An appraisal of nursing informatics research and the influence of the unified theory of acceptance and use of technology

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Abstract

The study recognises the importance of healthcare informatics in today's dynamic health systems, and indicates how nursing informatics, a component of healthcare informatics, can provide efficient and effective healthcare delivery. Hence, underpinned by the unified theory of acceptance and use of technology (UTAUT), the study aimed at situating research activities on nursing informatics within existing studies that have applied the theory to investigate healthcare informatics in general. The study adopted a systematic review of literature to explore online databases: Google Scholar and Ebscohost from 2014 to 2019. The search returned a total of 205 articles for the specified period. However, only eight eligible studies were found to be related specifically to nursing informatics. The study also revealed that performance expectancy and effort expectancy (respectively), both being constructs of the UTAUT, are the dominating factors influencing the acceptance/adoption/use of nursing informatics among the papers under review. The study recommends that researchers should further explore the use of nursing informatics technologies in healthcare. In addition; nursing informatics system designers should factor in the effectiveness and ease of use of the technologies for easy usage. On the other hand, the stakeholders in the medical field are called upon to provide the enabling infrastructure to enhance the use of nursing informatics technologies.

Keywords: UTAUT, nursing informatics technologies, performance expectancy, effort expectancy, social influence, facilitating condition

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Introduction

Though technology has been a major part of our lives, it is only recently that the medical field became influenced by the speedy pace of technological innovation in the digital age. Hence, advances in medical technology are changing the practice of medicine, leading to more specific specialised care and access to more real-time information and specific data (Topol, 2012). According to the author, heartbeats can be remotely monitored with the use of technology. With the rapid development of new technologies, health information systems (HIS) are required to keep up with current trends, and this has led to the recognition of health informatics, which in the view of Hersh (2009), is more comprehensive than HIS. There is no single universal definition for the concept of health informatics. For instance Fenton & Biedermann (2014) describe health informatics as a study within the field of information science that deals with the application computer technologies and management of all related health data and information; while according to Dinya and Tóth (2013) it is a meeting point of information science, computer science and health care, and it comprises nursing, medical and biomedical informatics, among others.

Health informatics plays a major role in the health care system, creates and maintains a culture of safety and reduced medication and prevents treatment errors. Health informatics tools include procedures and strategies undertaken by clinicians, prescribed medical terms, computerisation, communication of information systems, which can be applied to nursing care, dispensary, dentistry, professional therapy, community health, medical care, medical research, other medicine, and physiological therapy. Selected innovations in health informatics include: health information exchange (HIE) systems; electronic health/medical records (EHRs); digital blood pressure; Computerised physician order entry (CPOE); computerised decision support system; diagnosis image archiving (Owolabi, Mhlongo & Evans, 2016). While studies in healthcare informatics are gaining a wider audience, studies specifically targeting nursing informatics, a subsect of healthcare informatics, are not as readily available (Hersh 2009). Hence, Owolabi, Mhlongo & Evans (2016) recommended that more studies on other types of health informatics such as nursing informatics should be explored. The present study is a step in the response to this call.

The American Nurses Association (ANA, 2008), defines nursing informatics (NI) as a field that combines the application of information science and nursing science, computer science, to manage information and communicate data, and knowledge in nursing practice. NI supports patients, nurses and other providers in their decision-making through facilitation and integration of data, information and knowledge in all roles and settings. NI cuts across all areas of nursing care, which comprises medical practice, management, training, and research. Career Gut (2013) identifies NI technologies as tools specifically used for nursing practice and clinical information systems. These include staff reminder work lists, planned nursing interventions, computerised generated client documentation, vital signs monitoring devices, electronic medical records, computer automatic billing documentation. ii) Nursing Administration- these include automated staff scheduling, communicated e-mail and budgetary system; and iii) Nursing Education- these include e-record-keeping, e-assisted instruction and interactive video technology.

There are various advantages to using nursing informatics tools, which include the efficient discharge of daily routines, improving quality of care, patients' safety, cost cutting and time saving (Kuo, liu and Ma, 2013: 2). Greenwood & Kwiatkowski (2018) attest to the fact that nursing informatics technologies, such as BP monitors, resuscitators, ventilators, and many others, have led to adequate healthcare delivery to patients and the reduction of medical errors. Kuo, liu and Ma (2013:2) assert that the acceptance of NIT can support nurses in achieving their day-to-day care and practices more quickly in an efficient and effective manner.

From the point of view of Fridsma (2018), while many health professionals see the potential that these technologies can bring to improving the quality and cost effectiveness of healthcare, Vollmer (2016) observes that the adoption rate is still very poor in many countries.,e.g. over 60% of the nurses in Germany could not use nursing informatics systems (NIS). This makes it pertinent to ascertain the factors that promote or hinder the use of the technologies (Kim, 2016:2). Different models have been used to capture the factors that influence the acceptance and use of informatics

in the healthcare domain. The models are identified in Table 1, from the most recent to the oldest.

Table 1: Most cited influential theories and models in technologies acceptance research

Model	Author	Year
EMRs HIMSS Adoption Model	Hersh & Wright	2008
UTAUT	Venkatesh et al	2003
TAM2	Venkatesh & Davis	2000
TAM, TPB and the decomposed theory of plan behavior comparison	Taylor &Todd	1995
Information Systems Success Model (ISSM)	Delone & Mclean	1992
Diffusion of innovation theory (2)	Moore & Benbasat	1991
Model of the ICT Implementation Process	Cooper & Zmud	1990
Diffusion of innovation theory (1)	Rogers	1983
TAM and TPB comparison	Mathieson	1975

Source: Author generated from multiple sources (Mellikeche *et al.*, 2019:4) and (Aljohanil, Davis &Connolly, 2018:598)

In order to understand the acceptance and use of healthcare informatics, especially as it concerns the nursing informatics component, the present research is premised on the UTAUT model (Venkatesh, Morris, Davis & Davis, 2003). The rationale for this is discussed in the next section.

Unified theory of acceptance and use of technology (UTAUT)

Venkatesh *et al.*, (2003) formulated the UTAUT. The model was designed to unify the various models used by researchers to appraise their literature on acceptance and use. The UTAUT model is said to be the most appropriate and relevant model in understanding user intention and adoption of technology (Monilakshmane & Rajeswar 2018: 153-154). Many researchers have adopted and employed the model to explore technology acceptance in different fields of study, especially in healthcare. According to Tan & Ooi, (2018:1619), this is because of its performing power, over the previous eight models, to explain the discrepancy in users' intention to adopt healthcare informatics technologies.

Despite the importance of UTAUT in users' intention to adopt healthcare technologies, the model is not without its limitations. Prior to the present study, as suggested by past scholars, they claim that the UTAUT model is capable of explaining only 0.3% of behavioural intention to use technology in the medical field (Vollmer, *et al.* 2016:122). Kim *et al.* (2016:2) report the internal discrepancies

between the factors of UTAUT and the use of technologies. Tan & Ooi (2018:1619) identifies that UTAUT only considers the behaviour of an individual, which is dependent on the context only, neglecting other behavioural factors such as the psychological perception of an individual's use of technology; the combination of different theories into one single framework is also seen as constraint.

In spite of the criticisms, Venkatesh *et al.* in 2003 created the UTAUT to measure the intention and actual usage by disintegrating and fusing eight, mostly intention-based existing technology adoption theories and models that can provide a succinct model to further understand and improve on the adoption of technology in a professional setting. The combination of the competing models will enable researchers to understand more fully users' intentional behaviour and usage of technologies in any setting such as the hospital (Ooi and Tan, 2016). The competing models include: theory of planned behaviour (TPB) (Eagley & Chaiken, 1993); theory of reasoned action (TRA) (Fishbein & Ajzen, 1975); innovation of diffusion theory (IDT) (Rogers, 2003); social cognitive theory (SCT) (Bandura, 1977); technology acceptance model (TAM) (Davis, 1989); extended technology acceptance model (TAM2) (Taylor & Todd, 1995); model of personal computing utilisation (MPCU) model of PC utilisation (Thompson, Higgins, & Howell, 1991); and the motivation model (MM) (Davis, Bagozzi, & Warshaw, 1992).

The eight theories were empirically tested and validated for six months in four different Universities in business and management studies. These are the University of Maryland, University of Virginia, University of Minnesota and University of Arkansas (Owolabi, 2017). The results of the six-month study show that the eight individual models explained 17% to 53% of variance in behavioral user intentions to use technologies, but UTAUT was considered to have better explanatory power than the eight individual models (Williams, Rana, & Dwived, 2015:444). Extant literature supports the application of UTAUT to technology acceptance in major fields of studies, especially in the healthcare industry. Owolabi & Evans (2017:75) argue that UTAUT is the "easiest and simplest theory that is most appropriate and relevant in the prediction of end-user intention and adoption of informatics technology". In addition,

Kim *et al*. (2016: 2) supports the assertion that the combination of different models has given UTAUT a positive scorecard in predicting user intention in any given study such as nursing informatics. Vollmer *et al.* (2016: 122) added that UTAUT constructs are the best analyses of the acceptance and use of informatics technologies. Hence, this study is supported by the UTAUT theory and considers the four main constructs that determine the behavioural intention and actual utilisation of informatics technologies as: performance expectancy (PE), social influence (SI) and facilitating conditions (FC), as identified by Evans (2013: 56).

Performance expectancy (PE):

PE is related to the acceptance of an individual as to whether using technologies would improve task performance (Venkatesh *et al*., 2003). In other words, nurses' intention to use informatics technologies tends to change with their perceived benefit satisfaction (Monilakshmane & Rajeswari, 2018: 157).

Effort expectancy (EE):

This refers to friendliness' and ease of use when using a system (Venkatesh *et al*., 2003). Aljohanil, Davis and Connolly (2018:601) put it this way, "easy of learning, little effort and less time, improving the quality of services by simple words and phrase and providing health web based assistance tools which declare the procedures and instructions for all services".

Social influence (SI):

This refers to "degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh *et al*. 2012:451). It is measured by the perception of how social communications impact on users' intentions to use technologies and services.

Facilitating condition (FC):

Simply put, facilitating conditions represent the evidence of technical infrastructure and other internal support that are made available to users by top management for up to date activities of the healthcare system (Ifinedo, 2012:2939). Consequently, Hsiao and Chen (2017:9) view FC as resources such as time, budgetary allocation, and

human resources provided by health care management to nurses to improve their diagnostics skills.

The present study aims at situating nursing informatics in the existing literature that has used UTAUT, as the framework, to investigate the available literature on nursing informatics; be it in terms of intention to use, acceptance, adoption or actual use. Hence, the study answers the following research questions: i) What is the level of use of UTAUT in exploring NIT, compared to healthcare informatics in general? ii) What are the predominant factors that determine the intention to use, the acceptance or adoption, or the actual use of NIT?

Methodology

This paper adopted the systematic review of literature, using both Google Scholar (GS) and Ebscohost discovery databases to analyse the number of articles that employed UTAUT to inform their research between 2014 and 2019 in a health informatics study. The reason for using Google Scholar was based on the Scientometrics research analysis by Gusenbauer (2019: 177-214), who currently reported GS as the most comprehensive academic search engine. On the other hand, the Salem Encyclopedia (2018:1-2) describes Ebscohost Discovery Service (EDS) as a current, accurate and relevant subject areas search engine which ranges from science and medicine to literature and history. EDS has numerous and comprehensive collection from a wide range of publisher partnerships, superiorly indexed from top subject indexes, full text, and the all-inclusive library collection, customisable discovery stratum practice. To access the relevant studies that have used UTAUT in health informatics, the author searched using the following keywords: “health informatics” OR “nursing informatics” OR “medical informatics” AND “UTAUT” between 2014 and 2019 to view the extent to which UTAUT has been used in healthcare in the specified period.

The full text review to identify the studies that actually used the original UTAUT to investigate healthcare informatics returned a total of 205 articles (Table 2), but with delimited search to isolate the studies that majored on nursing informatics, 31 articles

were found. However, after critically examining the two databases (GS and EBS), eight (8) articles from the relevant selected studies that emanated from Ebscohost Discovery were duplicated in Google Scholar, leaving 22 supposed eligible articles. It should be noted that after the attempt to read through the 22 studies that would have been eligible, 8 studies were excluded because they were not open access journal articles. This limited the articles to 15 (Table 3), of which only 7 were found to be nursing informatics-specific studies (Table 4).

Findings

The findings are discussed as follows:

This section presents the findings from the search of databases. Table 3 indicates that only 15 of the 31 eligible articles were found relevant to the subject of interest. And of the 15, only 7 (Table 4) were specifically on nursing informatics.

This answers the first research question of this study, as it shows that the level of use of UTAUT in Nursing Informatics in comparison to other areas of medical informatics is limited.

The section also discusses the findings concerning the predominant factors that influence the adoption or use of NIT, which is the second question that the study aimed to answer. Figure 1 illustrates this finding and reveals that performance expectancy is the most influencing factor, closely followed by effort expectancy.

Table 2. Health/Medical/Nursing Informatics and UTAUT from 2014-2019

Database	No. of articles found	Relevant articles
Google Scholar	129	23
Ebscohost Discovery	76	8
Total	205	31

Table 3: Publications that applied UTAUT in healthcare informatics studies from 2014 to 2019				
S/N	Author	Year	Focus	Factors, in the order of significance.
1	Ibrahim	2019	Nurses	Performance expectancy Effort expectancy

Table 3: Publications that applied UTAUT in healthcare informatics studies from 2014 to 2019				
S/N	Author	Year	Focus	Factors, in the order of significance.
2	Kalavani, Kazerani, Shekofteh	2018	Resident Physician	Performance expectancy Effort expectancy Social influence Facilitating condition
3	Ehrlera, *et al*.	2018	Nurses	Effort expectancy
4	Aljarullah et al	2018	Physicians	Social influence
5	Jamie Vargo-Warran	2017	Nurses	Performance expectancy
6	Owolabi, Neil and Ocholla	2017	Medical doctors	Performance expectancy Effort expectancy Social influence Facilitating condition
7	Ju-Ling Hsiao and Rai-Fu Chen	2016	Physician	Social influence
8	Waleed and Mhamed Al-Hadban	2016		Effort expectancy
9	Owolabi, Mhlongo & Evans	2017	Medical Doctors	Performance expectancy
10	Owolabi, Evans and Ocholla	2016	Medical Doctors	Performance expectancy Social influence

Table 3: Publications that applied UTAUT in healthcare informatics studies from 2014 to 2019				
S/N	Author	Year	Focus	Factors, in the order of significance.
11	Vollmera, *et al.*	2016	Nurses	Performance expectancy Effort Expectancy
12	Nguyen, *et al*.	2015	Nurses	Effort expectancy
13	Ahmed Samed Al-Adwan Hilary Berger	2015	Physicians	Social influence
14	Sharifian, *et al.*	2014	Nurses	Performance expectancy Social influence Facilitating condition.
15	Maillet, Mathieu and Sicotte	2014	Nurses	Performance expectancy Effort expectancy

Table 4: Publications that applied UTAUT in Nursing informatics studies from 2014 to 2019			
S/N	Author	Year	Factors, in the order of significance.
1	Ibrahim	2019	Performance expectancy Effort expectancy
2	Ehrlera, *et al*.	2018	Effort expectancy
3	Vargo-Warran	2017	Performance expectancy

4	Vollmera, *et al*.	2016	Performance expectancy Effort expectancy
5	Nguyen, *et al.*	2015	Effort expectancy
6	Sharifian, *et al*.	2014	Performance expectancy Social influence Facilitating condition.
7	Maillet, Mathieu and Sicotte	2014	Performance expectancy Effort expectancy

The 7 eligible articles were then critically explored to identify the reported factors that influence the adoption or use of nursing informatics. Figure 1 presents a summary of the findings.

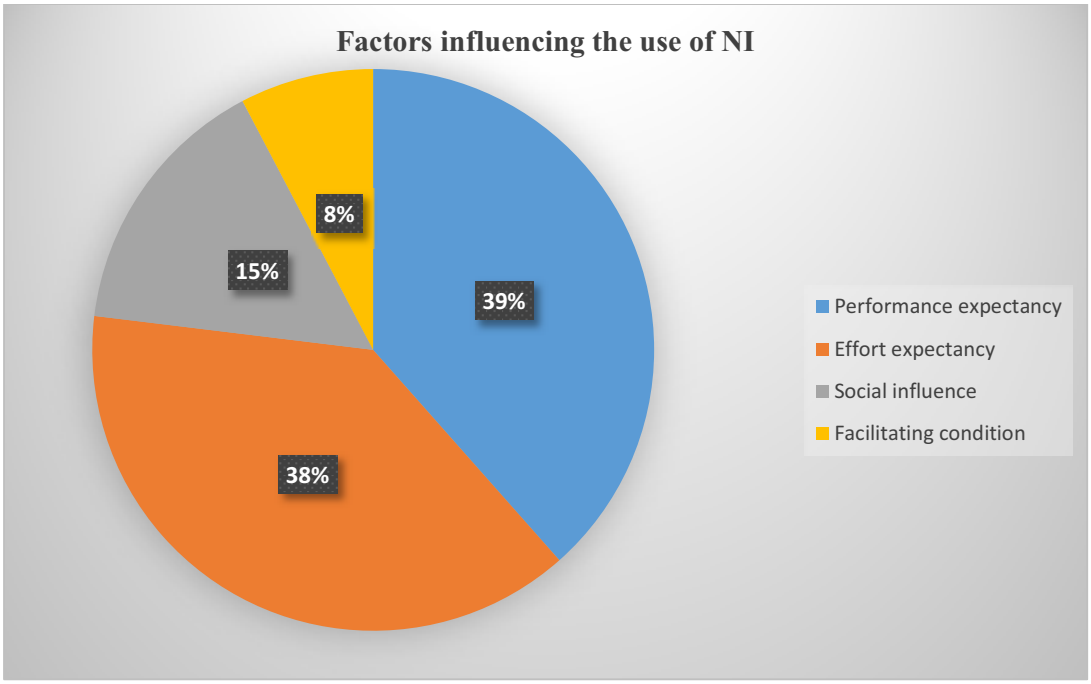

Figure 1: Factors influencing the use of NIT from the reviewed study

Discussion

The findings from Google Scholar and Ebcohost revealed that, between 2014 and 2019, a total number of 205 publications were identified with UTAUT in healthcare informatics studies, but after the exclusion exercise, only 7 of the 205 publications actually used the original UTAUT to explore NI. This is less than 4% of the total, which shows the inadequacy of research work on the subject of NI. In other words, research activities on nursing informatics with UTAUT are very limited when compared with healthcare informatics in general.

The study further revealed that the application of UTAUT to nursing informatics research has focused mostly on the adoption of nursing informatics that relates to hospital information systems, electronic health records, etc. This shows the dearth of literature on the actual use of NIT. On the factors that influence either the intention to use or the adoption of NI, performance expectancy (39%) was the leading determinant, followed closely by effort expectance (38%). The factor that appears to be the least inconsequential is facilitating conditions (8%). This suggests thatthe nurses would consider the use of NIT if it would give them the expected outcome of task performance and if there was less rigour/stress required to get the task doneusing the technologies. The low reference to facilitating conditions that refers to infrastructures (material, training, policies and support) is worth exploring because of its importance in NI provision and support.

Conclusion & recommendations

The paper revealed that very few studies focus on nursing informatics research, particularly from the viewpoint of developing countries. Secondly, to the best of my knowledge, no study has so far focused on the factors that influence the use of NIT by nurses applying the UTAUT. The study examined the factors that would promote the use of nursing informatics technologies among nurses in healthcare sectors, guided by the theory of UTAUT. The extant literature review confirmed that nursing informatics' acceptance/adoption/use can be incited by all the constructs of UTAUT, but significantly by performance expectancy, closely followed by effort expectancy.

The study recommends that more studies be carried out on the use of nursing informatics, and that nursing informatics system designers should develop NITs bearing in mind the effectiveness and ease of use. Given that facilitating conditions appears to be the least mentioned factor, policy-makers and other stakeholders are called upon to provide the enabling infrastructure to enhance the use of nursing informatics technologies.

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