An Exploratory Study of Mobile Learning for Tertiary Education: A Discussion with Students

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Abstract

The drive to understand and to improve the adoption of self-service, technology-based teaching and dynamic learning environments has created interest in recent years. Owing to the availability, flexibility and convenience of wireless devices, learning/training programs appear to be providing benefits to instructors and students alike. Over the years, wireless technologies have improved communication capabilities, videoconferencing, data management and live discussion forums. The reduction in the cost of hardware and Internet services and the increased capabilities of wireless devices in conjunction with the capabilities of the World Wide Web are popular among students and academics. While universities, Technical and Further Education colleges and other training providers realise the potential role played by wireless technologies in dynamic learning environments, users of those technologies have indicated conflicting outcomes, claiming a failure of wireless technologies in learning environments. What appear to be consistent factors in the success or failure of such technologies is the context in which these applications are used, the specific applications for learning and teaching, infrastructure and change management. The literature indicates that sophisticated applications and features are constantly being developed for the wireless learning environment. Australian institutions are using wireless technologies for specific objectives in educational environments, but the adoption of those technologies is a complex and technical process. This exploratory research reports outcomes of a preliminary discussion with students about the influence of wireless technologies on learning purposes. The prime focus of the discussion was to extract themes that can identify factors that have an impact on the adoption of wireless technologies in learning environments in order to develop an initial conceptual model.

Introduction

The current competitive environment has resulted in increased customer expectations in almost every service industry. Lee and Allaway (2002) suggest that service marketers need continually to employ new and innovative ways to meet customer expectations. For instance, the growth of Internet and other multimedia technologies

has provided innovative communications and service delivery solutions. Wireless technologies are not an exception to the service industry, especially in a training environment. Recently the use of wireless technologies in education has attracted special attention from both the private and the public sectors owing to the flexibility and mobility offered by the technologies, as well as to the issues of running a hard wire around an institution, the cost of setting up the infrastructure for wired networks and the flexibility of movements of students and trainers around campuses. For instance, using wireless technologies allows exciting learning experiences to be captured instantly by students working in real time by developing problem-solving activities in team work environments, with an associated sharing of resources. The use of wireless technologies is not the only way that students will learn; however, those technologies expand the horizon of future education in a way that was not possible in the past. Therefore wireless technologies will enrich learning experiences as well as improve the productivity of students and academic staff.

The m-learning study by Attewell and Savill-Smith (2004) discussed the influences of learning on adult learners using mobile devices. The study specifically examined aspects of how to engage these learners in learning activities, how their attitudes change and the contribution of the activities towards improving literacy. The study indicated that adult learners used mobile devices, such as personal digital assistants (PDAs), to improve their organisational skills. Further, the mobile devices appear to have improved collaborative learning. The empirical evidence provided by Attewell and Savill-Smith (2004) established their findings on the use of mobile telephones only. Another study by Avellis, Scaramuzzi and Finkelstein (2004) explored the challenges offered by wireless devices in an education environment and concluded that the educational contexts and software applications are still not in the mature stage for learning contexts using mobile devices. They also questioned the knowledge activities offered in these mobile learning environments. Baber, Sharples, Vavoula and Glew (2004) asserted that "Mobile learning is an emerging paradigm that has yet to be clearly defined" (p. 21) and concluded that user requirements play a crucial role in mobile learning. The implication of this study is that one needs to understand user needs prior to developing any learning environment or context. Brandt, Hillgren and Björgvinsson (2004), while highlighting the importance of peer-to-peer learning in mobile contexts, warned of the need to contextualise the learning sequences to suit user requirements. Bull and Reid (2004) echoed similar sentiments, commenting that "…revision materials tailored to the needs of individuals and appropriate for viewing on a handheld computer are recommended…" (p. 35), indicating that user requirements play an integral role in m-learning. These studies indicate that user requirements are of paramount importance in an m-learning context and hence should be assessed prior to any development of content or context for m-learning.

While studies reviewed within the domain of education paid specific attention to 'learning aspects' using technology, very limited information can be found in the educational literature on the adoption of a technology for educational purposes. In fact, it appears that wireless technologies adoption studies are still in their infancy owing to the varied nature of devices, issues associated with telecommunication, multiple software and operating environments, and cost. In addition, the concept of mobile devices ranges from mobile telephones to iPods and, depending upon the user and the usage of the device, the context may change quickly.

While many technologies may fall under the banner of 'wireless handheld technologies', the focus of this exploratory study is the PDA as the appropriate technology for solutions to facilitate mobile learning. Our reasons for focusing on PDAs are primarily twofold: (i) PDA technology has come a long way and it now offers an all-in-one solution, including mobile telephone; and (ii) as part of current mobile technology, it has tremendous growth potential in the next few years. It is estimated that 83% of the population in Australia (17.2 million people) will own a mobile device within the next three years. An Australian consulting firm, IDC, predicted mobile services to grow at an average annual rate of almost 10% to reach AU$12.1 billion in 2007. The Allen Consulting Group has estimated that the mobile telephone industry added AU$5 billion to Australia's economy in 2002 (retrieved March 31, 2005, from http://www.itfacts.biz/index.php?id=P290). It is therefore envisaged that in the next three to four years a significant proportion of the mobile technologies would consist of integrated PDAs with mobile telephone facility.

Among the advantages of using PDAs in a tertiary setting are that:
- PDAs are lightweight, durable, safe, low power equipment that does not interfere with other technical equipment.
- There is no monthly usage charge.
- Wireless networks are now found in many tertiary institutions.
- Protocols to guide standard management decisions can be quickly revised for PDA application. (http://www.medindia.net/pda/index.asp)

These factors offer the impetus to study the adoption factors of mobile technologies for learning. However, owing to the infancy of the topic, there is a reluctance to use the word "adoption" in the title and therefore a broader title has been coined. In essence, our aim is to seek the opinions of the various stakeholders – including students, lecturers and instructional designers – in using mobile devices for learning and teaching. This study focused on students and their opinions about using mobile devices for tertiary learning.

This project therefore investigates wireless handheld technologies in the form of PDAs in tertiary setting in an Australian university. Despite its obvious advantages (as listed above), what are the reasons for the uptake of PDAs in tertiary institutions? What are the behavioural determinants that lead to the adoption of PDAs by students? What is the role of educational vendors in the context of PDA usage? What must they do to customise and/or develop applications for PDAs for students?

The specific aims of the research are:
1. To investigate the behavioural determinants of PDA adoption by students.
2. To develop a PDA adoption model based on (1) and the literature, and to test the validity and reliability of the model by application to the educational service providers.
3. To enhance the understandings of various stakeholders in tertiary education (including information technology vendors) of students' responses to PDA adoption in education.

The discussion in this paper is restricted to the first aim.

Literature Review

The literature has been reviewed with a technology adoption framework in mind. A wireless network is a wireless local area network (LAN) in a specific environment which uses radio waves, instead of physical wires, as its carrier to communicate between users. The wireless LAN enables users with wireless enabled devices (such as laptop computers and PDAs) to connect with the network or the Internet within the coverage area of the access point. Currently various types of wireless technologies exist in the market, the most common in use being the IEEE 802.11b and 802.11g standards.

The proliferation of wireless devices has enabled content providers to 'push' content to users. The devices enable users to access content any time, any how and anywhere. Recent implementations of these devices include a context-based information push, where users can be recognised based on their profile and their current location and where selective information is provided based on these two criteria.

One example is in the health and sports domains, where snippets of information are provided to users of handheld devices. Such innovative provision of information has enabled the device manufacturers to dictate an information push on users. In the past two years this concept has been introduced into the tertiary sector, where mobile devices have been used to study the effectiveness of communication between the content provider and students.

Despite the technological growth in this area, it is still unknown whether such technologies will be adopted by users. The reasons for this scepticism include the hardware limitations placed on the device, the complication encountered by users owing to relatively small screen sizes, unreliable wireless coverage and limited memory available for user applications.

There are models available to predict the acceptance of technology. In information systems, the Technology Acceptance Model (TAM) developed by Davis, Bagozzi and Warshaw (1989) is widely used for prediction. However, TAM has been criticised because of its inability to predict technology acceptance in professional settings such as health. Further, in recent years the weaknesses of TAM have been exposed in terms of its testing and suitability. There is also widespread criticism of TAM to the effect that, in circumstances such as wireless, TAM may not be able to predict the technology acceptance.

TAM was derived from Rogers's (1995) diffusion of innovation model. Understanding how organisations decide to change and do something different (Moseley, 2000) is critical to making sure that such change (and the methods by which this change is introduced) is effective. The diffusion of innovation model indicates how barriers can render such an implementation unsuccessful (Baskerville & Pries-Heje 2001). Rogers (1995) developed the diffusion of innovation model to represent the rate of adoption and the stages through which one passes before adopting innovation. This model has been widely believed to explain the adoption of innovation.

Innovation is "an idea, practice or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1995). An innovation is not an invention – it is "doing something which did not exist before in a particular territory or technical area" (Vuarin & Rodriguez, 1994). Rogers (1995) commented that his six step model was limited and may not always hold true owing to its linearity. It can be argued that innovation, like diffusion, is an "unstructured emergent phenomenon" (Baskerville & Pries-Heje, 2001; Rogers, 1995) and is too complex to be expressed in a step-like model. An emerging model of innovation is based on the premise that the diffusion of innovation is unstructured and is stimulated by shock – internal or external to the organisation – rather than being a steplike and rational process (Baskerville & Pries-Heje 2001; Van de Ven, Angle & Poole 1989).

Wejnert (2002) posits that the adoption process is not uniform and differs based on the nature of the innovation itself, the innovators and the environmental context within which the organisation is placed. These factors include such things as organisational readiness, attitude to risk, knowledge and experience with ICT and so on. Successful diffusion is realised in interactive models such as those developed by Burgelman and Sayles (1986) by using both technology-linking and need-linking. In this model a technical breakthrough achieves within the context of actual or potential market demand (Lucas, 1994). The applicability of this approach is considered across the various contexts included in this study.

Griffiths, Ronald, Ellen and Pat (1986) argued that organisations must possess certain traits if innovation is to have a greater chance of success. These include such things as skill, expertise and experience, management support, a strategic approach to risk and leadership, motivation and participation. It can be argued that the lack of these characteristics partly explains the slower rate of information and communications technologies adoption in tertiary education, for example.

This literature review clearly indicates that the introduction of new technologies to facilitate m-learning at the tertiary level moves beyond the traditional pedagogical aspects, as technology plays a crucial part. Hence it is important to note that the consequences of innovation may not be all positive and this needs to be borne in mind by those promoting m-learning in tertiary institutions. In the tertiary context, the prediction of technology also depends upon the academic content, as this is an integral part of the learning environment available to the users. Therefore any model that predicts the acceptance of technology should also consider how the content is enabled on the devices that use the technology. When it comes to wireless handheld devices, the major questions that need to be answered include the instructional design strategies for handheld devices, their limitations, user expectations and how academics will meet these expectations.

At the University of Southern Queensland (USQ) in Australia, a recent Network Review committee agreed that the university needed to develop a position paper on the use of wireless technologies at all campuses, with consideration of the application of those technologies for learning and teaching. USQ is committed to the implementation of wireless technologies at its new campus at Springfield (west of Brisbane). This research is intended to contribute to understanding and informing that application.

Student and staff use of mobile devices is increasing and these technologies has the potential to influence pedagogy and to change the way that students access campus facilities. Research into the Net Gen (people born in or after 1982 who have grown up with mobile devices) suggests that these students will be the drivers of institutional information technology agendas. Given that the use of mobile technologies will increase in the future, this research team plans to pilot strategies that research innovative pedagogy and infrastructure to ensure that USQ is well positioned to take advantage of the potential benefits of mobile learning. The concept of mobile learning (supported by wireless technologies) provides flexibility, and as noted above enables people to access learning materials anywhere, any time and any how. The authors believe that it is essential to research the application of mobile telephones – with sales of 600 million units a year, mobile telephones are the world's most widespread communication device – and it is important to research their application for learning in the university context. Given the existing pattern of falling prices, it is expected that smart phones will become affordable for students in the next few years. *The Economist* (Author unacknowledged, 2004) also notes that, when networks are not heavily used, especially at night times, vendors are offering concession rates to download music and video files using mobile telephones. Such a facility could also be used to send educational materials to university students or global business partners that enrol international students.

Finally, the adoption of mobile technologies for tertiary education requires further research. In a recent study of the failed uptake of e-learning in the United States of America, Zemsky and Massy (2004, p. iii) suggest that "the hard fact is that e-learning took off before people really knew how to use it". While there is a plethora of literature available about online learning, the impact of handheld devices on mobile learning is a relatively non-researched phenomenon (Bridgland & Blanchard, 2005). The research presented in this paper aims to contribute to mobile learning research by studying the factors that determine the uptake of wireless handheld devices for tertiary education purposes.

Research Design and Method

The initial examination of the literature clearly indicated the necessity for a suitable research method in order to extract user opinions. Previous studies in the educational domain used a range of approaches from qualitative to quantitative. In this study it was felt that, if technology adoption were to be studied with respect to a specific domain, then user involvement with the technology forms a major part of establishing the adoption (or inhibiting) factors. The rationale for this thinking was the consistent recommendation made in previous studies about the user requirement and its paramount importance in m-learning. This in turn necessitates the understanding of the research philosophy and the values of inquiry that would guide the study, and the choice of relevant research techniques required to conduct the investigation in order to answer the research questions. Further, there appears to be limited information available in the Australian information systems domain to guide the principles of this study (wireless technologies adoption issues).

This study recognises that the foundation of any research will be grounded by the researcher's fundamental philosophical view of the world (Myers, 1997). It is the contextual framework within which this is applied that provides consistency to an inquiry. Our review of the literature indicated that technology acceptance studies were predominantly looking at the technology and that they have ignored the context in which that technology was used.

The philosophical view of the world is evident to the individual researcher in the form of the knowledge that he or she possesses. For example, in educational settings, many aspects may not have been documented and can be extracted only by talking to people in that domain. While the choice of tools and methods is not linked to the philosophical view, the articulation, which is commonly the process of explaining the choice of research methods and the related choice of research instruments, helps to determine the philosophical disposition. This is usually achieved by asking questions about the beliefs, perceptions, experiences, advantages and disadvantages in order to determine this disposition. This may even include the researcher's personal experience within that domain or his or her expertise in explicating the information using any approach that may be suitable to that domain. We are not able to find suitable evidence in technology acceptance studies as to these aspects. In our opinion, this might explain why technology acceptance studies are not performing at an expected level in specific domains. Hence, this study chooses to explain the choice of research methods first and then the philosophy that dictates this choice.

Following an investigation into the positivist and interpretivist views of the world, and then an inquiry into quantitative and qualitative methods adopted by various researchers, as well as an understanding of paradigm wars as discussed in various sources (Creswell, 2003; Newman & Benz, 1998; Patton, 1990; Remenyi, Williams, Money & Swatz, 1998; Silverman, 1994; Tashakkori & Teddlie, 2003; Zikmund, 1994), it is evident that the research question posed in conducting this study is seeking to explore the adoption factors of wireless technologies, as well as to understand the behavioural intentions that underpin these adoption factors in a learning domain.

The technological component of the research question dictates the need to have quantitative research methods, while the behavioural component of the same investigation dictates qualitative research methods. The rationale for this approach is based on the notion that behavioural components require a thorough understanding of how users use wireless technologies in a given setting in order to understand the behavioural issues. This is best extracted or accomplished by a qualitative approach, as we need to extract a number of 'tacit' aspects. A quantitative instrument then can be developed to extract the quantitative aspects, such as the opinion scores.

Considering the above, the suitability of one research method over the other had to be carefully weighed. Therefore this study identified an exploratory approach to be suitable as an initial investigation. This approach is particularly favourable in confirming the direction of the study and variables chosen for the study and in helping refine the literature. The exploratory study could possibly eliminate some variables and could provide an opportunity to include other variables that are yet to emerge. Thus the principles of each method were applied to this study. Initially an exploratory phase was conducted using a qualitative approach to establish the direction for the

study. This is what is reported in this study. This will be followed up with a main study using quantitative approaches in order to establish generalisability.

In this phase a pilot focus group session was facilitated with a selected group of students at USQ to understand issues associated with the choice of wireless devices. The principal purpose of this focus group was to unearth themes required for the study, as very limited information can be found in the literature on wireless adoption for educational purposes. The focus group session was conducted to ascertain drivers of and impediments to the choice of devices and user expectations. The session *generated*, *discussed* and *evaluated* a set of themes, as derived from the initial literature review, in a focus group environment.

Data Collection: Some Issues

The focus group was facilitated for a duration of two hours. A special room with audio- and videorecording facility was booked for this purpose. The data collection involved five participants chosen from a third year information systems course at USQ. The choice of this course was justified by the fact that: (i) the students were aware of frontier technologies such as wireless technologies; (ii) students were conversant with the learning management systems (LMSs) used by USQ; (iii) students were able to comment on the merits of using mobile technologies for learning purposes; and (iv) students were aware of the technology adoption issues.

Three out of the five participants were international students. One was from China, one from Thailand and the other from Africa. This student combination added value to the focus group discussion, as the university caters to a large population of overseas students using its LMS system. However, some participants had difficulty in communicating owing to language barriers. This aspect was not particularly beneficial to focus group interaction. Specifically, one female participant could not provide much input into the whole process, owing to: (a) a lack of understanding of the content that was being discussed; and (b) her inability to respond to the questions presented. While the participants numbered five in total, owing to this lack of contribution by one member, it can be considered as a focus group with four members and thus the data collection was from a mini group. This is an acceptable level for a pilot study.

The issue of homogeneity was addressed by selecting participants who were completing their third year of undergraduate study within the Faculty of Business and studying the same course. This was considered suitable since awareness of the subject under discussion (m-learning) and the type of course learning (with all participants being enrolled in network management) should provide some correlation and provide a similar background to understanding the issues under discussion.

While every effort was taken to identify participants from a third year course, the facilitator had very little knowledge of the students and their prior qualifications. Not until the completion of the focus group was it learnt that one international student had been exposed to USQ only for two months, another for approximately one semester and another for four years. This possibly could have compromised the homogeneity issue. In addition to this, the ages of the participants could have compromised the homogeneity issue. Among the five participants, two students can be classified as

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mature-age students (40 to 50 years old) and the others can be grouped in the 20 to 30 years age group category. Another factor that became quite obvious after the selection of the participants was the difference between the local students and the international students. At the start of the focus group this was not evident; however, the local and international students did identify differences in issues such as language, age and type of enrolment in the course as well as their backgrounds, which may be potential factors in understanding and implementing focus group findings.

The range of student background experience was useful, as the purpose of the pilot focus group discussion was to identify such issues. These issues will be explored in the next set of focus groups. These issues will be resolved through a questionnaire asking questions about participants' background, nationality, number of years at USQ, age, gender, exposure to handheld devices, the use of mobile telephones and PDAs and the ability to show and relate the nuances of features, thereby comparing the different models and their functionality. This is considered to be important for this study as this research endeavours to understand whether course materials can be supplied through handheld devices. Participants' prior knowledge of devices might be worthwhile in this investigation, as students will have the ability to discuss the types of courses that can use handheld devices and the nature of activities that can be performed using these devices and to identify the advantages and disadvantages of learning that can be conducted with these devices, subject to issues such as bandwidth, models and features.

Data Analysis

Preliminary analysis of data identified that m-learning was a concept still in its infant stages and may not be well received by students owing to the lack of available resources. Based on the data collected in the focus group discussion, the following reasons appear to influence the adoption of mobile learning technologies in tertiary education:

- A number of overseas students were poor in English and would like to learn this language through interaction with students and the lecturer. Classroom interaction was considered to be a good place for this sort of interaction. Hence the suitability of the mobile learning model was questioned by participants.
- Participants were reluctant to pay hefty tuition fees simply to obtain study materials from the web or through electronic textbooks using mobile devices. Obviously this can be done in their home country. The students did not like the idea of being provided with numerous textbooks and reading materials without interaction with other students and academic staff.
- Participants suggested that students pay a substantial amount of money to experience interaction with lecturers. Therefore the concept of m-learning, whilst good, would not allow expected levels of real time interaction.
- Real time interaction also has some disadvantages. For example, many overseas students work outside university hours and may be encouraged to be connected to the computing networks after hours. This may influence students to avoid lectures. This is seen as a disadvantage facilitated by the technology.

- In terms of legal issues, participants felt that engaging in study modes facilitated by the technology may adversely impact on their visa status, as there is a requirement by the Australian Department of Immigration for face-to-face attendance.
- One of the rules imposed by the various departments of education in Australia for overseas students enrolled in full-time study is a compulsory 80% attendance, and anything less would jeopardise their study and thus their stay in Australia. Therefore, according to these participants, m-learning may not be useful to overseas students unless m-learning is accepted as a legitimate learning channel by government departments. However, these participants felt that m-learning can be complemented by classroom education.
- Mature age students felt that m-learning, although beneficial, is limited by hardware features such as the size of the gadgets, displays that were hard to see and limited memory and processing capabilities. These were cited as barriers to the use of technologies for m-learning.
- There was a perception that staff engaging in m-learning would have a need for training, as the participants believed that some possible skill imbalances exist among staff in various departments. For example, in the use of computers as a tool to convey teaching materials, students felt that staff from the information systems or computer science disciplines possess the necessary skills and background; however, they question the competence of staff in other departments such as marketing. They felt that this may adversely influence the production of course materials and compromise the standards dictated by the university.
- The prices of the mobile devices were considered to be another limitation of m-learning, with many brands offering more features for more money.

When the data were examined using NVivo, a software application for data analysis, the following themes emerged. The analysis was conducted based on the initial themes as portrayed above and Table 1 below represents the 'nodes' as extracted by the software application. The initial extraction of free nodes was aggregated using the 'tree' option provided by NVivo to arrive at the following table:

Table 1: Preliminary table of factors influencing mobile learning in tertiary education

FACILITATORS	INHIBITORS
• Easy access • Interaction • Improved service • Broadcast facility • Flexibility • Detection of plagiarism • Security • Multilingualism • Teamwork • Convenience • Connectivity • Availability • Improved communication • Better device features	• Expense • Training for staff • Dependence upon courses • Device limitation • Connectivity • Resource availability • Physical interaction • Learning styles • Age • Security • Legal implications • Health issues • Experience • Lack of access

Discussion

The preliminary focus group discussion indicates that there are 14 factors each for drivers and inhibitors, as listed in Table 1. Participants in the focus group clearly indicated that access and the flexibility provided by the wireless technologies are the major driver of m-learning in a tertiary setting. They also highlighted that the convergence of technology, where voice, text and graphics can be combined in one device, would provide advantages as there is the possibility of establishing interaction in a wireless technologies domain. A surprising factor that emerged was the use of multilingual dictionaries with the technology that would facilitate better understanding with regard to non-English speaking students. This aspect is worth considering as various translation programs are already available in the market and their integration into mobile devices for m-learning may not be difficult. Similarly, the connectivity schemes offered by the wireless technologies were found to be a major driver of the technology for m-learning purposes.

In terms of inhibitors, cost and security issues appear to be significant. Participants expressed the view that the device cost and the cost to access services were major inhibitors. Despite the fact that hardware charges are rapidly declining and telecommunication access charges are also decreasing, participants found these two aspects to be potential inhibiting factors in m-learning adoption. Participants also recognised existing limitations such as device size, screens that are difficult to see and the memory restrictions as major inhibitors of m-learning adoption. Three issues raised by participants – namely, learning styles, legal implications and health issues – appear to be surprising as the educational literature is yet to uncover these inhibiting factors. While legal implications in this context refer to Australian immigration policies, the other two inhibiting factors are applicable to other international settings as well. The inhibiting factors of age and experience appear to be somewhat surprising because many previous studies have indicated that, owing to technology advancement and maturity, users have gained considerable experience with digital devices and hence any training aspects associated with adoption can comfortably be ignored. However, the focus group discussion has clearly identified these two factors as inhibiting factors. Further, training for academic staff in handling these devices is also considered to be an inhibitor.

In essence, the focus group discussion identified 14 factors each as drivers and inhibitors during this preliminary investigation. The model is still in its early stages and we did not establish any relationships among these factors. This is evident from the fact that the issue of security appeared in both drivers and inhibitors, as participants felt that this factor can fall under both categories.

Conclusion

The pilot focus group enabled the identification of initial factors in order to pinpoint a range of issues to be explored in a second focus group. As indicated, the pilot focus group contained limitations and these need to be addressed in the next focus group. The initial set of drivers and inhibitors provides a basis on which the second focus group can be facilitated to concentrate on identified issues. Once this is accomplished, a survey instrument will be prepared to quantify the factors. While the focus group discussion data were analysed using NVivo, the survey data will be analysed using

SPSS regression models. This will provide a list of drivers and inhibitors to determine the factors in the adoption of wireless technologies.

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