South African physicians' acceptance of e-prescribing technology: an empirical test of a modified UTAUT model

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ABSTRACT

E-prescribing systems hold promise for improving the quality and efficiency of the scripting process. Yet, the use of the technology has been associated with a number of challenges. The diffusion of e-prescribing into physician practices and the consequent realisation of its potential benefits will depend on whether physicians are willing to accept and engage with the technology. This study draws on the Unified Theory of Acceptance and Use of Technology (UTAUT) and recent literature on user trust in technology to develop and test a model of the factors influencing South African physicians' acceptance of e-prescribing. Data was collected from a sample of 72 physicians. Results indicate a general acceptance of e-prescribing amongst physicians who on average reported strong intentions to use e-prescribing technologies if given the opportunity. Partial least squares (PLS) analysis revealed that physicians' performance expectancies and perceptions of facilitating conditions had significant direct effects on acceptance whilst trust and effort expectancy had important indirect effects. Social influence and price value perceptions did not add additional explanatory power. The model explained 63% of the variation in physician acceptance.

KEYWORDS: Health information technology, electronic prescriptions, technology acceptance, UTAUT

CATEGORIES: H.1.2, J.3

1 INTRODUCTION

Information technology (IT) systems have the potential to address numerous problems in healthcare delivery, patient safety and clinical practice. However, implementing new IT systems into healthcare is often problematic [1] [2] and the diffusion of IT innovations into the frontlines of healthcare practice is often met by resistance [3] [4] [5].

Our ability to succeed in the implementation of health IT innovations requires that we improve our understanding of the factors influencing healthcare worker attitudes and intentions toward the use of IT systems. For example, when deciding to accept a new IT innovation into their clinical practice, to what extent do healthcare professionals consider the characteristics of the innovation and its potential to improve health system efficiency and quality of care over their reluctance to change established practices? How much of the response is driven by the social influence of colleagues or professional bodies versus the individual's perceptions of the availability of resources to support them working with a new technology? To what extent might scepticism and lack of confidence in the reliability of IT innovations overshadow their beliefs in the need for change?

This study uses the context of electronic prescribing technology (e-prescribing) to address these and other questions relating to the acceptance of IT systems into healthcare. Specifically, we draw on the Unified Theory of Acceptance and Use of Technology (UTAUT) [24] to develop a model of physician acceptance of e-prescribing and we test the model using data collected from a sample of South African physicians. We make a theoretical contribution to the IT acceptance literature by extending UTAUT to incorporate additional factors such as trust beliefs and explore their inter-relationships with traditional IT acceptance factors. We also contribute to a growing literature base on South African physicians' acceptance of information technologies (e.g., [6] [7]). We provide both quantitative and qualitative evidence to highlight the beliefs and expectations that physicians have of e-prescribing technology together with their areas of concern. Our results will thus provide useful guidance to software vendors, health IT advocates and potential users of e-prescribing technology.

The next section of this paper describes e-prescribing and outlines the benefits as well as concerns associated with the technology's use. This is followed by a discussion of UTAUT and the development of the research model and hypotheses underpinning the study. The research methods are then presented fol-

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lowed by empirical results. The paper concludes with a discussion of findings together with implications for practice and future health informatics research.

2 ELECTRONIC PRESCRIBING

Electronic prescribing or e-prescribing is the use of information technology to support physician decision making in the capture, review and issue of medication prescriptions [8]. In addition to replacing the physician's prescription pad, e-prescribing systems provide a wide range of functions [9] [10] [11] [12]. For example, they can integrate into other patient management systems or provide stand-alone functionality for display of patient demographic, medical and medication history information. They provide clinical decision support through inclusion of formulary lists, drug reference guides, and automated checks and safety alerts for contraindications and interactions, e.g., drug-drug, drug-age and drug-allergy. Moreover, they facilitate the recording of therapeutic indications for each drug prescribed.

E-prescribing systems hold much promise for improving the quality of the scripting process. The technology can help to reduce prescription errors and preventable adverse drug events [13] [14] [15] [16]. For example, Kaushal et al. [15] found that ambulatory practices using e-prescribing experienced a statistically significant decrease in prescription error rates one year after adoption but they found no statistically significant change in error rates in their control group of non-adopters. E-prescriptions are also easy to read and can thus be processed quickly by pharmacists [17] and with fewer dispensing errors that result from illegible handwriting, or unclear abbreviations or dose designations [16]. They can thus provide time savings for physicians when pharmacists no longer need to call them with queries [9] [11]. An added benefit for patients is that physicians can help them with choices on equally effective but cheaper (e.g., generic) drug options [8].

However, the international evidence suggests that e-prescribing has not diffused rapidly into physician practice [15] [16] [18] [19] [20]. Some explanations for the low levels of adoption include system cost [16], perceptions of little direct benefit to the physician [18] [19], technical problems such as network connectivity and lack of interface into practice management systems [21], concerns over the additional time it takes to use such systems in day to day processes [14], and that it makes the scripting process more complex than it should be [16]. One study found that e-prescribing took on average 29 seconds longer than handwriting for new prescriptions in ambulatory settings and presented only limited time-savings for renewing prescriptions [14]. Although the increased time spent to e-prescribe may be worthwhile if it improves the safety and quality of the prescription process [14], the added decision support might only prove useful during more complex clinical situations [8]. For example, physicians have been found to only selectively use e-prescribing when dealing with more vulnerable patients and those with multiple medications [11]. Wang et al. [21] found that fewer than half the physicians they sampled were familiar with accessing functions in the e-prescribing systems such as medication history information. This was resulting in low use of much of the technology's functionality. Many users have also developed parallel systems for collecting and maintaining medication history data, and thereby limiting efficiency gains from the technology [19]. There is also low reported trust in the technology with physicians often still feeling more comfortable with their manual processes [16]. A study of Swedish e-prescribers found that although users were generally satisfied with the technology, 73% still felt the need to perform a final check before transmitting an e-prescription [22]. Studies have also found that e-prescription systems are often prone to errors. For example, Nanji et al. [23] found that around 12% of the e-prescriptions they reviewed contained errors such as omitted information, e.g. duration, dose or frequency of administration, unclear instructions, and conflicting or clinically incorrect prescriptions, e.g., potential overdoses. They indicated that such errors were consistent with hand-written error rates thus bringing the technology's benefits into question. However, they did find that the number, type and severity of errors differed significantly according to which computerised prescribing system was used. This suggests that system design, user interface and functionality embedded in systems are important to benefits realisation and that not all certified systems guarantee success [23]. Hellström et al. [22] found that user interfaces for e-prescribing systems may not be intuitive enough to support less experienced users. Moreover, while scripts can be saved and printed, the technology's potential is limited by regulatory controls such as the requirement for prescriptions to be signed and the lack of facilitating network infrastructure to integrate into pharmacies and other physician practices [11].

E-prescribing is clearly a high potential health IT application but it is evident that there are a number of issues that may limit its widespread adoption and use. It is important therefore that we improve our understanding of South African physicians' perceptions of e-prescribing and the factors influencing their willingness to accept the technology into their clinical practice. The next sections of this paper describe the theoretical underpinning for our examination of e-prescribing acceptance.

3 THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

The theoretical underpinning for our research study is the Unified Theory of Acceptance and Use of Technology (UTAUT) [24]. UTAUT integrates and contains within it a number of earlier models of user acceptance (e.g. Davis' technology acceptance model, Rogers' innovation diffusion theory) as well as social psychology models of individual behaviour (e.g. theory of planned behaviour). The model identifies four core constructs, namely performance expectancy, effort expectancy, social influence and facilitating conditions as determinants of IT acceptance and usage. Its originators indicate that the model is able to explain up to 70% of the variation in user acceptance of an IT [24]. The UTAUT model also incorporates variables of gender, age, experience and voluntariness of use as potentially important to explanations of acceptance depending on the technology context under study.

Over the last decade, UTAUT has become one of the most widely cited models in studies of user acceptance. It has been tested in numerous contexts and has been extended through the inclusion of additional determinants of use (e.g., [25] [26]). These extensions have highlighted the importance of additional variables such as price value perceptions in contexts where users need to absorb the cost of implementation and use [25], and trust and risk related beliefs where uncertainties and risks are high [27] [28].

Given its general applicability to the study of IT acceptance, the UTAUT model has also gained support within health informatics studies. Hennington and Janz [29] were among the first to suggest that UTAUT could be applied to the study of health IT acceptance and more recently, Li et al. [30] identified UTAUT as a useful framework for organising past findings related to electronic health record adoption. Empirical work has drawn on UTAUT to examine acceptance of electronic medical record systems by nurses and physician assistants [31] and hospital physicians in the US [32], and the post-adoption satisfaction and continued usage intentions towards electronic health record technology by US physicians [33]. Elsewhere, UTAUT has been used to examine PACS acceptance by radiologists in a Belgian hospital [34]; physicians' acceptance of a pharmacokinetics-based clinical decision support system in Taiwan [35]; health IT adoption in community health centres in Thailand [36]; acceptance of telemedicine in South Africa's public health care system [37]; acceptance of teledermatology systems in Spain [38]; Australian occupational health therapists' intentions toward use of ICT [39]; and the acceptance of computers by a mixed sample of healthcare professionals in Canada [40]. UTAUT has also been used to underpin qualitative investigations and mixed methods studies. For example, a small US study drew on UTAUT to assess the attitudes and perceptions of 7 physician residents towards the use of electronic medical records [41] whilst another explored the adoption of robotic-assisted surgery by US surgeons [42].

In the context of e-prescribing, one study included only the UTAUT factors of performance and effort expectancy [21]. It found performance expectancy a significant predictor of volume of use whilst effort expectancy was strongly associated with discontinuance, i.e., quitting intentions.

Past studies have thus demonstrated the model's usefulness across country contexts and IT applications, and shown that UTAUT can be usefully extended through incorporation of additional factors. UTAUT is thus considered an appropriate theoretical framework to underpin our examination of South African physicians' acceptance of e-prescribing. Our research model and associated hypotheses are developed next.

4 RESEARCH MODEL AND HYPOTHESES

Our research model is illustrated in Fig. 1. Consistent with UTAUT, our study's criterion variable is physician acceptance of e-prescribing systems, which is defined as the physician's behavioural intention to make use of e-prescribing technologies given the opportunity.

As suggested by UTAUT, the model identifies performance expectancy (H1), effort expectancy (H2), social influence (H4) and facilitating conditions (H5) as direct determinants of acceptance.

The model also identifies trust (H6) and price value (H9) as additional determinants of acceptance. This is consistent with recent extensions of UTAUT [25] [27] [28] and health IT acceptance studies (e.g., [43]). The model further proposes that performance expectancy is a mediator of the effects of both effort expectancy (H3) and trust beliefs (H7) on acceptance, and that trust will reduce effort expectancies (H8). The hypotheses as illustrated in the model are developed next.

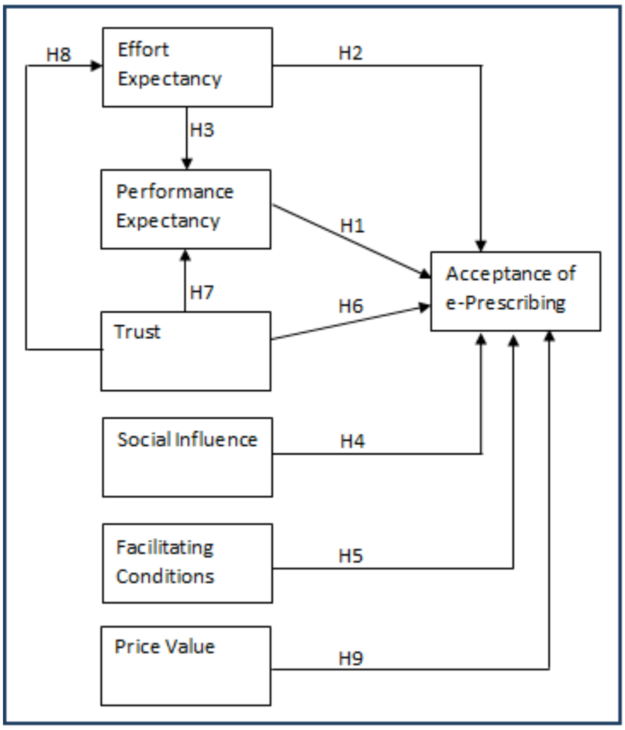

Figure 1: Research model

Performance expectancy refers to the perceived gains a user will achieve from using a system in their job context through direct improvements to work productivity and/or quality [24]. It is well recognised in technology acceptance research that user intentions to adopt a new technology are determined primarily by their perceptions that using such technology would be advantageous and performance enhancing [44] [45]. E-prescribing has the potential to improve physician productivity [8] and to improve the quality of the scripting process [9] [11] [13]. However, some studies raised concerns that using an online scripting system may create few time savings for physicians and can take significantly longer than simply writing a script [14], whilst others have suggested that the clinical benefits may be in question [16]. Physicians will need to believe that e-prescribing can improve their effectiveness and productivity if they are to accept it into their clinical practice. It is therefore hypothesised:

H1. The greater the performance expectancy, the greater will be physician acceptance of e-prescribing.

Effort Expectancy denotes the degree to which the use of a system is perceived to be free from physical or mental effort [46]. Technologies that are perceived to be easier and less complicated to use (low effort expectancy) will have a higher likelihood of acceptance [47]. Perceptions of increased effort would discourage physicians from using an e-prescribing system. Frustrating features of the technology might include clinically irrelevant alert messages that need to be dismissed [8], and unnecessary complexity added to the scripting process [16]. Studies have shown that e-prescribing systems must be easy to use for physicians under time pressure and to ensure safe e-prescribing [23]. Wright and Marvel [33] found effort expectancy to be the most important factor influencing physician satisfaction with an electronic health system. It is therefore hypothesised:

H2. The lower the effort expectancy, the greater will be physician acceptance of e-prescribing.

The technology acceptance model - upon which UTAUT is based - suggests that user perceptions of a system's usefulness (performance expectancy) mediates the effects of ease of use perceptions (effort expectancy) on system usage [44]. This is because users are unlikely to anticipate benefits from a system that is perceived difficult to use [45]. Prior health IT acceptance studies support the effect of effort expectancy perceptions on performance expectancy (e.g., [40] [48]). Thus, we further hypothesise:

H3. The lower the effort expectancy, the greater will be the performance expectancy.

Social Influence is an individual's perception that important others believe he or she should be using the technology in question [24]. Physicians are likely to have varying perceptions as to whether important others, such as professional bodies or their patients and colleagues, would support and approve of their use of e-prescribing. Despite suggestions that high levels of autonomy may lessen the influence of social influence on the behaviour of health professionals [34], social influence has been found in some empirical studies to predict healthcare professionals' acceptance of IT [40] [49]. It is therefore hypothesised:

H4. The greater the social influence to use e-prescribing, the greater will be physician acceptance of e-prescribing

Facilitating conditions are the resources needed by an individual to make use of a system [24]. These include financial and technical resources, support and training. An individual's perception of resource availability acts as a behavioural control influencing their decision on whether or not to make use of a technology [25]. In at least one health IT study, facilitating conditions were identified as the most important factors influencing adoption [38]. Inadequate technical support and limited onsite technology resources have also been identified amongst the barriers to e-prescribing [19], while financial resources to run e-prescribing systems have also been considered important [9] [16]. Kaushal et al. [15] found that the availability of extensive technical support was important to the successful use of e-prescribing. Moreover, training has been found important to ensuring safer use of e-prescribing technologies [23]. It is therefore hypothesised:

H5. The greater the perception of facilitating conditions, the greater will be physician acceptance of e-prescribing.

Trust in a technology is defined as a user's belief that the technology has attributes beneficial to the user, will behave in a dependable manner and in the interests of the user, and will perform according to the user's expectation [50]. Trust is considered important to user acceptance in contexts where uncertainties regarding the adequate functioning or benefits to be provided by the technology are high [51] or where risks of loss resulting from system use may be high [52]. Health informatics researchers recognise the importance of trust and that physician concerns over the functioning of health IT applications will slow adoption [43]. Trust is relevant in the e-prescribing context due to the potential for risk and liability if an e-prescribing system should prove to be unreliable or inaccurate, e.g., displaying incorrect medication or patient information or failing to adequately safeguard patient information. Trust has thus been suggested as a potential barrier to acceptance of e-prescribing systems [16] [19]. If a physician believes that an e-prescription system cannot be counted on to function in a consistent and reliable manner, it is unlikely that he or she will be accepting of it. It is therefore hypothesised:

H6. The greater the trust in e-prescribing technology, the greater will be physician acceptance of e-prescribing.

Moreover, recent IT usage research incorporating trust factors suggest that users are unlikely to form strong beliefs in benefits to be provided by a system, i.e. performance expectancies will be low, if they have uncertainties or lack confidence in the technology's ability to function reliably and consistently [51] [53]. Users will not believe they can successfully accomplish tasks and benefit from an IT system if they do not trust the properties of the system [51]. Hence, trust beliefs are proposed to influence performance expectancy. Empirical evidence in the context of electronic document services [28] and in nurse's perceptions of the usefulness of an electronic logistics system [54] suggests that trust beliefs are important to performance expectancy. We thus further hypothesise that:

H7. The greater the trust in e-prescribing technology, the greater will be the performance expectancy.

Finally in relation to trust, we recognise that trust beliefs may reduce perceptions of effort expectancy. This is because trust reduces the need for users to understand, monitor and pay extra attention to all aspects of their engagement with the system [53]. If trust is low, the need to monitor and check details will increase and consequently the time and effort required to interact with the system will increase [53]. Hellström et al. [22] found that a majority of Swedish e-prescribers felt the need to double check the system before transmitting prescriptions. We therefore hypothesise that:

H8. The greater the trust in e-prescribing technology, the lower will be the effort expectancy.

Price Value perception is an individual's evaluation of the net gain that could be derived from system use [25]. If physicians have to bear the cost of implementing and using the technology but experience few direct benefits then they will have little incentive to adopt [18] [19]. It is therefore hypothesised:

H9. The greater the perception of price value, the greater will be physician acceptance of e-prescribing.

5 METHODS

Data was collected via a cross-sectional survey methodology. A structured questionnaire was used to capture information from physicians who were familiar with e-prescribing systems. A sampling frame was constructed from a list of 379 physicians provided by an e-prescription application provider and a list of 260 physicians extracted from the South African Yellow Pages and having valid email addresses. This provided a combined sample of 639 potential respondents.

To capture the UTAUT variables, the survey made use of multi-item, 5-point Likert-type scales. The survey items are presented in the Appendix. All items were sourced from the literature. Performance and effort expectancy were each measured with six scale items adapted from [4] [24] [46]. Effort expectancy was measured such that high values represented low perceptions of effort and thus positive correlations with other constructs are expected. Social Influence was measured with three items from Ajzen [55] and Yi et al. [49]. Trust was measured with four items [56]. Price Value was measured with three items [25], and technology acceptance was measured using Venkatesh et al.'s three item scale [24]. We collected data on age, gender, computer experience, and asked physicians whether their primary source for having learned about e-prescribing was via their own research, from colleagues in the medical profession or from outside parties. Physicians were also provided an opportunity to add qualitative comments.

Ethics clearance was obtained from the relevant review committee at the University of the Witwatersrand, Johannesburg (protocol number: CINFO/1021). The cover letter with a link to the online questionnaire was sent to potential respondents via email. The instrument was pilot tested with two physicians prior to its administration.

6 RESULTS

6.1 Response profile

A total of 78 physicians responded to the survey, but after removing responses with large amounts of missing data or those with outlying response patterns, 72 usable responses remained.

Most of the responding physicians were male (75%), roughly 25% were between 30-45 years of age and 50% were between 45 and 60 years. Three quarters of respondents (75.4%) reported having more than 15 years of computing experience, whilst only 4% reported less than 5 years of experience. Approximately one-third of the responding physicians reported that they use or have trialed e-prescribing systems. There was generally a high level of acceptance of e-prescribing amongst the responding physicians (m=4.03). Of the responding physicians, 12.5% were over 65 and they exhibited the lowest acceptance scores. Acceptance is however generally comparable to findings in other countries (e.g. [44]).

Almost half (48%) of the responding physicians reported having done their own research into e-prescribing but others reported learning about it from other physicians (28%). We compared physician acceptance scores based on how they had learned about e-prescribing. Physicians who had heard about e-prescribing from fellow physicians were somewhat more likely to accept e-prescribing (m=4.32) than those who reported learning about it from other sources (m=3.81) or their own research (m=3.97).

There were no significant differences between current users and non-users along any of the variables, except price value where users had slightly higher perceptions of price value than non-users.

6.2 Measurement model

Prior to model testing, initial exploratory factor analyses were carried out to confirm unidimensionality of the reflective constructs. Results supported the theoretically defined constructs. Only one item was dropped at this stage as it loaded poorly (TR4).

The partial least squares (PLS) approach to structural equation modeling was then employed using the SmartPLS 2.0 software [57]. PLS proceeds in two phases. First, it allows for a confirmatory factor analysis to be carried out in order to ensure adequate convergent and discriminant validity of the measurement model. Second, it provides for an analysis of the hypothesised structural model.

We modeled all constructs in the reflective mode except facilitating conditions which we modeled in the formative mode. This is because the different facilitators such as technical resources, financial resources and support services will not necessarily covary. Results of the confirmatory factor analysis are reported in Table 1. Convergent validity was established by examining the average variance extracted (AVE) scores. These were all well above the recommended 0.60, confirming that constructs explained above 50% of the variance in their underlying items. Discriminant validity was confirmed by ensuring constructs shared more variance with their own items than with other constructs in the model[1] (refer Table 2). Cronbach's alpha and internal consistency scores confirmed the reliability of all scales.

6.3 Structural model

Satisfied as to the reliability and validity of the measurement model, we proceeded to test the hypothesised structural model (Fig. 1).

Given large observed correlations between facilitating conditions and effort expectancy (r=0.69) and trust (r=0.66) (Table 2), we included additional path between these constructs to improve the model fit. Results are presented in Fig. 2. The significance of the paths was determined by bootstrap resampling (1000 resamples), which is used to produce standard errors for calculating t-values. Our model controlled for age, gender and years of computing experience.

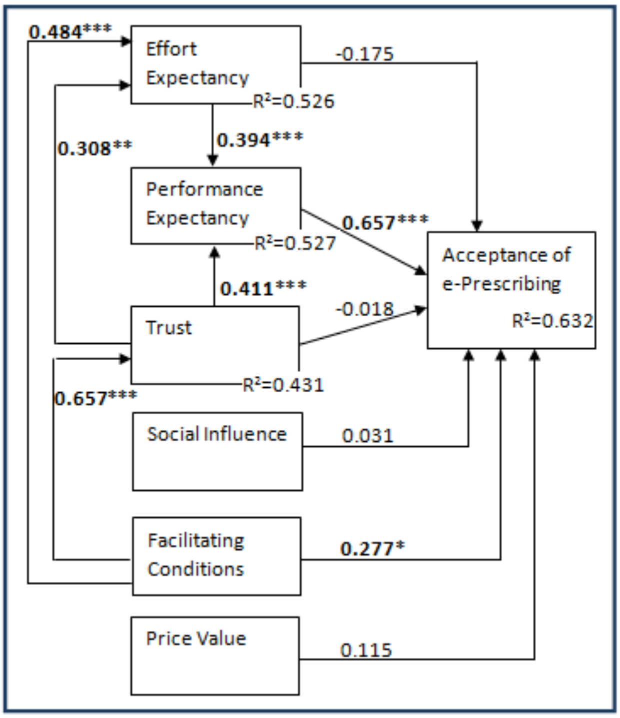

Figure 2: Partial least squares test of structural model (*** p<0.001; ** p<0.01; * p<0.05).

The model explains 63% of the variance in physician acceptance in e-prescribing (R2=0.632) and 5 of our 9 original hypotheses were supported. Firstly, results support H1 and confirm that performance expectancy has the largest impact on physician acceptance. This suggests that physicians must believe benefits from use will accrue and will outweigh the time spent prescribing electronically. The direct effects of both effort expectancy and trust on acceptance were not supported here and their effects are fully mediated by performance expectancy. Effort expectancy and trust are thus important to ensuring that physicians form positive perceptions about the impacts the technology will have on their work performance. Thus H3 and H7 are accepted but H2 and H6 are rejected. Some past studies found that capturing certain e-prescriptions took longer than writing prescriptions by hand. Any difficulties in using e-prescribing systems are likely to prevent expected benefits from being realised. H8 was also supported. Low levels of trust are a hurdle and lead to increased effort expectancy. Physicians must believe e-prescribing systems will be free of error and capable of delivering on expectations. Facilitating conditions has a significant direct effect on acceptance, thus supporting H5. Technical infrastructure and resources are needed if e-prescribing is to diffuse more rapidly into clinical practice. Although not originally hypothesised, it appears that facilitating conditions, such as technical support, help to promote trust and reduce effort expectancies. The variables of social influence and price value perceptions do not add additional explanatory power to the model, resulting in the rejection of H4 and H9.

Physician computer experience (β=-0.005), age (β=0.083) and gender (β=0.001) did not have significant links with acceptance. They are omitted from Fig. 2 to improve readability.

6.4 Qualitative findings

Qualitative comments provided by respondents corroborated much of the quantitative results, especially with regards to factors of performance expectancy, effort expectancy and facilitating conditions.

In relation to performance expectations, a number of physicians expressed concerns that the technology would negatively impact their process, and were not optimistic about time savings:

> "E-scripting is impractical . . . it is best to use traditional methods. Handing a patient a script improves therapeutic intervention, makes the service personal and in my opinion is better than facing a PC sending scripts out. Technology is great but it must not affect personal care."

> "too time consuming to use during a consultation."

> "I tried to use e-scripting but I still save a lot of time just writing them by hand."

> "Takes more time than writing a script - not cost effective."

> "My practice works more speedily & efficiently when scripts are hand written."

On the other hand, other physicians were more optimistic about the potential of the technology to improve performance:

> "[e-prescribing software X] eliminates all the errors in dosing, and at the same time the software itself has in-built ICD10 coding which is now a pre requisite to prescribing patient treatment."

[1] i.e., discriminant validity is confirmed when diagonal elements (square roots of each construct's AVE) are greater than off-diagonal elements (inter-construct correlations).

Table 1: Convergent validity and scale reliability

Construct and items	Loadings	Weights	Average Variance Extracted	Composite Reliability	Cronbach's alpha
Performance Expectancy (PE)			0.84	0.97	0.96
PE1	**0.91**	0.18			
PE2	**0.91**	0.18			
PE3	**0.93**	0.18			
PE4	**0.93**	0.18			
PE5	**0.95**	0.19			
PE6	**0.88**	0.19			
Effort expectancy (EE)			0.64	0.91	0.89
EE1	**0.83**	0.23			
EE2	**0.80**	0.18			
EE3	**0.79**	0.15			
EE4	**0.74**	0.26			
EE5	**0.79**	0.15			
EE6	**0.85**	0.28			
Trust (TR)			0.82	0.93	0.89
TR1	**0.87**	0.37			
TR2	**0.94**	0.39			
TR3	**0.90**	0.35			
Social Influence (SI)			0.95	0.98	0.97
SI1	**0.97**	0.34			
SI2	**0.98**	0.32			
SI3	**0.98**	0.37			
Facilitating Conditions (FC)			N/A	N/A	N/A
FC1	0.32	**0.03**			
FC2	0.38	**0.10**			
FC3	0.84	**0.46**			
FC4	0.89	**0.64**			
Price Value (PV)			0.93	0.98	0.96
PV1	**0.95**	0.31			
PV2	**0.98**	0.34			
PV3	**0.96**	0.39			
Acceptance (A)			0.94	0.98	0.97
A1	**0.97**	0.34			
A2	**0.97**	0.36			
A3	**0.96**	0.34			

> "Makes for easier record keeping and fits into a more comprehensive ePatient Record System."

In relation to effort expectancy and ease of use, there were also some concerns expressed:

> "The user interface is still quite cumbersome ... I don't use the program much because of the cumbersome nature of it . . . it is not always on line when I am consulting."

> "Too much admin to use."

> "Patients do not like a doctor whose nose is frequently stuck in a computer."

It was also apparent that vendors can do much to improve usability and ease of use as reflected in this physician's comment:

> "[e-prescribing software Y] was free but not very user friendly. I used it and was great but my software I use now is much more friendly and works for me!"

Some physician practices may still struggle with the required facilitating conditions. The need for facilitating resources together with the absence of skills and vendor support led to some frustration in a few practices. For example, some physicians commented:

> "[I] do not have the time nor the money for extra staff to capture all the initial data on the computer."

> "[The vendor] took more than a month to link me to the system after registering, so I never started using it."

> "Need easy step by step explanation setup and how it works and how to use it."

> "My current [software] system cannot be updated, i.e., new medications cannot be added by the suppliers."

> "system works but developer has no interest (as per usual) to make it work well, let alone optimal."

Table 2: Discriminant validity

	A	EE	FC	PE	SI	TR	PV
A	0.97						
EE	0.47	0.80					
FC	0.60	0.69	N/A				
PE	0.75	0.65	0.60	0.92			
SI	0.35	0.11	0.21	0.39	0.98		
TR	0.54	0.63	0.66	0.66	0.24	0.91	
PV	0.46	0.47	0.58	0.41	0.19	0.48	0.96

Additional insights were also provided with regards to physicians' broader concerns about the regulatory and technical environments available to support e-prescribing. Broader technical and regulatory issues are still undermining the perceived benefits of the technology, with physicians commenting:

> "e-prescribing still requires ink signature to be legal . . . electronic signature or image should be legalised."

> "Interoperability and confidentiality remain the two biggest problems."

> "Have yet to find a product that integrates properly with the billing system, but remains fully functional and quick."

7 DISCUSSION

Diffusion of e-prescribing systems into physician practice has been slow. This is despite the potential of such systems to improve the quality and safety of the prescribing process. To better understand the perceptions and attitudes of physicians, we carried out a survey of 72 physicians in South Africa. We found that physicians were generally accepting of the technology.

In the context of health IT acceptance, prior work has been inconclusive regarding which factors are most important to acceptance. Our results show that in the context of e-prescribing technology, it is performance expectations that are most important to acceptance. Physicians must be convinced about the performance advantages of e-prescribing. E-prescribing systems must therefore be designed to bring direct benefits to the physician in the form of improved productivity and a more effective prescribing process. The reliability of e-prescribing must also be demonstrated. This is important to ensuring that trust in the technology is built and consequently increasing perceptions of e-prescribing's usefulness.

Our findings also confirm that e-prescribing is a complex task that requires both software and hardware to be optimally configured [14]. E-prescribing systems must be stable, accurate and perform consistently, and must add value without impacting negatively on the physician's ability to interact with patients. The systems must be easy to use, and unobtrusive at the point of care. Convincing physicians that e-prescribing is low effort will be important to ensuring they see advantages in using technology.

In addition, physician practices often lack necessary technology infrastructure and skills. Our findings thus corroborate suggestions [9] that vendor monitoring and outreach are essential to ensure that physicians have up-to-date software and functional hardware. Vendor support can go a long way to removing the frustration and barriers to use, but must be delivered in a reliable manner.

Our study has provided a useful theoretical contribution by modifying UTAUT to include trust as a salient belief in technology acceptance. Physicians must feel comfortable using the technology [16], and feel they can trust the technology to perform reliably and meet their expectations. Lack of trust, e.g., the need to carry out additional checks [22], will increase the effort and decrease potential productivity benefits of e-prescribing.

Our findings in relation to social influence are similar to those reported in Duyck et al.'s study of PACS acceptance by radiologists [34]. In the presence of other factors, social influence does not appear sufficient to influence the acceptance of technology by autonomous health workers. These professionals appear to act based on their own assessments and are less likely to be sufficiently swayed by the influence of others.

Full benefits and support for the technology may not however be realised until electronic signatures, integration into other health IT systems, and connectivity into dispensing pharmacy systems are in place [20]. While these issues were raised in qualitative comments, we had not included them in our research model and future research may wish to incorporate these considerations more explicitly.

Future research should consider the hardware platforms, e.g., tablet vs desktop, most supportive of use. Moreover, our performance expectancy scale focused mostly on productivity benefits to the physician. Future work should focus on physician perceptions of other benefits such as to the patient experience. Moreover, additional impact studies should be undertaken to confirm the technology's potential to improve the safety of the scripting process.

While physicians were generally positive about the potential for e-prescribing, both quantitative and qualitative findings indicate there is a good deal of variation in physician perceptions of its usability and the value it could bring to their clinical practice. Future research should continue to investigate these perceptions as well as the impacts of e-prescribing on the quality of care provided.

7.1 Practical implications

E-prescribing is a high-potential application of health information technology. Yet, a number of problems can complicate their use and limit their acceptance into clinical practice. Our quantitative and qualitative findings show that physicians will only be persuaded to incorporate the technology into their clinical practice if they perceive advantages, which must be accompanied by high levels of system usability and trust in the capabilities of the technology to perform reliably. The interface of the system must be intuitive and promote ease of use without compromising safety in prescribing or interfering with physician-patient interaction. Should the physician struggle to access functionality, it is likely that e-prescribing won't achieve the performance benefits expected, and users will revert to hand written prescriptions. System design should ensure the stability and reliability of the system so as to engender trust and reduce uncertainties and risk.

Systems must be kept up-to-date (e.g., formulary lists) and be seen to benefit clinical practice. Facilitating conditions must also be present e.g. users must receive adequate technical support and training. Vendors can go a long way to removing the frustration and barriers to use, but their support must be delivered in a reliable and responsive manner. Benefits of the technology can also be enhanced by enabling easier integration with existing medical record and practice management systems. If the use of the technology is associated with duplication of data and effort, it will not gain widespread acceptance.

Our results also suggest that e-prescribing must not only provide productivity and clinical benefits but must also represent a cost-effective solution for physicians. It may be necessary not only to subsidise initial software costs but also the costs associated with ongoing maintenance and use.

Moreover, the benefits of use are unlikely to materialise without complementary regulation that promotes health IT use more broadly. Lessons may be learned from the Swedish experience with the use of e-prescribing and the electronic transmission of prescription data within a context of a national health system.

7.2 Limitations

Our study was limited in a number of respects. The sampling frame was constructed and thus the generalisability of the findings may be compromised. Moreover, our focus on physicians with email addresses and the use of an online rather than paper-based survey acted as a partial control for computer literacy and PC experience that might bias our findings with regards to the acceptance of e-prescribing. Results are less generalisable to physician groups without email and little computer experience. The cross-sectional nature of data collection also limits our ability to draw strong causal inferences.

8 CONCLUSION

This study has improved our understanding of the factors influencing South African physicians' acceptance of e-prescribing. Analysis of a modified UTAUT model allowed important interrelationships amongst explanatory factors to be examined and their combined effects on acceptance to be tested. Findings reveal that performance expectancy and facilitating conditions are directly related to acceptance whilst effort expectancy and trust have important indirect effects. Physicians are not necessarily motivated by social influence. Incorporating trust into UTAUT was an important theoretical extension and trust was shown to have important effects on the formation of performance and effort expectancies. Vendors should ensure that systems are designed to provide productivity and clinical benefits without compromising usability. Systems must be trusted to perform reliably and consistently and with adequate support on hand.

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APPENDIX

Measurement items

All items were measured on a five-point Likert scale (1 = 'strongly disagree' — 5 = 'strongly agree').

Performance expectancy

(PE1) Using e-prescriptions in my job would enable me to accomplish tasks more quickly.
(PE2) Using e-prescriptions would improve my job performance.
(PE3) Using e-prescriptions in my job would increase my productivity.
(PE4) Using e-prescriptions would enhance my effectiveness on the job.
(PE5) Using e-prescriptions would make it easier to do my job.
(PE6) I would find e-prescriptions useful in my job.

Effort expectancy

(EE1) Learning to operate e-prescriptions would be easy for me.
(EE2) I would find it easy to get e-prescriptions to do what I want it to do.
(EE3) I would understand how to interact with e-prescriptions.
(EE4) I would find e-prescriptions to be flexible.
(EE5) It would be easy for me to become skilful at using e-prescriptions.
(EE6) I would find e-prescriptions easy to use.

Facilitating conditions

(FC1) I would have the resources necessary to use e-scripting.
(FC2) I would have the knowledge necessary to use e-scripting.
(FC3) e-Scripting would be compatible with other systems I use.
(FC4) A specific person (or group) would be available for assistance with system difficulties.

Social influence

(SI1) People who influence my behaviour think that I should use e-prescriptions.
(SI2) People who are important to me think that I should use e-prescriptions.
(SI3) People whose opinions I value think I should use e-prescriptions.

Trust

(TR1) I believe e-prescriptions will always meet my expectations.
(TR2) I believe e-prescriptions can be counted on to fulfil their function well.
(TR3) I believe e-prescriptions will be reliable.
(TR4) I believe e-prescriptions cannot always be trusted (reverse coded)[2].

[2]This item dropped following initial exploratory factor analysis.

Price value

(PV1) e-Prescriptions are reasonably priced.
(PV2) e-Prescriptions is good value for money.
(PV3) At the current price, e-prescriptions provide good value.

Acceptance

(A1) I intend to use e-prescriptions, given the opportunity.
(A1) I predict I would use e-prescriptions, given the opportunity.
(A1) I plan to use e-prescriptions, given the opportunity.