around him or her, particularly in his/her immediate environment (Venkatesh & Davis, 2000). Chau and Hu (2013) conducted a study on factors that influence the usage of clinical informatics tools and they discovered that social influence has a significant influence on clinical informatics tools usage among medical doctors in Hong Kong.

Facilitating conditions entail the adoption of enabling environment and resources that will promote the usage and adoption of ICT. Facilitating conditions are related to the TAM's perceived ease of use, combined facilitating conditions (MPCU), and compatibility (DOI) (Owolabi, 2016). The resources could include the following: hardware, software, training and technical support. Adoption of these resources will influence the behavioural intention of medical doctors to use clinical informatics tools (Owolabi, Evans & Ocholla, 2017). Facilitating condition is very important in the adoption of clinical informatics tools among medical doctors in order to promote effective healthcare delivery (Holden & Karsh, 2010). Therefore, this paper aims to identify factors that influence medical doctors' adoption of clinical informatics tools in South Africa.

Research methodology

The study employed a positivism paradigm anchored on descriptive design. Data were collected through the use of questionnaires, aimed at extracting specific data from a particular group of people (participants) about their thoughts, feelings and opinions on the subject of focus. The sample for the study was drawn from medical doctors at Ngwelezane hospital, South Africa. The hospital, with 554 beds, provides district, regional, and tertiary services to various communities in South Africa (Department of Health South Africa, 2014). The hospital was selected for the study due to the fact that it was well established in terms of funding as regards infrastructural and human development. The sample frame for the study was sought from the office of the hospital administrator. There are 317medical doctors in the hospital. Applying the Taro Yamane (1967) sample size calculation formula, the study got a sample size of 177 medical doctors as the appropriate sample size for the study as calculated below.

$$n = \frac{N}{1 + N(e)^2} \quad \text{......} \quad (1)$$

Where n is the sample size, N is the population size, and e is the level of precision (0.05).

Substituting the population of the medical doctor in Equation 1 gave:

$$n = \frac{317}{1 + 317(.05)^2} = 177$$

Therefore, simple random sampling was used to select 172 medical doctors. From these, only105 questionnaires were returned, representing a 61% return rate.

Pre-test results

To confirm if the UTAUT instrument was understood by respondents, a pilot reliability test was conducted. A total of 30 questionnaires were distributed to the medical doctors based on their easy accessibility. Afterwards, the returned 30 pilot questionnaires were coded and a Cronbach's alpha test was employed. The results showed that the Cronbach's alpha value of all the variables of the study met the threshold of 0.7 and above

Demographic characteristics of the sampled medical doctors

Table 1: Demographic information (n = 105)

	Count	Percent
Age (years)		
24 – 34	22	21.0
35 – 44	31	29.0
45 – 54	42	40.0

Above 55	10	9.5
Experience level (years)		
3 – 15	33	31.4
16 – 30	52	49.5
Above 30	20	19.1
Gender		
Male	58	55.2%
Female	47	44.8%
Position		
Medical consultant	4	3.8%
Medical intern	50	47.7%
Medical officer	35	33.3%
Medical registrar	16	15.2%

The result (Table 1) on the demographic characteristics of the medical doctors revealed that most (40%) of them were between the ages of 45 and 54 years and 49.5% have had between 16 and 30 years of experience. With reference to gender, majority of the medical doctors were male (54.9%) with most (40.2%) of them occupying the medical intern position.

Missing data treatment

The Little's Missing Completely at Random (MCAR) test was conducted to verify whether data were missing completely at random or missing at random. The result showed that the data were missing completely at random since the null hypothesis was accepted (χ^2 = 7.422, df=11, p>.05). Based on this result, missing data were replaced using median of nearby point method since <10% of the data were estimated to be missing (Baraldi & Enders, 2010).

Multivariate normality test

Multivariate normality test was carried out using Mardia's coefficient test (Mardia, 1970). However, Mardia's coefficient estimate = 201.191, p< .00, which suggested that the data were not normally distributed.

Descriptive statistics and Pearson Correlations

The study conducted an independent t-test to examine gender difference between medical doctor's behavioural intentions to use clinical informatics tools. The results showed no statistically significant difference (t = -1.272, p> .05) in behavioural intention to use the tools. The results from the Pearson correlation analysis (Table 2) revealed that behavioural intention was positively correlated to facilitating condition (r = .563, p < .01), effort expectancy (r = .626, p < .01), performance expectancy (r = .714, p < .01) and social influence (r = .621, p < .01); social influence was positively correlated with facilitating condition ((r = .687, p < .01), effort expectancy (r = .789, p < .01) and performance expectancy (r = .704, p < .01); performance expectancy was positively correlated with facilitating condition (r = .693, p < .01) and effort expectancy ($r = .468$, $p < .01$); and effort expectancy was positively correlated with facilitating condition ($r = .504$, $p < .01$).

Table 2: Pearson product correlation for performance expectancy, effort expectancy, social influence, facilitating condition and behavioural intention among medical doctors.

Variables		1	2	3	4
1.	Behavioural Intention				
2.	Social Influence	.621**			
3.	Performance Expectancy	.714**	.704**		
4.	Effort Expectancy	.626**	.789**	.468**	
5.	Facilitating Condition	.563**	.687**	.693**	.504**

***Correlation is statistically significant at the .01 level (two-tailed).*

Measurement model

Result of the confirmatory factor analysis showed that the measurement model produced an acceptable fit, with $\chi^2 = 52.910$, $df = 44$, $p > .05$, CFI = 0.987, TLI = 0.981, RMSEA = 0.05 and SRMR .047, The estimated Cronbach's alpha coefficient, composite reliability (CR) and ordinal reliability were used to test for reliability of the data. Reliability is achieved when the value of the Cronbach's alpha and ordinal reliability coefficients is above the threshold value of 0.7, which indicates an acceptable level. In addition, all CRs should also achieve value above 0.7 (Hair, Hult, Ringle and Sarstedt, 2014) meaning that all indicator items measure the latent constructs with reliability. Results (Table 3) revealed that these thresholds were met in this study which revealed that the reliability of the instrument was achieved.

Table 3: Cronbach's alpha, composite reliability and ordinal reliability test for each construct

Factors	Cronbach's alpha	Composite reliability	Ordinal reliability
FC	0.926	0.929	0.928
BI	0.829	0.834	0.835
EE	0.916	0.917	0.917
PE	0.781	0.788	0.784
SI	0.905	0.906	0.905

Note: FC = Facilitating condition; BI = Behavioural intention; EE = Effort expectancy; PE = Performance expectancy; SI = Social influence

The next test was construct validity, which was done to ensure that the selected factors have the required accuracy for measuring the desired constructs. For this purpose, convergent validity and discriminant validity were tested. In order to examine the convergent validity, and the average variance extracted (AVE). Factor loadings and composite reliability (CRs shown in Table 3) were estimated and used. Composite reliability and factor loadings for each construct were above the threshold value of 0.7. Results for the AVEs were also all above 0.5; hence, according to Fornell and Larcker (1981), they were at the acceptable level. Also, the standardised factor loadings for the retained items ranged from 0.72 to 0.96 and were all significant at $p < .001$ level

(Table 4). Based on these findings, convergent validity was achieved. Table 5explained the AVE and factor loadings for each construct.

Table 4: Convergent validity results for each construct

Factors	Items	Standardised loadings	AVE	t-value
PE	PE1	0.749	0.651	8.374***
	PE2	0.862		7.131***
EE	EE1	0.893	0.847	9.850***
	EE2	0.947		10.787***
SI	SI1	0.936	0.828	10.730***
	SI2	0.883		9.734***
FC	FC1	0.920	0.813	10.688***
	FC2	0.824		8.966***
	FC3	0.956		11.435***
BI	BI1	0.721	0.627	7.053***
	BI2	0.859		8.934***
	BI3	0.789		7.957***

*Note: ***p < 0.001.*

Discriminant validity was the next to be tested. The AVEs and correlations between each construct were used to perform the test. It was observed that the square root of each AVE was greater than its corresponding correlations (Fornell & Larcker, 1981); therefore, discriminant validity was also achieved. Based on the results of the convergent and discriminant validity, construct validity was achieved and validated in the data. Table 5 presented the discriminant validity results

Table 5: Discriminant validity for each construct

	FC	BI	EE	PE	FC
FC	**0.902***				
BI	0.512	**0.792***			
EE	0.475	0.569	**0.921***		
PE	0.626	0.629	0.411	**0.807***	
FC	0.648	0.556	0.743	0.633	**0.910***

*Note: *Diagonal elements report the AVE and other matrix entries report the squared correlation estimation between them.*

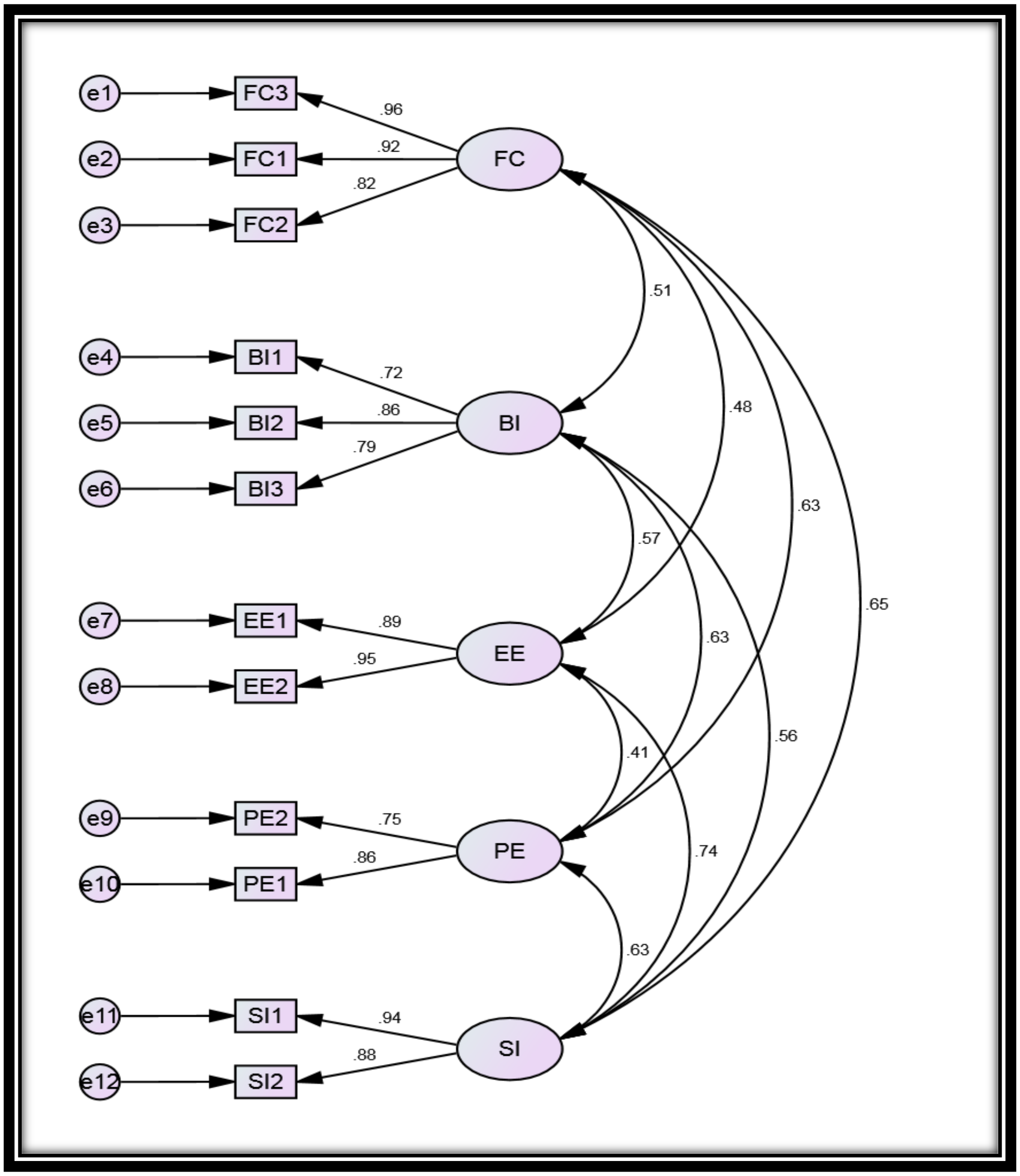

Figure 2: Confirmatory factor analysis model

The structural model was performed using IBM Amos version 24. Due to the non-normality of the data, the research employed the use of Bollen-Stine bootstrapping method for parameter estimation with the maximum likelihood (ML) estimation method. The model fit the data well with $\chi^2 = 52.910$, $df = 44$, $p > .05$, CFI = .987, TLI = .981, RMSEA = .05 and SRMR .047. As shown in Table 6, facilitating condition was not related to behavioural intention to use clinical informatics ($\beta = 0.09$, $p > .05$), effort expectancy was positively related to behavioural intention to use clinical informatics tools ($\beta = 0.41$, $p < .05$), performance expectancy was positively related to behavioural intention to use clinical informatics tools ($\beta = 0.47$, $p < .01$) and social influence was not related to behavioural intention to use clinical informatics tools ($\beta = -0.11$, $p > .05$).

Table 6: Hypothesis testing results

Hypothesis	Path coefficient	*t*-value	*p*-value	Hypothesis result
FC > BI	0.09	0.61	0.54	Rejected
EE > BI	0.41	2.392	0.02	Confirmed
PE > BI	0.47	2.663	0.01	Confirmed
SI > BI	-0.11	-0.491	0.62	Rejected

Note. FC = Facilitating condition, EE = Effort expectancy, PE = Performance expectancy, SI = Social influence and BI = Behavioural intention.

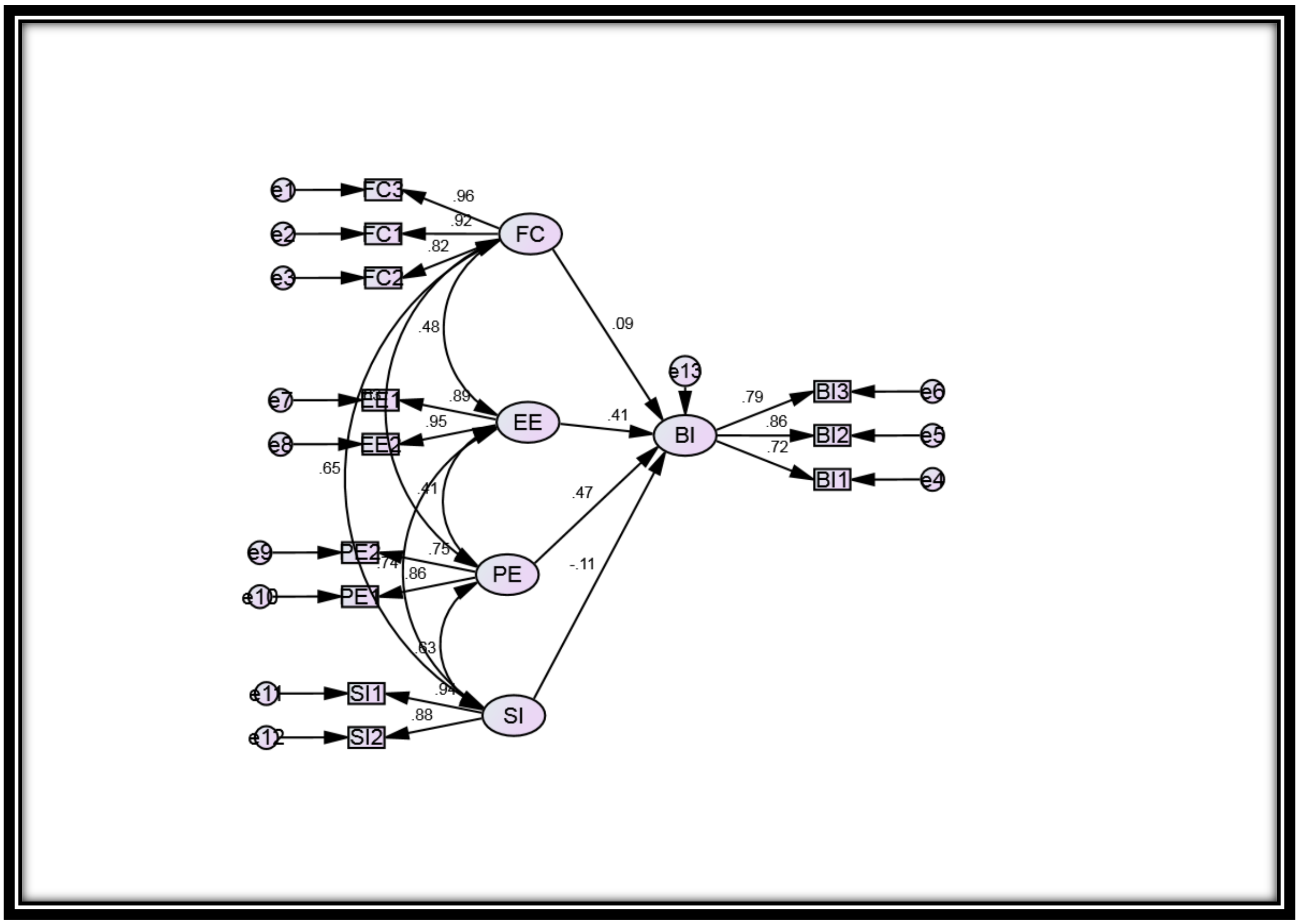

Figure 3: Structural equation model on the association between medical doctors' behavioural intention to use clinical informatics tools

Discussion of findings

The study has identified the factors that influence the adoption of clinical informatics tools among medical doctors in a teaching hospital, by using SEM analysis of questionnaire survey data. Based on the UTAUT constructs, the findings of the study revealed that effort expectancy and performance expectancy are two of UTAUT constructs that influence medical doctors' adoption of clinical informatics tools in the hospital. This finding supports the finding of Owolabi, Evans & Ocholla (2017) in a similar study on factors that influence medical doctors' behavioural intention to use clinical informatics tools.

In another development, Owolabi, Adenekan, Nssien and Durojaiye (2017) reveal that effort expectancy and performance expectancy influence the behavioural intention of medical doctors in a teaching hospital in Nigeria to use health information technology. This result is in line with the finding of this research. The finding of the study was also in line with the finding of Ogundani (2016) on the adoption and use of electronic information system in public hospitals in Western Cape Province, South Africa. It was also revealed that effort expectancy and performance expectancy influence the use of the resources among medical doctors and other healthcare givers. Dunnebeil *et al.* (2012) also used UTAUT model to confirm the degree of acceptance of e-health among medical doctors in Germany. The finding of the study supported that effort expectancy and performance expectancy influenced the use of e-health among medical doctors in the country. This corroborates the finding of this study. Effort expectancy and performance expectancy also significantly influenced the use of e-health among medical doctors in Taiwan (Kijsanayotin *et al.*, 2009). Other studies have found that performance expectancy and effort expectancy significantly influence the adoption of clinical informatics tools (Wu, Wang & Lin, 2007).

On the other hand, English, Ankem and English (2017) revealed that performance expectancy and effort expectancy have no significant influence on the use of clinical decision support system among medical doctors. As such, their finding contradicts the finding of this study. Like-wise, Venkatesh *et al.* (2003) revealed that facilitating condition has significant influence on medical doctors in the adoption of ICT systems.

Conclusion and recommendations

Effective adoption of clinical informatics tools usage will promote efficiencies in effective healthcare delivery. Adoption of clinical informatics tools usage is very important in addressing healthcare priority, not only in developed, but also in developing countries. The extent of the adoption of clinical informatics tools usage among medical doctors is a function of medical doctors' intention to adopt the use of the tools. The study has revealed that effort expectancy and performance expectancy are the two of UTAUT constructs that influence the adoption of the clinical informatics resources. Performance expectancy and effort expectancy are positively correlated to behavioural intention to adopt the use of clinical informatics tools in the hospital. Hence, adoption of clinical informatics tools by medical doctors in the hospital is done because it will make their work easier, and at the same time, increase their performance.

The study recommends adequate training on ICT because that will promote the ease of use of the technology hence saving medical doctors from challenges associated with operating the systems. In addition, in designing the tools, the companies need to make them more user-friendly. Adoption and accessibility of the tools need to be considered by the hospital management. This means that clinical informatics tools need to be available and accessible to medical doctors in various medical departments.

References

Almulhen, J. A. (2015). Importance of medical informatics in medical students' curricula in Saudi Arabia. A thesis submitted to the Department of Health care Informatics, University of Wiscoinsin –Milwaukee.

Ani, O. E. (2013). Accessibility and utilization of electronic information resources for research and effect on productivity of academic staff in selected Nigerian universities between 2005–2012.PhD thesis, University of South Africa.

Arvanities, K. & Loukis, E. (2016). Investigating the effects of ICT on innovation and performance of European hospitals: an exploratory study. *European Journal of Health Economic*, 17(4), 403-418.

Baraldi, A. N. &Enders, C. K. (2010).An introduction to modern missing data analyses. *Journal of School Psychology*, 48, 5-37.

Bean, K. Davis, A. & Valdez, H. (2013).Bridging the digitals; a bilingual interactive by health kiosk for disparity. *The Journal of Community Informatics.* 9(2) 1-7

Bello I.S. Arogundade F.A. Sanusi, A. A.Ezeoma, I.T. Abioye-Kuteyi, E. A. & Akinsola, A. (2004). Knowledge and utilization of information technology among health care professionals and students in Ile-Ife, Nigeria: A case study of a university teaching hospital. *Journal of Medical Internet Research,* 6(4), 1-12.

Bukachi, F.& Pakenhamo-Walsh, N. (2007). Information technology for health in developing countries.*Chest*132 (50), 1624-1630.

Chau, P. & Hu, P.(2013). Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories. *Information Manager* 39, 297-311.

Chinghai, P. N. &Holt, A. (2010). The disparity information and communication technology for developing countries has in the delivery of healthcare information. *Open Medical Informatics,* 4(1), 195-201.

Cohen, J. F. Bancihon, J. &Jones.M. (2013). South African physicians of e-prescribing technology: an empirical test of a modified UTAUT model. *South Africa Computer Journal* 50 (1), 43-50

Coleman, A. Herselman., H. E. &Corade, D. P. (2013).ICT applications as e-health solutions in rural healthcare in the Eastern Cape –Province of South Africa .*Health Information Management Journal* 39(1), 17-26.

David, A. (2009).Information Behaviours of physicians: implications for digital reference *Health Information and Libraries Journa,l* 24(1), 78-94.

Dunnebeil, S.Sunyaev A, Blohm I, Leimeister J. M, &Krcmar, H.(2012). Determinants of physicians' technology acceptance for e-health in ambulatory care. *International Journal Medical Informatics,* 81(11), 746–760

Edwards, K. Felix, P. and Lambert, M. (2010).Caffeine for the prevention of injuries and errors in shift workers.*The Cochrane Database of Systematic Reviews*, 5 (5), 1 -12.

English , D. Ankem, K & English, K. (2017). Acceptance of clinical decision support surveillance technology in the clinical pharmacy. *Informatics for Health and Social Care,* 42(2),135-152.

European Commission (2008). Survey takes pulse of e-health in Europe and prescribes wider ICT use among doctors, press realise data base [Retrieved from release_IP-08-641en.htm?locale=en](release_IP-08-641en.htm?locale=en)

Flynn-Dapaah, K.& Rashid, A. T. (2010). Gender digital equity in ICT intervention in health: evidence from IDRC supported projects in developing countries. *The Journal of Community Informatics* 6(1), 1-9.

Gatero, G. (2011). Utilisation of ICTs for accessing health information by medical professional in Kenya;a case study of Kenyatta National Hospital. *Journal of Health Informatics in Developing Countries* 5 (1), 1- 7.

Hair, J. F., Hult, G. T., Ringle, C. M. & Sarstedt, M. (2014).*A primer on partial least squares structural equation modelling (PLS-SEM)*, Los Angeles: Sage Publications.

Haux, E.(2006). Health information systems: Past, present, future. *International Journal of Medicare* 75 (1), 268-281.

Holden, R. J. anKarsh, B. T. (2010). The Technology Acceptance Model: Its past and its future in health care. *Journal of Biomedical Informatics*. 43(1), 159-172.

Houshyar A. B. Bahadorani, M. Tootoonchi, M. Gardiner, W. & Adib, P. (2012). Information and communication technology in medical education: An Experience from a Developing Country. *Journal of Pakistan Medical Association* 3(2) 71-75.

International Telecommunication Union (2012). Key ICT indicators 2012-2014. World TelecommunicationPress. Retrieved from http://www.itu.int/en/ITU-D/Statistics/Pages/publication s/w tid.aspx

Kaba, B. Diallo, A. Plaisent, M Bernard, P. &N' Da, K. (2017).Cellur phones use in Guinea: *The Electronic Journal of Information Systems in Developing Countries*, 28(1) 1-7

Karsenti, T. & Charlin B. (2008). Information and communication technologies (ICT) in medical education and practice: The major challenges. *International Journal of Technologies in Higher Education*. 5, 68-81.

Kijsanayotin, B. Pannarunothai, S. & Speedie, S. M. (2009). Factors influencing health information technology adoption in Thailand's community health centres: Applying the UTAUT model. *International Journal of Medical Informatics*, 78(6), 404-416.

Kommalage, M. & Gunawardena, S (2008). Feasibility of introducing information technology based activities into medical curricula in developing countries, *Medical Education*, 42 (1), 113-120.

KPMG (2018). Funding NHI: a spoonful of sugar? An economic analysis of the NHI.KPMG South Africa.

Li, J. Talaaei-Khoei, Seale, H. Ray, P. &Maclnyre, C. R. (2013).Healthcare provider adoption of e-health systematic literature review. *Internet Journal Medical Research* 2(1).1-12.

Lluch, M. (2011). Healthcare professionals' organisational barriers to health informationtechnologies-a literature review. *International Journal of Medical Informatics*, 80(12):849–62.

Makary, M.A, & Daniel, M.(2016). Medical error-the third leading cause of death in the USA.*BMJ*. 353, 139.

Mardia, K. (1970). Measures of multivariate skewness and kutorsis with applications. *Biometrika*, 57(3), 519-530.

Moahi, K. H. (2009). ICT and health information in Bostswana: Towards the millemium development Goals. *Information Development*.25 (3), 198-206.

Moududdin, A. & Moore, J. (2008) .The underserved and health information technology issues and opportunities United National Department of Health and Human Services.

Musa, P. F. (2006). Making a case for modifying the technology acceptance model to account for limited accessibility in developing countries. *Journal of Information Technology for Development* (JITD), 12 (3): 213-224.

Nwagwu, W. &Adio, A. (2013). Contexts of utilisation of ICT by medical practitioners in private hospitals in Osun State, Nigeria. *World Journal of Science Technology and Sustainable Development*. 10(3), 229-246.

Odini, S.&Omuoke, A. (2014).Use of ICT by medical professionals in accessing information for healthcare delivery at Moi Teaching and Referral Hospital MTRN) in Eldoret Kenya.*Journal of International Academic Research for Multidisciplinary* 2(5), 153-180.

Ogundani, O.O. (2016).Adoption and use of electronic healthcare information systems to support clinical care in public hospitals of Western Cape Master of Technology, Faculty of Information and design. Cape Peninsula University of Technology.

Olasina, G. (2014). Predictors of legislators ICT acceptance and use in the performance of legislative functions at the Nigerian National Assembly PhD thesis submitted to the Department of the Information Studies in the University of Kwazulu-Natal *Pietermaritzburg*.

Olasina, G. & Popoola, T. (2014). Predictors of the use of e-medicine by medical doctors. *Journal of Health Medical Informatics*, 5 (166), 16- 24.

Owolabi K.A. (2016). Access and use of clinical informatics among medical doctors in selected teaching hospitals in Nigeria and South Africa PhD thesis submitted to the Department of Information Studies , University of Zululand, Kwa-Dlengezwa.

Owolabi, K.A., Evans, N. and Mhlongo, P.T. (2016).Applying UTAUT in Clinical Informatics Research.*Library Philosophy and Practice*paper 1478.Published by University of Nesbraska- Lincoln. Retrieved from http://digitalcommons.unl.edu/libphilprac/1478

Owolabi, K.A.Adenekan, F.N. Nssein, F.N. &Durojaiye, A.O. (2018).Behavioural Intention to use of Health Information Technology among medical doctors in Nigeria. *International Journal of Information Processing and Communication,* 6(2), 241 -254.

Owolabi, K.A.Evans, N.D. & Ocholla, D.N.(2017) Factor that influence medical doctors that influence medical doctors behavioural intention to use clinical informatics. MOUSAION: *Journal of Library and Information Science*, 36 (1), 130 -154.

Price, M. & Lau, F. (2014). The clinical adoption meta-model: a temporal meta-model describing the clinical adoption of health information systems. *BMC MedicalI Informatics and Decision Making*, 14(1): 43.

Protti, D. J. Bowden, T. & Johansen, I. (2008). Adoption of information technology in primary care physician offices in New Zealand and Denmark, part 1: Health care system comparisons. *Informatics in Primary Care*, 16(3), 183-187.

Rogers, E.M. (1995). Diffusion of innovations (4th ed). New York: The Free press

Safdari, R. Jebraeily, M. Rahimi, B. &Doulani, A.(2014).Smartphones medical training of medical students of UMSU and its influencing factors.Relagia*Research Library*, 2 (1), 633-637.

Salamn, S. B. &Ahamed, S. (2013). Information seeking in primary care: A survey of doctors working in remote government health facilities in Pakistan. *Library Philosophy and Practices*, Paper 9.

Schumacker, R. E. & Lomax, R. G. (1996).*A beginner's guide to structural equation modelling.* Erlbaum: Mahwah, NJ.

Shifeew.F. & Zolfo.M. (2012).The role of ICT towards universal health coverage. The first steps of a telemedicine. *Global Health Action* 5 (1), 1- 17.

Shikhtaheri, A, Sadeqi-Jabali, M &Hashemi-Dehaghi, Z (2018) Physicians perspectives strategies: A study in a developing country .*Iranian Journal of Public Health* 47(5). 720-728.

Venkatesh, V. & Davis, F. 2000. Theoretical extension of the Technology Acceptance Model:Four longitudinal field studies. *Management science*, 46(2), 186–204.

Venkatesh, V. & Davis, F.D. (2000) A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science, 46, 186-204.

Venkatesh, V. Morris, G. Michael, G. Davis, G. & Davis, F. D. (2003) .User acceptance of information technology: toward a Unified View. *MIS Quarterly 8.* (27), 425-478

Venkatesh, V., Davis, F. D., & Morris, M. G. 2007.Dead or Alive? The Development, Trajectory and Future of Technology Adoption Research, *Journal of the AIS* 8 (4), 268-286.

Venkatesh, V., Morris, M., Davis, G. & Davis, F. (2003). User acceptance of information technology: Toward a unified view.*MIS Quarterly*, *27*(3), 425-478.

Venkatesh, V., Morris, M.G., Hall, M., Davis, G.B., Davis, F.D. &Walton, S.M. 2003. Useracceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425–478.

Venkatesh.V., Thong. J. Y. L.& Xu. X.(2012) Consumer Acceptance andd Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly* 36 (1),157-178.

Verbeke, F. Karara, G. & Nyssen, M. (2010). Evaluating the impact of ICT-tools on health care delivery in sub-saharanhospitals.*Studies in Health Technology and Informatics.*192 (1), 11-21

Wu, J. H., Wang, S. C.&Lin, L. M. (2007). Mobile computing acceptance factors in thehealthcare industry: A structural equation model. *International Journal of Medical Information*, 76(1), 66–77.

Yamane, T. (1967).*Statistics, An introduction analysis*(2nd ed.). New York: Harper and Row.

Yoo, S. J. Han, S.H.& Huang, W.B. (2012). The roles of intrinsic motivators and extrinsic motivators in promoting e-learning in the workplace: A case from South Korea. *Computers in Human Behavior*. 28 (1), 942-950.

Zhang, H. Cocosile, M. &Archer, N. (2010). Factors of adoption of mobile information technology by homecare nurses; A technology acceptance model 2 approach. Computers *Informatics* 28 (1), 49-50.