

12-31-2005

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Carol Alcock
University of South Australia

Lois Burgess
University of Wollongong

Joan Cooper
Flinders University

Damian Ryan
Wollongong Hospital, Wollongong, Australia

Jason Sargent
University of Wollongong

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Recommended Citation

Alcock, Carol; Burgess, Lois; Cooper, Joan; Ryan, Damian; and Sargent, Jason, "Enhancing User Acceptance of Mandated Technology Implementation in a Mobile Healthcare Setting: A Case Study" (2005). *ACIS 2005 Proceedings*. Paper 40.
<http://aisel.aisnet.org/acis2005/40>

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Enhancing User Acceptance of Mandated Technology Implementation in a Mobile Healthcare Setting: A Case Study

Jason Sargent
Lois Burgess
Professor Joan Cooper
Associate Professor Carole Alcock
Dr Damian Ryan

School of Economics and Information Systems (SEIS)
University of Wollongong
Wollongong, Australia
Email: jsargent@uow.edu.au

School of Information Technology and Computer Science (SITACS)
University of Wollongong
Wollongong, Australia
Email: lburgess@uow.edu.au

Flinders University
Adelaide, Australia
Email: Joan.Cooper@flinders.edu.au

University of South Australia
Adelaide, Australia
Email: Carole.Alcock@unisa.edu.au

Medical Director, The Ambulatory Care Team (TACT), Northern Illawarra
Lawson House, Wollongong Hospital
Wollongong, Australia
Email: RyanD@iahs.nsw.gov.au

Abstract

A paradigm shift is underway towards the acceptance and utility of Personal Digital Assistant (PDA) systems within mobile-based healthcare environments. This paper contends that intervening to address user concerns as they arise throughout the system development lifecycle will lead to greater levels of user acceptance, while ultimately enhancing the deliverability of a system that provides a 'best fit' with end user needs. It is envisaged this research will lead to the development of a framework based on an agile approach to user acceptance measurement. The results of an ongoing study of user perceptions towards a proposed mandated electronic point-of-care (ePOC) information system in the Northern Illawarra Ambulatory Care Team (TACT) are presented.

Keywords

User Acceptance, Mobile Health, Health Information Systems, Personal Digital Assistants, Agile Approach

INTRODUCTION

From a clinical perspective, the use of mobile technologies such as Personal Digital Assistants (PDAs) within hospital environments is not new. Forrester Research indicates that "Doctors were the first large worker base that started using PDAs on the job" (Havenstein, 2005). Additionally, the U.S. Department of Health and Human Services in 2004 highlighted a 10-year roadmap for improving the nation's healthcare system through increased hospital use of information technology (MedPDA.net, 2004). PDAs as wireless deployment platforms for mobile-based *hospital* clinical information have "proven to be among the most cost effective ways to improve patient care quality and reduce medical data collection errors. Medical professionals empowered by information make better decisions while at the patient's bedside" (ibid). A paradigm shift in the acceptance and

utility of such PDA-based systems is underway. The challenge for Australian community health services, many of which rely on legacy and paper-based systems, is to map clinical pathways so that the beneficial aspects of mobile-based health information systems progress beyond the confines of traditional ‘bricks & mortar’ hospital infrastructure into increasingly essential point-of-care settings, particularly Ambulatory Care settings. This challenge is non trivial and should not be underestimated.

Three levels of perceptions in regards to proposed technology implementations must be acknowledged to achieve ‘best fit’; perceptions at an organizational level (Government health departments), at the Service level (community health services) and at the end user level. Introducing new technologies and associated work practices has intrinsic risks which must be addressed preferably through, as this research suggests, a strong consultative process between system developers and end users. This paper contends that intervening to address end user concerns as they arise throughout the system development lifecycle will lead to greater levels of user acceptance, while ultimately enhancing the deliverability of a system that provides a ‘best fit’ with end user needs. By adopting this approach, researchers aim to achieve acceptance levels approaching 100% of a PDA-based health information system for deployment within Ambulatory Care services. Preliminary analysis of results suggests this aim is achievable.

THEORETICAL BASIS OF THE STUDY

Extensive research on user intentions to adopt new technologies exists, however, much of this research has been conducted in environments where adoption is voluntary (Brown et al., 2002). A voluntary use environment is defined as “one in which users perceive the technology adoption or use to be a wilful choice; a mandated environment is where users perceive use to be organizationally compulsory” (ibid). Brown et al. go on to suggest that in these environments, the new system must be used to complete job tasks that are tightly integrated with the tasks of multiple workers. Impressions may exist whereby any form of consultative input from end users is inherently removed; leaving end users disillusioned with the technology.

The impact of many well intentioned technology integration projects has not always been viewed favourably. In fact, many projects are destined to fail from the outset by not considering fundamental IT systems investment risks (technical failure, data failure, user failure, organizational failure) (Lyytinen and Hirschiem, 1987). With any new technology “an element of uncertainty exists in the minds of decision makers with respect to the successful adoption of them” (Bagozzi et al, 1992). According to Rogers (1995, cited in Toleman, 2004), the adoption process is defined as “the process through which an individual or other decision making unit passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision”.

The approach used in this study is not a substitute for traditional technology acceptance models. Rather, the approach taken by the authors should be viewed as tangential upon the overall theme of user acceptance. The results of this research support the acknowledged hypotheses of the Technology Acceptance Model (TAM) (Davis, 1985), the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980) and the Theory of Planned Behavior (TPB) (Ajzen, 1985), yet go further by seeking to illustrate improved deliverability of information systems, particularly mandated mobile health information systems, using an approach consistent with the premise of agile approaches to software development. The approach used assesses user perceptions of the proposed technology at regular points throughout the system development lifecycle, consistent with Toleman et al’s (2004) assertion that perception “takes place through a sequence of stages through which a potential adopter of an innovation passes before accepting the innovation”. A continuous consultative approach with users, with the intention of allaying user concerns over the new system, along with regular user surveys, focus groups and workshops enables intervention at critical points in the system development lifecycle. The aim of this process is to enhance user acceptance, the goal being to achieve 100% acceptance of the “delivered” system. This process was facilitated through the use of a measurement scale (Kline’s Groupware Adoption Scale) combined with Davis and Venkatesh’s model of “preprototype user acceptance”. Socio-cognitive models such as TAM and TRA aim to predict and explain end user adoption and acceptance of information systems (IS). Both models assume that given sufficient time and knowledge about a particular behavioral activity, an individual’s intention will closely resemble how they do behave (Rawstorne et al, 2000). Rawstorne though, contends the TRA is ill equipped to predict situations in which individuals have low levels of volitional control as described by Ajzen (Ajzen, 1985). This is important considering that the technology implementation on which this current study is based is a mandated implementation.

Davis and Venkatesh (2004) state that due to the current knowledge in the field of information systems development it is impossible to predict the degree of post implementation user acceptance “before writing a single line of code, possibly before even building a working prototype”. They do, however, propose that “researchers should investigate better ways to perform such “preprototype user acceptance testing””. Taking this point further, they ask “Can predictively accurate assessments of the likelihood of workplace acceptance of a

new system be made based on measures taken from prospective users who have been informed about the features and functionalities to be included in the new system, but have not yet had an opportunity to experience hands-on interaction with it?”. From the outset, the research approach adopted by the electronic Point-of-Care (ePOC) project has centered on an open consultative approach with all project team members. In particular, project team health area managers (Clinical, Research and IT) and the intended end users (Ambulatory Care Doctors, Nurses and Para-Health Professionals) of the application. According to Davis and Venkatesh, taking an iterative, consultative approach helps “focus upon the identification, correction and prevention of requirements errors that have been introduced in the original specification of requirements” (ibid).

The ePOC project seeks to enhance user acceptance of new innovations by employing a process where users are involved throughout the system development lifecycle. This involves continuous interaction between the ePOC project team and clinicians who will eventually use the system. The interaction is taking place through focus groups, workshops and surveys at identified milestones from inception of the project to delivery of the system. In addition, more informal interaction is encouraged through a discussion forum on the project website and notice board at the research site. Clinicians are actively encouraged to raise questions and/or concerns regarding the proposed system. Depending on the nature and imperative of the concern, the project team will either provide an immediate response or schedule it for discussion at the next workshop.

A fundamental difference between variants of technology acceptance models and the approach proposed in the ePOC project is the timeframe in which review of the information system being studied occurs. TAM and the extended Technology Acceptance Model (eTAM, also referred to as TAM2) are tools which evaluate the perceived ease of use of technology application adoption (such as PDAs) however, the time when the process of managing an information system adoption occurs is made by reviewing prior actual adoptions, investigating variance of perceptions and applying the results to subsequent implementations. Liang et al’s study of usage of eTAM to predict actual PDA usage among healthcare professionals is such an example of this traditional ‘review past implementations by applying findings to new/next implementation’ technology acceptance approach (Liang et al., 2003). Davis and Venkatesh hypothesize that stable and representative measures of perceived usefulness only require that potential users be informed of what a system will be designed to do, i.e., its intended functionality, and do not require hands-on interaction with a working system (Davis and Venkatesh, 2004).

RESEARCH ENVIRONMENT

The Ambulatory Care Team (TACT) Northern Illawarra

Community-based health services within New South Wales (NSW), Australia currently deliver over eight million occasions of service per annum. These services are provided by more than 7,000 clinicians from more than eight hundred and fifty health service locations across NSW. The cost of this service is estimated to be almost \$450 Million dollars per annum (NSW Health CHIME Overview). The Ambulatory Care Team (TACT) Northern Illawarra¹ is one such area health initiative, based on providing patients with a choice of having treatment in their usual place of residence (including aged care facilities)² or other locations as an alternative to hospital. TACT is a unit with 21 staff members consisting of 3 x Doctors; (including a Medical Director), 1 x Nurse Manager, 13 x nurses (4x full-time and 9x Part-time), 2 x Pharmacists (part time), 1 x Physiotherapist and 1 x COPD coordinator³.

The population of the Northern Illawarra is expected to reach in excess of 280,000 by 2006 and 340,000 by 2026 (DIPR, 2004), placing increased demand on community-based health services. In 2004, TACT Northern Illawarra provided medical, nursing and Allied-health professional services (such as physiotherapy and pharmacy services) to more than 1,300 patients, with an average of 114.4 separations⁴ per month. An indicative workflow for TACT includes a patient being referred a request for a particular TACT service or services (such as Anticoagulation Management or COPD Assessment/Coordination), pre-patient visit OH&S assessment, patient visit and treatment for episode of care, and post-patient visit documentation. TACT receives referrals from several sources: Hospitals (Emergency Departments and inpatient facilities), General Practitioners (GPs), Visiting Medical Officers (VMOs) and Staff Specialists (SS) and Peri Operative Clinics. The two largest referral sources (2004) were Wollongong Hospital (50.3%) and GPs/ VMOs/ SSs (29.3%).⁵ The pre and post patient visits pose the areas of existing workflows where immediate improvement is possible through the introduction of a mobile-based health information system for TACT clinicians. Accessing patient data, populating fields on a

¹ Northern Illawarra comprises Wollongong, Shellharbour and Kiama Local Government Areas (LGAs)

² Ambulatory Care literally refers to ‘*Hospital in the Home*’

³ Chronic Obstructive Pulmonary Disease Specialist.

⁴ Separation (Discharge) numbers are equivalent to referral source numbers

⁵ TACT Referral Sources (2004), TACT Illawarra.

mobile device, collecting and modifying data at the point of care and diffusing relevant patient data are examples of the transformation of work flows and practices possible in TACT with the implementation of an electronic point of care (ePOC) system.

ePOC (electronic Point of Care) Project

The ePOC (*electronic* Point-of-Care) PDA project is a multi-phase, collaborative research and development project funded as a 3 year Australian Research Council (ARC) Linkage Grant. The project is based in the School of Information Systems, University of Wollongong. A small team of research partners are drawn from the University of Wollongong, as well as Flinders University and the University of South Australia. The Ambulatory Care Team (TACT) Northern Illawarra, South Eastern Sydney and Illawarra Area Health Service (SESIAHS), is the project client while Pen Computer Systems Pty Ltd, a leading Australian health informatics company perform the role of health informatics/ technical partner.

A PDA based point-of-care system is significant as it will provide for *collection, delivery and exchange* of timely information (both text and images) at the point-of-care leading to a more efficient health care system. Effective healthcare delivery within community based health services depends upon efficient information access⁶. The current systems at TACT are paper-based and are limited to what the healthcare worker can effectively carry. The key advantages of a PDA system will be its high mobility and flexibility in matching complex healthcare workflow requirements as well as immediate updating of healthcare records at the point-of-care. Such a system has the potential to save people's lives or at least significantly improve their health outcomes by responding more quickly and with more appropriate interventions.

RESEARCH PROCESS

Development of the Pre-implementation instrument

Kline's Groupware Adoption Scale (Kline, 2001) was developed for the purpose of measuring user acceptance of Groupware Systems post implementation. The ePOC project sought to gain end user perceptions of a proposed new electronic point-of-care system, highlighting points where intervention may be required to ensure higher levels of user acceptance and support for the proposed system. Kline's scale was adapted to meet this need. The intention of the ePOC pre-implementation instrument is twofold; firstly, to discover the perceptions of TACT end-users towards PDA technology adoption/integration and secondly, to test the instrument for validity and reliability as a measure of user acceptance of mandated mobile technology implementations in healthcare environments.

Data Collection Phases and Procedure

Data collection for the project follows an evolutionary path; pre-implementation, during implementation and post-implementation. Stage I of the ePOC project involved preliminary workflow mapping and process analysis, initial requirements specifications and development and feasibility testing of proposed system components. Several iterations of components from Stage I have continued ('rolled over') into Stage II of the project. The main focus of Stage II, is the assessment of end user perceptions towards the implementation of ePOC. This involved: Selection of a suitable user acceptance instrument (scale), Survey One (Phase One data collection), Focus Groups (Phase Two data collection), and Survey Two (Phase Three data collection). At the same time a number of ongoing process verification workshops have been conducted. Workshop participants include software development manager/s (technical project partners), TACT medical director and nurse unit manager (health project partners) and researchers representing the academic project partners.

TACT staff were approached by the services' medical director and nurse manager and asked to participate. Participation was voluntary and anonymous. Participants were not remunerated for their participation. University and Regional Health Service approved ethical clearance for the study was obtained prior to contact with the TACT staff members. For the first study, Kline's six subscales: Ease of Use; Training; Technical Support; Consultation; Work Needs Met and System Capabilities and three commitment items were incorporated into the refined instrument. A five point Likert scale with responses ranging from "Agree completely" through to "Disagree completely" was utilized. The first study (Phase I of the data collection process) involved distribution of the survey instrument to all 21 TACT staff in mid December 2004. All 21 questionnaires were completed and returned. The analysis of the data from survey one highlighted a number of issues that could impact negatively on user acceptance. Taking the idea of employing a continuous consultative approach to enhancing user acceptance, the research team intervened by following up on these issues with the

⁶ NSW Health Information Management and IT Strategic Plan, 2001

staff at TACT in workshops and focus groups. The outcomes from the focus groups and workshops were used to further refine the survey instrument and an additional subscale, persuasion, was incorporated. The purpose of the inclusion of the additional subscale was to assess the impact that management support for the implementation of the new system might have on user perceptions of the system. The survey was then re-administered; this in effect being the commencement of a longitudinal study (intervening throughout the systems development life cycle to address end-user or developer concerns and providing the opportunity for overall analysis at the conclusion of the research project). The second survey was completed by all twenty-one TACT staff and returned to the ePOC project team in June, 2005 as was the case with the first survey. This represents a 100% response rate. The results of the second survey were compared with those of the first. Microsoft Excel was used to analyse the data.

RESULTS AND DISCUSSION

Results were categorised according to the Kline subscales and the commitment items included in the instrument. The questions in each subscale have been aggregated to provide an overall view of the TACT member's responses to each of the items comprising the subscales. A concern that arose from the analysis of the data from survey one was a trend by respondents to neither "agree" nor "disagree" on a number of the items comprising the subscales. The follow up focus groups and workshops revealed that staff had not been adequately consulted on the development and progress of the project. More specifically, they received information that they deemed to be inadequate (i.e. management interpretations of how the project was progressing). A marked decrease in the number of respondents perceptions were recorded in the second survey, that is, the number of respondents who previously indicated neither a positive or negative response. All values returned as "Neither Agree Nor Disagree" improved between survey one and two. The largest improvements being in the subscales of Technical Support (from 29% to 0%), System capabilities (36% to 11%) and Ease of Use (17% to 4%). This indicates that once TACT staff became more familiar with the proposed ePOC system and the systems' impact upon their workflows and work practices, then their perceptions improved and staff were willing to make a judgment call on their perceived level of acceptance. The analysis of survey one data also revealed a number of other issues in regard to the proposed system implementation. Discussion relating to these issues follows.

Ease of Use

From the analysis of the results of the questions in the sub-scale "ease of use" it is apparent (Table 1) that the process of intervening by direct and immediate response to address end users concerns assisted in allaying TACT staff's perception that the system would be difficult to use. The majority of staff at TACT (89%) now agree they expect that the new system will be easy to use. This is an improvement on results reported in the first survey (74%). It was revealed in the follow up focus groups that staff were unaware of exactly what skills they would require to use the new system effectively. To address this issue, a number of workshops that centered on the skills required to use a PDA-based system were conducted. Staff were given the opportunity to get "hands on" experience with the PDA that will be used to run the point-of-care system once implemented.

Sub-Scale	Survey I	Survey II
<i>Ease of Use</i>	<i>Aggregated Results</i>	<i>Aggregated Results</i>
Disagree Completely	0%	0%
Disagree Somewhat	8%	7%
Neither Agree Nor Disagree	17%	4%
Agree Somewhat	41%	40%
Agree Completely	33%	49%

Table 1: Ease of use sub-scale results

Training

Training needs do not appear to be an issue (evidenced in Table 2), with the number of TACT staff who either agreed completely or somewhat with the items in the training subscale. The levels of positive response rose from an already acceptably high level (84%) to a resounding (98%). Staff acknowledged that they would need to retrain and were supportive of undertaking further training, however, stated that they would require time out from normal duties in order to undertake training. This illustrates the beneficial nature of the consultative approach taken by the research project team. Therefore, using this approach, a suitable, future intervention may be to determine the types and modes of training as the knowledge of the system by end users increases as the project evolves.

Sub-Scale	Survey I	Survey II
Training	Aggregated Results	Aggregated Results
Disagree Completely	0%	0%
Disagree Somewhat	0%	0%
Neither Agree Nor Disagree	16%	2%
Agree Somewhat	22%	14%
Agree Completely	62%	84%

Table 2: Training sub-scale results

Technical Support

The “technical support” subscale sought responses to questions regarding whether technical support would be available and whether or not this would be provided in a timely manner. A significant result from this sub scale is illustrated by the reduction in the number of respondents who provided “no response” (29% in survey one compared with zero in survey two) and the marked increase in the positive (agree somewhat and completely) responses between the two studies (from 55% to 97%, respectively). The issue of technical support was addressed in a workshop where the technical support team from South Eastern Sydney Illawarra Area Health Service (responsible for providing help desk and system support for TACT) were able to answer staff questions regarding the level and mode of support that would be provided both during and post-implementation.

Sub-Scale	Survey I	Survey II
Technical Support	Aggregated Results	Aggregated Results
Disagree Completely	0%	0%
Disagree Somewhat	17%	3%
Neither Agree Nor Disagree	29%	0%
Agree Somewhat	7%	11%
Agree Completely	48%	86%

Table 3: Technical support sub-scale results

Consultation

The results detailed in Table 4, indicate that TACT staff have an increasingly positive perception (greater than 90% agreeing somewhat or completely) that they will be consulted during the system design and development phases of the ePOC project and that their needs will be taken into consideration and incorporated into the final version of the system. This compares with >70% reported in survey one, providing further support to the notion proposed by the authors that consultation and early intervention have a positive impact on user perceptions. It is imperative that the project team continue to ensure that end users are actively engaged in all phases of the project. Through the intervention process, users were assured that continuous consultation would take place throughout the life of the project.

Sub-Scale	Survey I	Survey II
Consultation	Aggregated Results	Aggregated Results
Disagree Completely	2%	4%
Disagree Somewhat	10%	2%
Neither Agree Nor Disagree	17%	2%
Agree Somewhat	38%	40%
Agree Completely	33%	52%

Table 4: Consultation sub-scale results

Work Needs Met

The results depicted in Table 5 indicate that there is still a diverse range of staff expectations and perceptions as to whether their “work needs” will be met through the implementation of the ePOC system. Favourable responses increased for those questions regarding accomplishing more work in the same time frame, enhanced quality of work, time savings and increased capacity to carry out work. In regard to meeting imposed deadlines, the percentage of staff who were unable to respond fell from twenty six percent (26%) in the first survey to just five percent (5%) in the second survey. The percentage of staff whose perceptions rose, increased from an aggregated seventy two percent (72%) to eighty seven percent (87%). The workshops conducted on the systems capabilities helped educate the end users on what particular aspects of their work needs the new system would address.

Sub-Scale	Survey I		Survey II
<i>Work Needs Met</i>	<i>Aggregated Results</i>		<i>Aggregated Results</i>
Disagree Completely	2%		3%
Disagree Somewhat	10%		2%
Neither Agree Nor Disagree	16%		8%
Agree Somewhat	32%		36%
Agree Completely	40%		51%

Table 5: Work needs met sub-scale results

System Capabilities

The project team will need to work closely with users with respect to system capabilities. The majority of the staff at TACT who have a high expectation (agreeing completely) on what the system “should” be capable of, increased from seventy five percent (75%) in survey one to ninety percent (90%) in survey two. Staff perceptions of what the system “will” be capable of are not as positive. The number of staff (up to 60% in survey one) answered “neither agree nor disagree” to this item. After intervention however, this number fell to sixteen percent (16%). While this is still significant and will require further exploration as to the reasons why this perception prevails, the result obtained in the second survey is a marked improvement on survey one results. The project team is hopeful that this issue will be further addressed at the next intervention point of the project, that is, through a series of information sessions and workshops aimed at “stepping” staff through the individual components of the new system.

Sub-Scale	Survey I		Survey II
<i>System Capabilities</i>	<i>Aggregated Results</i>		<i>Aggregated Results</i>
Disagree Completely	0%		0%
Disagree Somewhat	2%		4%
Neither Agree Nor Disagree	36%		11%
Agree Somewhat	7%		18%
Agree Completely	55%		67%

Table 6: System capabilities sub-scale results

Commitment

The commitment subscale indicates the level of commitment of staff to use the new system when introduced. The results in Table 7 clearly indicate a strong commitment by staff to using the system when introduced. This was evident in the results of survey one and has increased from eighty nine percent (89%) to one hundred percent commitment. None of the 21 TACT staff responded with “neither agree” nor “disagree” to this question in survey two. This is a pleasing outcome when compared with the first survey results, where eleven percent (11%) provided no response. The focus groups revealed that a number of staff at TACT had not provided a response to this subscale because they were not sure of the implications that the introduction of the new system might have on work practices at the Unit. A series of information sessions outlining the project team’s commitment to limiting the impact of ePOC on existing work practices and involving TACT staff in future discussions on anticipated changes to work practices has assisted in alleviating staff concerns.

Sub-Scale	Survey I		Survey II
<i>Commitment</i>	<i>Aggregated Results</i>		<i>Aggregated Results</i>
Disagree Completely	2%		0%
Disagree Somewhat	0%		0%
Neither Agree Nor Disagree	11%		0%
Agree Somewhat	25%		11%
Agree Completely	62%		89%

Table 7: Commitment sub-scale results

Persuasion

This final subscale was incorporated into the scale when it was refined after the first survey and the focus groups. It indicates the impact of management persuasion on the benefits of and support for implementation of the new system. This item is not a subscale of Kline’s original scale and was not explored in the first staff

survey. The item was included to assess the influence that management (senior and operational) have on the perceptions of end users towards the adoption of mobile health information systems in TACT; an issue which was raised in focus groups. It is postulated that if management are committed to the new system and provide positive commentary on the benefits of the system, this will in turn, lead to more positive perceptions of the system by staff at the Unit. Despite an aggregated eighty seven percent (87%), the results clearly indicate there is a small, yet still significant level of negative responses (13%). It may be that TACT staff have reservations about management commitment to the new system. This will need to be further explored by the project team during the next intervention.

Sub-Scale	Survey I	Survey II
<i>Persuasion</i>	<i>Aggregated Results</i>	<i>Aggregated Results</i>
Disagree Completely	-	4%
Disagree Somewhat	-	1%
Neither Agree Nor Disagree	-	8%
Agree Somewhat	-	25%
Agree Completely	-	62%

Table 8: Persuasion sub-scale results

CONCLUSION

This paper has outlined an innovative approach to the assessment of user acceptance and adoption of a mandated electronic point-of-care health information system. It is anticipated that by adopting a continuous, consultative approach to user acceptance assessment (based on “agile” systems development methodology), intervening throughout the system development lifecycle, at points where user concerns are raised, it is possible to improve adoption outcomes. The results of this initial study of user perceptions of a proposed mandated implementation of a PDA-based, point-of-care information system in TACT, Northern Illawarra; attest to the merits of such an approach. Data returned by an initial survey indicated several respondents were unable to give a positive or negative response to questions regarding the deployment of Personal Digital Assistants within an Ambulatory Care setting. An interventionist approach was implemented, whereby focus groups and information sessions were conducted to determine the reason for a lack of positive or negative response. This approach tested the hypothesis that by adopting a continuous, consultative approach to user acceptance assessment, it is possible to improve adoption outcomes. Results indicate that significant improvements, exclusively positive, were achieved in the responses to the post-intervention survey instrument. The overall aim of this research is to achieve user acceptance levels approaching 100% of the delivered PDA-based health information system. Further research, using the approach outlined in this paper is set to continue during the pre-implementation trial and training phases of the ePOC PDA project. The final outcome of this research project could have a significant impact on future approaches to the assessment and measurement of user acceptance and adoption of new innovations.

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ACKNOWLEDGEMENT

This research work results from an Australian Research Council (ARC) Linkage Grant entitled, A PDA (Personal Digital Assistant) based Point of Care (POC) e-Health Solution for Ambulatory Care Services. Further information regarding the ePOC PDA project can be found on the ePOC project's website at the following URL:
<http://www.itacs.uow.edu.au/cear/ehealth/ePOC/>

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