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USER ACCEPTANCE OF PICTURE ARCHIVING AND COMMUNICATION SYSTEMS AT INTERMEDIATE HOSPITAL KATUTURA, NAMIBIA

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Abstract

Aim. The success of technology such as picture archiving and communication systems (PACS) depends on users' willingness to accept it. Despite its widespread adoption and the huge financial investment associated with it, there is still very limited knowledge concerning user acceptance of PACS in Africa. User acceptance of PACS influences how beneficial the technology will be to healthcare therefore it should be investigated. This study aimed to understand user acceptance of PACS by diagnostic radiographers at a Namibian hospital.

Methods. This was a quantitative study conducted at a Namibian state hospital from May to June 2022. All the radiographers who had experience working with PACS at the hospital were assessed using a modified unified theory of acceptance and use of technology (UTAUT) model. The data were analysed using IBM SPSS to determine factors affecting user acceptance.

Results. The results indicate performance expectancy ($p=0.000$), and perceived trust ($p=0.046$) significantly influenced the willingness of users to accept PACS. The study also reported a high level of the participants' willingness to accept PACS (88.5%). Only 30.7% of the participants were found to have had formal training on PACS.

Conclusion. To enhance PACS's success, training for all users must be prioritised. This study identifies factors that influence user acceptance. The findings therefore can be used as evidence in future PACS implementation.

Keywords. radiology information systems, information storage retrieval, radiography, health information systems, medical informatics

INTRODUCTION

It is well established that medical information systems such as picture archiving communication systems (PACS) improve the quality of patient care and make work more efficient for radiographers because it enables image retrieval, manipulation, and transfer over long distances.^[1] PACS is a technology that aids in the diagnosis and treatment of patients. Therefore, its acceptance should be thoroughly established while user acceptance is defined as the willingness of users to use a certain technology.^[1,2] It is known to improve workflow, increase output, and reduce patient waiting time and turnaround times of clinical reports.^[2] Despite the numerous benefits of PACS, like any new technology, it is also faced with implementation challenges. Financial, technical, organisational, and human challenges were identified as the four main threats to PACS implementation.^[3] Studies concerning user acceptance of PACS are still surprisingly

very limited, especially in developing countries, despite its widespread adoption.^[1] The researcher could not find published studies conducted in Southern Africa concerning user acceptance of PACS from the user's perspective using the unified theory of acceptance and use of technology (UTAUT) model. Therefore, there exists a real need to fill this gap in the literature. This study represents one of the first of its kind to be conducted in Namibia.

Studies conducted in Kuwait, Iran, and Saudi Arabia confirmed that the success of technology greatly depends on users' willingness to accept it thereby proving that user acceptance of technology must be assessed for every new technology.^[1,2,4] PACS acquisition is an activity that is too expensive to leave to chance. It is thus important to ensure its success by identifying factors that could influence adoption and minimise nonacceptance.^[1,2]

User acceptance plays a crucial role in the successful implementation of PACS because of the four main PACS implementation threats identified; the human factor is considered the most crucial.^[5] Many authors^[6-10] have established user acceptance of technologies such as social media, e-learning applications, mobile banking systems, and e-government to determine the level of user acceptance, and to identify factors that could hamper adoption and use.

A study conducted in a radiology department in Saudi Arabia revealed that users believed PACS greatly enhanced the quality of their work in providing patient care and were keen on using PACS^[11] proving that for PACS to be accepted, it would have to increase productivity and efficiency. The same study concluded that PACS training needed to be aimed more at ensuring that users found the system useful in doing their jobs which meant managers had to ensure that technical and organisational structures were in place.^[11] One study in South Africa^[5] assessed PACS implementation challenges faced by vendors. The results of this study identified a lack of computer literacy and basic IT skills as the main contributing factors to the failure in the adoption and use of PACS. Training of staff is thus essential in ensuring a smooth transition from a paper-based to a computer-based system.^[5,11,12] Furthermore, it was noted that a large number of PACS in South African state hospitals were still not functioning properly. The paucity of research investigating factors influencing user acceptance of PACS in developing countries has been the motivation behind this study because, to the researcher's knowledge, such a study is yet to be conducted in Namibia.

TECHNOLOGY ACCEPTANCE THEORIES

The literature reviewed revealed that user acceptance of technology can be assessed using different models, however for this study, the UTAUT model was selected because it demonstrates as much as 70% of the variance in intention to use technology better than other models.^[10,13] Furthermore, it can be modified to suit the context.^[2,9,14-16]

Given the paucity of investigations on this topic worldwide and, specifically in Southern Africa, this research aimed to gain an understanding of user acceptance of PACS and to determine factors affecting user acceptance by diagnostic radiographers at a Namibian hospital using a modified UTAUT model.

METHODS

Research ethics approval was acquired from the university and the Ministry of Health and Social Services Research Ethics Committee. Site permission was acquired from the hospital. To adapt the research instrument^[17] the researcher used focus group discussions to identify themes that were considered significant to user acceptance of PACS by radiographers. Three themes were identified: perceived trust (PT), perceived awareness (PA), and perceived use (PU). These themes were added to the original UTAUT mod-

el bringing the total to eight constructs. The questionnaire was reviewed by peers to eliminate any faults or ambiguity and no changes were made.

The survey instrument consisted of structured questions which participating radiographers rated using a five-point Likert scale (*strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*). A link was distributed to the total number of radiographers employed at the hospital at the time of data collection who had experience with PACS (n=26) resulting in a 100% response rate. Data were collected through a Google survey from all the radiographers who voluntarily and anonymously returned completed questionnaires. The hospital was the only state hospital in the country that had a PACS therefore, due to the limited size of the population (i.e., 26 radiographers), no sampling was done to avoid distortion of data. Furthermore, to respect participants' privacy and confidentiality, the completed questionnaires had no personal identifiers. Completion and submission of the survey questionnaire showed informed consent (written) to partake in the study.

The data from the amended UTAUT questionnaire were analysed using IBM SPSS (version 26). Cross tabulations and descriptive analysis were performed to include mean, standard deviations, frequency, and percentages. The inferential analysis included paired and independent t-tests, Stepwise multiple regression, and ANOVA tests. Comparisons were made using Chi-square tests. A p-value of $p < 0.05$ was considered statistically significant.

RESULTS

» Questionnaire reliability

The reliability of the amended UTAUT questionnaire was measured using Cronbach's alpha and found to be $p=0.90$. Cronbach's alpha for new instruments is required to be over $p=0.70$.^[1-3]

» Demographics

There was an equal number of male and female participants (male 50%/female 50%). Most of the participants were between the ages of 25 to 35 years (76.9%); a mean age of 33.5 ± 7.9 years. In terms of qualifications, the majority (84.6%) had degrees in radiography. Most of the participants had a bachelor's degree (65.4%). Participants with the highest working experience with PACS had 1 to 5 years (46.2%).

» The participants' responses to the eight constructs

Overall, users had a good intention to accept PACS (88.5%). Over 50% of participants found that PACS was easy to use and greatly improved their work. Participants recommended the continued use and installation of PACS country-wide (92.3%). Only 30.7% of the participants reported having had formal PACS training. The main reason that participants use PACS was that it allows them to store and retrieve old images (84.7%). The rest of the results are shown in Table 1.

» Association between demographic factors and behavioural intention

Table 2 shows a cross-tabulation between the demographic factors and behavioural intention (acceptance) indicated p-values above $p=0.05$ for all demographic factors. Thus had no statistical significance.

» Factors affecting user acceptance of PACS.

The analysis of the factors affecting the acceptance of PACS was adapted from Aldosari and Marchewka.^[1,9] A stepwise multiple regression between behavioural intention (use) and the amended UTAUT constructs revealed that only performance expectancy ($p=0.000$) and perceived trust

Table 1. The participants' responses to the eight constructs

CONSTRUCT	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Mean	SD
EFFORT EXPECTANCY	%						
EE1: My interaction with PACS is clear and understandable (ee1)	19.2	57.7	7.7	11.5	3.8	2.23	1.032
EE2: Learning to use PACS was easy for me (ee2)	23.1	46.2	7.7	19.2	3.8	2.35	1.164
EE3: I find PACS easy to use (ee3)	19.2	53.8	11.5	0	15.4	2.23	.951
EE4: I find PACS flexible to interact with (ee4)	19.2	42.3	34.6	3.8	0	2.23	.815
EE5: It was easy to become skillful at using PACS (ee5)	11.5	46.2	23.1	19.2	0	2.50	.949
EE6: It is easy to get PACS to do what I want it to do (ee6)	11.5	30.8	26.9	30.8	0	2.77	1.032
EE7: Using PACS does not take too much time from my normal duties (ee7)	15.4	50.0	23.1	3.8	7.7	3.23	1.210
EE8: I don't prefer manual radiography over PACS (ee8)	23.1	53.8	19.2	0	3.8	3.54	1.174
PERFORMANCE EXPECTANCY	%						
PE1: I find PACS useful in doing my work (pe1)	15.4	69.2	7.7	3.8	3.8	2.12	.864
PE2: PACS helps me accomplish my tasks more quickly (pe2)	11.5	65.4	15.4	3.8	3.8	2.23	.863
PE3: PACS improves my work performance (pe3)	15.4	46.2	30.8	7.7	0	2.31	.838
PE4: PACS improves the quality of patient care provided to patients (pe4)	23.1	50.0	11.5	15.4	0	2.19	.981
PE5: Using PACS increases my productivity (pe5)	19.2	46.2	23.1	11.5	0	2.27	.919
PE6: Using PACS makes it easier to do my job (pe6)	23.1	57.7	11.5	3.8	3.8	2.08	.935
PE7: Using PACS means I can access old patient images whenever I need them (pe7)	34.6	30.8	34.6	0	0	2.00	.849
FACILITATING CONDITIONS	%						
FC1: I always have the resources necessary to use PACS (fc1)	7.7	23.1	46.2	11.5	11.5	2.96	1.076
FC2: I have enough knowledge to use PACS (fc2)	15.4	30.8	30.8	19.2	3.8	2.65	1.093

FC3: PACS is compatible with the other technologies in the X-RAY department (fc3)	11.5	46.2	30.8	11.5	0	2.42	.857
FC4: There is always someone available to assist me should I need help with PACS (fc4)	3.8	26.9	26.9	26.9	15.4	3.23	1.142
FC5: PACS fits into how I like to work (fc5)	23.1	42.3	15.4	7.7	11.5	2.42	1.270
SOCIAL INFLUENCE	%						
SI1: People important to me think I should use PACS (si1)	23.1	23.1	38.5	11.5	3.8	2.72	1.137
SI2: People whose opinion I value think I should use PACS (si2)	23.1	26.9	30.8	7.7	11.5	2.80	1.291
SI3: In general, the hospital supports the use of PACS (si3)	19.2	34.6	42.3	0	3.8	2.46	.948
SI4: The senior management of the hospital has been helpful in the use of PACS (si4)	19.2	26.9	38.5	3.8	11.5	3.12	1.107
BEHAVIOURAL INTENTION	%						
BI1: I recommend the installation of PACS at other hospitals (bi1)	61.5	26.9	3.8	0	7.7	1.65	1.129
BI2: I recommend the continued use of PACS (bi2)	57.7	34.6	0	0	7.7	1.65	1.093
PERCEIVED AWARENESS	%						
PA1: I know the benefits of using PACS (pa1)	38.5	53.8	0	0	7.7	1.85	1.047
PA2: I have gone through official training on using PACS (pa2)	3.8	26.9	19.2	19.2	30.8	3.46	1.303
PA3: I know about the overall features of PACS (pa3)	7.7	26.9	34.6	19.2	11.5	3.00	1.131
PERCEIVED TRUST	%						
PT1: The PACS is overall reliable (pt1)	19.2	50.0	11.5	15.4	3.8	2.35	1.093
PT2: If I save images on PACS, I am guaranteed to find them later (pt2)	15.4	53.8	19.2	7.7	3.8	2.31	.970
PT3: Images I take are automatically saved on PACS (pt3)	7.7	30.8	19.2	34.6	7.7	3.04	1.148
PERCEIVED USE	%						
PU1: I use PACS because it allows me to store images for long periods (pu1)	42.3	46.2	3.8	3.8	3.8	1.81	.981
PU2: I use PACS because it allows me to retrieve old images (pu2)	46.2	38.5	7.7	3.8	3.8	1.81	1.021
PU3: I use PACS because it allows me to do post-processing of images (pu3)	26.9	30.8	26.9	7.7	7.7	2.38	1.203
PU4: I use PACS because the hospital management requires me to use it (pu4)	3.8	26.9	30.8	23.1	15.4	3.19	1.132

Values are presented as mean \pm standard deviation.

Table 2. Association between demographic factors and behavioural intention

Variable	Sig.	95.0% Confidence Interval
Participants' age	.733	-0.357 (-2.506-1.792)
Participants' gender	.568	-0.549 (-2.521-1.423)
Participants' years of experience	.491	0.717 (-1.411-2.845)
Participants' highest qualification	.856	0.199 (-2.060-2.458)
Participants' job title	.858	0.361 (-3.809-4.532)

a. Dependent variable: BI_SCORES

Table 3. Results of stepwise multiple regression for behavioural intention

Independent variable	t	Sig.	Upper bounds	Lower bounds
EE SCORES	.508	.618	-.167	.273
PE SCORES	4.791	.000	.209	.537
FC SCORES	-1.868	.079	-.473	.029
SI SCORES	-.747	.465	-.328	.156
PA SCORES	-1.570	.135	-.608	.089
PT SCORES	2.154	.046	.007	.640
PU_SCORES	.838	.414	-.201	.465

($p=0.046$) had any statistical significance, as shown in Table 3.

DISCUSSION

The study aimed to investigate the modified UTAUT factors' influence on the willingness of users (radiographers) to accept PACS at a Namibian state hospital. Demographic factors did not affect the participants' willingness to accept PACS. Studies like the current one also noted no strong evidence to suggest that demographic factors had any influence on the intention to use technology.^[1,9,18]

The results show that overall, the participants had a good acceptance level of PACS. This was confirmed by 88.4% of them recommending the installation of PACS in other radiology departments nationwide. Of these 86.9% confirmed that PACS helped them accomplish tasks quicker and more efficiently meaning that even though PACS use was compulsory, they were encouraged to use it due to its increased performance efficiency. This finding is in keeping with other researchers who studied user acceptance of various technology.^[10,12,17,19] What was surprising to note was that although PACS has been in use for several years, only 30.8% of the participants underwent professional training regarding the overall features of PACS which suggests that although radiographers used PACS, they may not know how to exploit it to its fullest potential.

Performance expectancy ($p=0.000$) was found to be the most significant determinant of user acceptance. These findings are in line with results by authors who used the older model, the modified TAM,^[1,18] and authors using a variation of UTAUT models^[10,12,19,20] thereby confirming the significant role that performance expectancy plays in the

willingness to accept technology. Most participants (61.6%) believed that PACS improved their work performance and improves the quality of patient care provided. However, 34.6% were more neutral in terms of whether they could access all images when they needed them. This could be due to the concern that participants highlighted with regards to the PACS only saving images after a radiographer is prompted to do so rather than automatically saving all images taken by radiographers. Furthermore, participants were concerned that because the study site is a teaching hospital, inexperienced students may forget to save images that would then be lost as a result.

Contrary to findings in the literature,^[21] which rejected the hypothesis that trust significantly affects the willingness of users to accept technology, the current study demonstrated a positive correlation between perceived trust and behavioural intention to use PACS ($p=0.046$). For example, 69% of the participants agreed that PACS was overall reliable. Of these participants, more than half (61%) recommended the continued use of PACS, proving that trust in a system plays a significant role in users' willingness to adopt it. According to the literature, the biggest concern regarding trust is PACS image storage capacity, which is the number of images that can be archived on PACS until patients' records can be stored;^[5] this was also indicated to be a concern by participants in this study. A study investigating PACS implementation challenges in South Africa noted that hospitals do not calculate their image storage needs correctly which leads to insufficient storage capacity in the years following PACS installation.^[5]

Effort expectancy, social influence, perceived awareness, perceived use, and facilitating condition had no statistical significance on the participants' willingness to accept PACS.

The p-values for these constructs were above $p=0.05$. Other authors also noted no statistical significance in these constructs during similar studies.^[10,12] Concerning effort expectancy, most participants (53.8%) found PACS easy to use. This may be because 65.4% had a bachelor's degree, which indicates a high educational background, and may explain why effort expectancy had no significant influence on acceptance. Furthermore, a study found that it made no difference how hard the system was to use, if it proved useful to their job, radiographers would use it.^[3] Overall, most participants agreed that the system was easy to use (73%). However, less than half of these participants knew about the overall features of the system (47%), indicating a strong need for training. The results indicate that although perceived awareness had no statistical significance on acceptance of PACS, participants rated the item PA3 "I know about the overall features of PACS" poorly. A study in Romania found that failure to adequately offer training to all system users had a less than favourable outcome in its implementation.^[22] Concerning social influence, a study discovered that social influence was only significant in the first four weeks of implementation and became less important as time went on which suggested that social influence was only important when users had limited familiarity with the new technology.^[7] Due to the PACS in this study being in existence for several years, social influence did not affect acceptance.

LIMITATION

The population size of the study was small and may reduce the generalisability of findings. However, despite this, the study gives useful insights into factors motivating user acceptance of PACS in developing countries.

CONCLUSION

The study indicated that PACS significantly improved work performance, and the participants had a positive attitude toward it. This is advantageous because it has an impact on PACS's success. A lack of training was surprisingly noted in most participants. To ensure successful PACS implementation, training should be prioritised for all radiographers including newly employed radiographers. Furthermore, a PACS with sufficient image storage and automatic image storing to prevent image loss must be made available to ensure user confidence in the system. One of the key strengths of this study is that it is the first of its kind to investigate user acceptance of PACS in Namibia. The modifications to the UTAUT model applied in this study can be used as a foundation for further research assessing user acceptance of PACS in developing countries.

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COMPETING INTERESTS

The authors declare no financial or personal incentives that may have influenced the writing of this paper.

AUTHORS' CONTRIBUTIONS

MM was the main researcher and drafted the manuscript. YS reviewed the manuscript and provided critical comments on methodology and literature review.

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