Mobile Technology for Improved Productivity: analysis of a preliminary study at an Australian University.

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Abstract

This project is part of research into mobile staff productivity in Australian universities, a $1.36m Research Grant funded by the Australian Federal Department of Education, Employment and Workplace Relations (DEEWR). To achieve productivity gains for maintenance workers, a preliminary study of a wireless technical solution for managing maintenance work-orders was tested. A second exploratory study considered the implementation of a mobile (roaming) solution to support job completion and resolution, as well as reduce time and travel costs. This paper offers a background into the requirement for the study, supported by literature in the area of mobility and productivity. It also surmises the results of the preliminary investigation – actually, an exploratory analysis - including discussion about limitations of the technology, reported user skill levels, and obstacles to use. Juxtaposed, we investigate the user's self-efficacy using the chosen technology and the impact this has on their work related activities. Finally, these self efficacy results within the context of the preliminary study are reported and discussed. The results indicated an increase in productivity for the period of time of the study.

Introduction

In environments where technologies are seen as too complex, or there is a lack of staff training to develop users' skills or where technology support systems are not in place, the employee's level of confidence to experiment and use (or continue to use) the provided technology may be quite low, and desired productivity gains not achieved. Accordingly, self-efficacy – users' levels of confidence in using new technologies – may be quite low (Compeau & Higgins, 1995). Moreover, self-efficacy has been found to predict employees' abilities to be productive when they telework (Meyers & Hearn 2001) as well as generative of other competencies (Meyers & Thompson 2003).

Practical examples have also been identified concerning how users can be asked to rank their perceived levels of both confidence and actual competence in using ICTs. To cite just one representative example, the role of individuals' beliefs about their abilities effectively to use computers (computer self-efficacy) was found to exert a significant influence on user expectations, users' perceived anxiety, as well as their actual computer use (Compeau & Higgins 1995). Once these perceived deficits in human capabilities have been identified, interventions via staff training or improved technical support (amongst other interventions) can be adopted.

Similarly, with respect to wireless mobility environments, the technology options that are available do not of themselves guarantee adoption and take-up rates. To cite one study, Lee and Cheng (2007) have found that position experience, cognitive style and computer self-efficacy were all major factors that can predict the fit between users and their actual technological adoptions in mobile commerce environments., Consistent with self-efficacy theory, it is reasonable to assume that antecedent conditions (e.g., perceived levels of technology complexity and actual levels of technical support) are likely to be important variables in users' adoptions of mobile devices (Bandura 2002). Further, and of perceived value in the on-going research, Wang, Lin and Luarn (2006) have adopted the self-efficacy model with other complimentary models such as the

Technology acceptance Model and Theory of Planned Behaviour to investigate wireless technology adoptions.

In order to facilitate a smooth transition and acceptance of mobile technology, a sample group was chosen to test potential technologies and offer honest opinions about whether participants thought these technologies and the processes implemented would be accepted across the Facilities Management groups at all campuses. Additionally, a survey was used to measure respondents' attitudes towards 'time spent getting their work done'; 'attitudes toward information technology'; and 'perceptions about the proposed wireless technology' *Time Usage was* the percentage of time spent on each identified activity (Stewart & Barrick 2000). *Engagement Mode* was the individuals' perceptions of the influence of IT in their lives (Montgomery Sharafi & Hedman 2004, Sharafi, Hedman & Montgomery 2006). Confidence in *Wireless Technology Use* was the individuals' perceived confidence in their use of wireless technology (Compeau & Higgins 1995; Bandura 2002). The trial and survey were developed to investigate a number of anticipated requirements for implementing wireless technology use across all campuses. Juxtaposed were a number of technical requirements also required evaluation the wireless artefact, supporting wireless network, security and software version conflicts.

In order to identify and address some of the issues that may be faced when implementing a wireless roaming solution the project manager and business analyst met with the Finance and Resources Manager to secure support for a roaming wireless technology trial. Trial participants were selected by the manager. These participants had a 'mix' of skills; consequently, some more comfortable with technology than others.

Work Arrangements within the University

The site for the trial is a University that has five campuses dispersed across the south east corner of the state. The institution is a multi-campus, complex organisation where both academic and general staff are often required to work across campuses. The University is technologically sophisticated, with high quality fibre optic networks, expanding wireless coverage and an increasing use of laptops. The technology exists within the University to support a more flexible, mobile workforce and take-up of laptops is strong. However, actual take-up of emerging mobile devices and collaborative technology is slower and not being leveraged for improved productivity, improved decision making, reduced consumption of paper, and reduced travel.

Further, each campus has facilities maintenance staff based at a workshop that houses materials and tools, as well as a PC for administrative purposes. Previously, a mobile technology (PDA) was adopted that enables the facilities maintenance staff member to download maintenance jobs to a mobile device, take the device (including all notes and contact details) to the work site, and record details regarding the type and duration of work. The existing PDA device has the capability to connect to the university's wireless network, but is two years old; quite large in size; and has limited battery life. Due to these limitations, many staff choose not to take their PDA out in the field with them. At regular intervals during the work day the staff member returns to his workshop and places the device into a docking station attached to a PC to allow it to synchronise. This process uploads all finished job details and downloads any new job requests, since the last synchronisation. Although this process has reduced the amount of administrative paperwork traditionally required for each service request, the requirement to return up to 4 km (Appendix 1) to the office to synchronise the mobile device, only to discover that the next job might be located in the building next to the previously finished job, causing unnecessary waste of time and money.. The facilities maintenance staff, who are plumbers, carpenters and electricians, are older adults (mostly over 45 years, with many being 60 years old or over), who have limited mobile technology skills. The majority of these staff still believe that the best way to manage work orders is by paper and a pencil.

In summary, a business analyst and project manager were employed to develop a roaming solution, make the workforce more mobile, look at potential productivity gains, and conduct a later trial to address productivity aspects. Accordingly, this paper discusses both the mobile technology trial that was conducted and the results of discussions and surveys undertaken by the staff involved in the mobile technology pilot study.

Case Study

Prior to the commencement of the trial, opinions toward the proposed wireless technology were sought from the initial N=8 staff potentially to be involved with the trial.[1] In discussion with the business analyst, staff varied in their attitudes toward the proposed wireless technology trial. Some staff took great delight in telling the business analyst it was a 'waste of time' and they 'don't take their current PDA out in the field with them, they were big, and they had a battery cut out problem.' In this situation the cover of the battery may be inadvertently removed and the device may turn itself off (staff found the best way to solve this problem was to leave the device docked in at the workshop). Others were not too interested in technology and, given their earlier experience with the PDA, were not keen to persist with it. One individual used a small notepad or piece of paper to write down the jobs listed on the PDA, then take that paper-list/hand-written notepad out in the field. This meant that it could be several days before he transferred the completed job information to the PDA docked in the workshop. This had a negative impact on the timeliness of billing and reporting.

More positive responses came from those who seemed to be amenable to be part of the trial. These staff always carried their PDA in the field and to ensure useability had found that, by wrapping tape over the back of the battery cover, the PDA would not turn off as frequently. Some could really see the benefits of 'going wireless' as their buildings were geographically spread over many locations. This would sometimes result in the problem of driving to a location, completing a job, then driving back to the workshop, then synching the PDA only to realise that they would have to drive all the way back to the original location, because another job at that location had now appeared in the system.

Although the operators had already been using a mobile device for recording work orders, there were a number of problems with the current PDA as follows:

1. Data was only as current as the last synchronisation - this may be several hours - priority 1 jobs would be radioed through and would appear on the PDA later on in the day with the next synchronisation, often after the job was complete.
2. The PDA was big and not easily carried in the pocket - most staff would carry it in the shirt top pocket, which due to size and weight, would occasionally fall out.
3. The device was out of warranty and was nearing its end of life.
4. All users were experiencing the battery cover/power off issue, which seemed to be an inherent fault with the device.
5. Many resented having to use the PDA device, preferring to continue to copy jobs to paper and then take the paper notes out in the field with them.

Roaming Trial – Technologies – Limitations.

Actual preparations for the trial identified advantages and disadvantages of using the current PDA technology to connect to the university's existing wireless network. The advantages included: no associated data costs to upload job data; and no training costs or learning curve due to use of the existing PDA (although as the potential trial participants had been using this technology for about two years). The disadvantages identified included:

> Connection limitations of the available wireless access coverage points on campus. These coverage points are designed for student and staff connection and do not work in many of the locations the trade staff need to go, e.g. roof spaces, basements, and maintenance workshops.
>
> Early testing of the PDA with the university's wireless network found authentication settings, which are required on the PDA, need to be reset from time to time. This is a random authentication (to the network) problem. Logging onto the network requires authentication, which usually occurs automatically; however, such authentication does at times fail, thereby requiring a hard reset of the device.
>
> Having the device 'wireless enabled' consumes battery life.
>
> The PDA's are also nearing the warranty 'end of life', which compounds other minor device issues such as the short battery life and a requirement to reboot the device regularly to solve these problems.

[1] Because of job and technical reasons, only N=6 employees could participate in the final study.

Finally, the operating platform (the current PDA and BEIMS software use Windows mobile 5), also needs to be considered.

Due to the above technical limitations, a second device was considered. This device is Windows Mobile 5 compatible (required for the version of the facilities maintenance software 'Pocket BEIMS' being used), on a Smart Phone. It is also part of the next generation of devices incorporating PDA and mobile phones. It also uses a mobile phone network and a Virtual Private Network (VPN) client to securely connect to the university's network. The advantages of this device include the availability of the GPRS coverage, available anywhere, and mobile phone coverage. However, the disadvantages of implementing this technology included:

Version conflicts between the current version of the facilities management software (Pocket BEIMS version 5.5.2.8.1), which runs on the now out-dated version of Windows (Mobile 5) and the newly released Windows Mobile 6.

Other technical limitations that might interfere with productivity aspects of the trial included device availability (the original Mobile 5 Smart phones are no longer available in the market place). However, an upgrade of the university's server, scheduled for later in the year, will allow Windows Mobile 6 devices to be used.

Pre-Pilot Survey

Implementing new technologies in the workplace involves human interaction with those technologies. The initial N=8 staff that would be testing the viability of the tool and support technologies (wireless networks, software interfaces) were surveyed . The survey was structured to measure these individuals' self-efficacy regarding their current work-place practices. The survey tool measured staff usage of time, modes of engagement with information technology; confidence with their technology use; and confidence to actually use the technology device being trialled. This initial survey was labelled 'Time 1 Survey' so that longitudinal analysis could be conducted between both time periods. Each individual was given a survey that was labelled with a unique identifier. This would not identify the individual, but would assist the research team in matching both the 'Time 1 Survey' and 'Time 2 Survey' for the longitudinal analysis. Owing to the small number of participants in the pilot study, the labelling of the identifier for each survey was provided by the project manager and returned to the research team once all surveys had been completed.

Due to the small number of pilot study participants (N=8 staff initially), no generalisation could be made from the results of either survey. However, it was thought that comparative analysis could be useful to provide some evidence of attitudinal changes and or productivity improvements between both time periods per individual. By conducting the surveys in this manner, the research team were also able to test the viability of some of the survey tools for the wider survey tool to be conducted across two large Australian universities.

Post-Pilot Survey

At the completion of the pilot study, the individual survey, labelled 'Time 2 Survey', was conducted. This survey was a duplicate of the 'Time 1 Survey' the distribution and collection of the surveys was conducted by the project manager. Once all surveys were completed and collected they were given to the research team for collation and analysis.

Pre-Post Pilot Survey Comparisons

Although this was only a preliminary study, frequencies for each time period and each tool were reviewed and compared using SPSS to determine whether there were any significant correlations. The Cronbach alpha of each survey tool was also tested to ensure reliability of the individual tools prior to completing the larger in depth survey tool to be conducted in the research into mobile staff productivity in Australian universities.

The frequencies were then collated and compared using Microsoft Excel. The results of the comparisons for the four survey tools are indicated below.

Time Usage. The percentage of time used per identified activity. Over all the respondents reported an increase in their reliance in the use of mobile technologies in 8 areas:

ideas generation;

choosing between alternative tasks;

dealing with conflict;

doing administrative paperwork;

supervising staff;

having informal meetings; and

providing formal and informal training.

Notable increases were identified in 4 of these domains: generating ideas, dealing with conflict, supervising staff; and a notable decrease in informal meeting attendance (Figure 1).

Figure 0 Time Spent Getting your Work Done

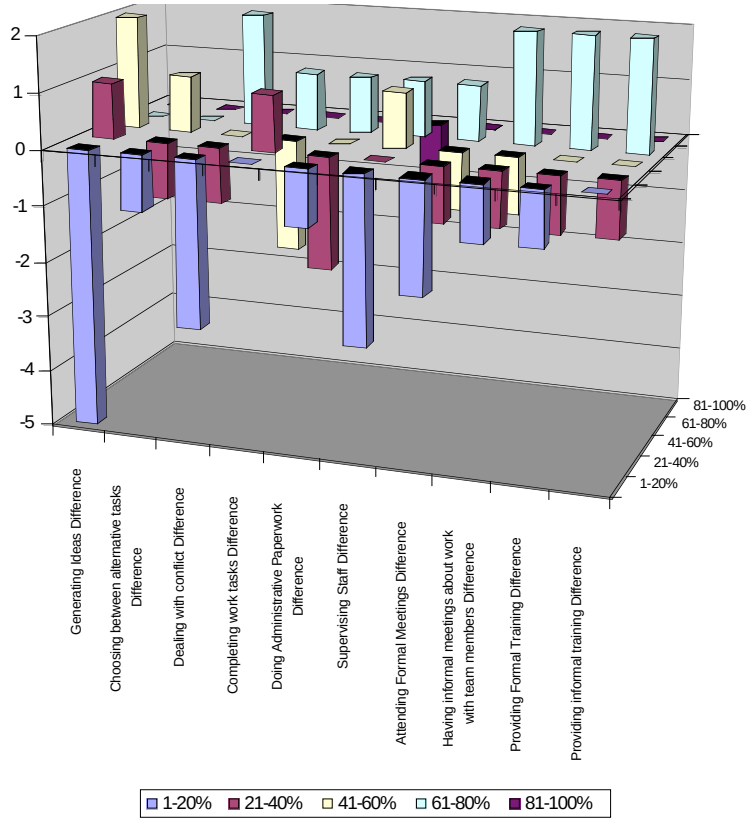


Figure 1 displays the differences between the percentages of time used per activity from Time 1 (T1) to Time 2 (T2). Where individuals had originally identified that they spent 1-20% of their time doing one or more of the activities, the percentage time allocated to conduct each of these activities has increased in T2 to the point that 8 of the 10 items are utilising 61-80% of an individual's time. These figures are a summary of all individuals and vary per individual. This suggests that the individuals may be more productive in each of these activities due to the use of the mobile technology, which was supported in the end of trial forum discussions. However, the participation limitations suggest further research is required with a larger number of participants in order to generalise these results statistically.

Engagement Mode. Individuals' perceptions of the influence of IT in their lives were assessed. The responses for the **Enjoying/Acceptance** modes were notably positive (no negative responses), indicating that all respondents enjoyed and accepted IT. The responses for **Avoidance/Hesitation** were all negative, indicating that the respondents did not want to avoid, nor were hesitant, in using IT. Similarly, respondents also reported that they experienced only low levels of **Frustration/Anxiety** when using IT. Interestingly, respondents gave considerably higher ratings

(e.g. agree/strongly agree overall in both time periods) in their responses to **Ambition/Curiosity** towards IT (Figure 2).

Figure 2 shows a summary of changes per engagement mode. This information was derived by removing all the neutral responses and only analysing those that acknowledged either Strongly Disagree or Disagree with Strongly Agree or Agree. The following explains what this means:

A/C = Ambition/Curiosity mode showed a positive change – This indicates that overall staff ambition/curiosity in using the technology **increased** over the trial period.

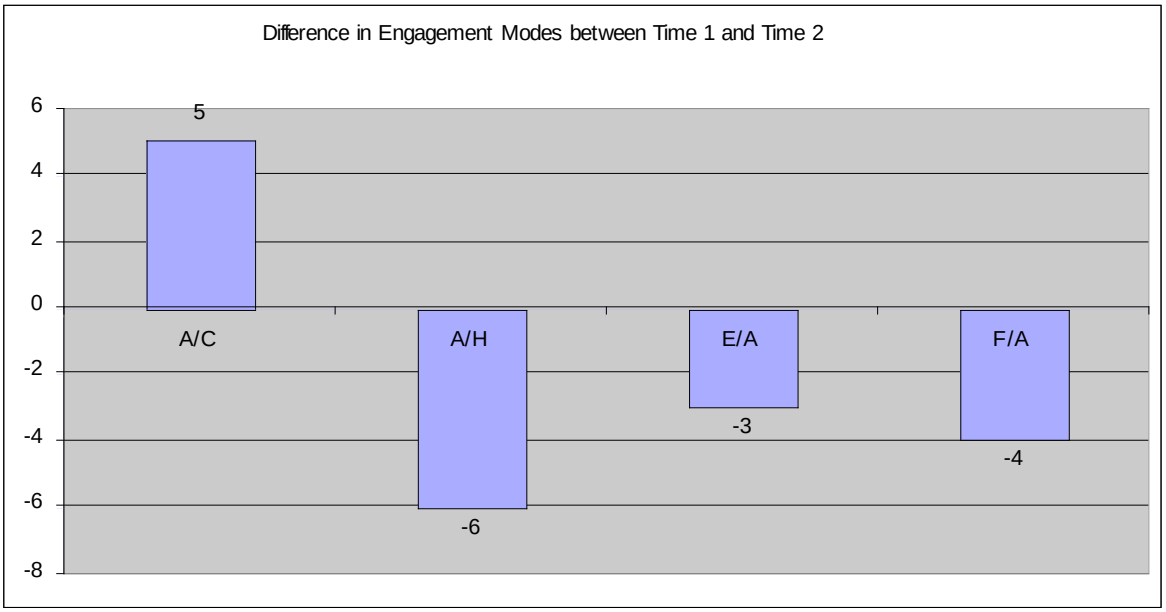
A/H = Avoidance/Hesitation mode showed a negative change – This indicates that staff avoidance/hesitation in using the technology **reduced** over the trial period.

E/A = Enjoying/Acceptance mode showed a negative change – This indicates that staff enjoying/acceptance in using the technology **reduced** over the trial period. The reason that this mode is in the negative was the change in the individual's view of the technology in 2 of the 5 questions. Individuals no longer considered IT as a toy, nor did they consider IT as entertainment, suggesting that they now considered IT as a work tool.

F/A = Frustration/Anxiety mode showed a negative change – This indicates that staff frustration/anxiety in using the technology **reduced** over the trial period.

Please note: In trial 1 there were 8 individual, however in trial 2 there were 6 individuals. In order to correctly analyse the data the information provided by the 2 individuals that were in trial 1, but not included in trial 2, were removed from the data.

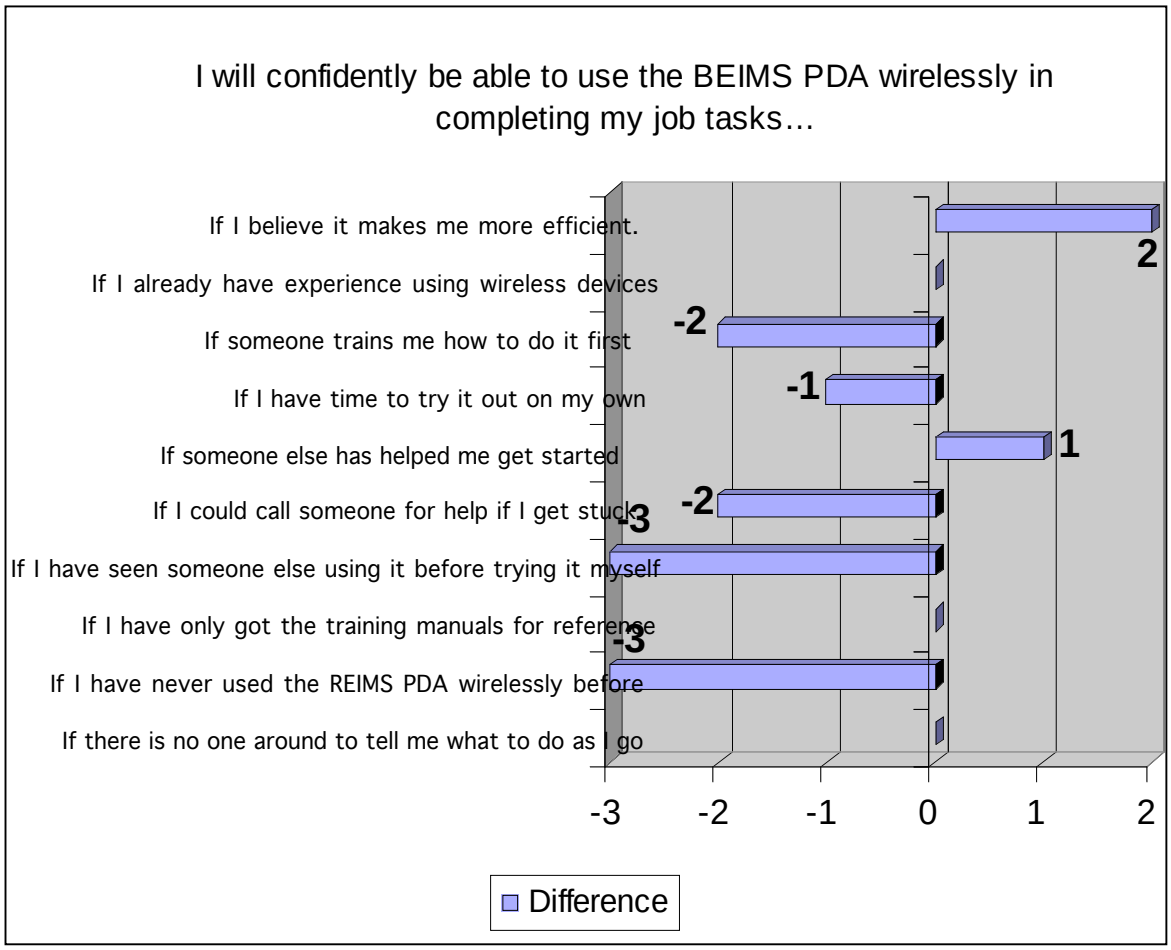
Figure 0 Changes in Engagement Modes from Time 1 to Time 2



Confidence in technology use. This section focuses on respondents reported general levels of confidence in their expectancies with regard to using the BEIMS PDA/Phone. Overall there were reported high levels of confidence in four critical areas: having someone available face-to-face, to ask for help; having someone available on call/contactable to help with problems; having someone available "to help me get started"; finally the user's perception that the technology will make him more efficient. This final area indicated a notable change in Time 2 (all agreed in Time 2), where as in Time 1 half of the group neither agreed nor disagreed – they were neutral (Figure 3).

Figure 3 results suggest that individuals support and training requirement had reduced, possibly indicating that specific types of training were considered of less importance due to the individuals experience with the BEIMS PDA/Smart Phone wirelessly.

Figure 0 Perceptions about Using your BEIMS PDA Wirelessly



Confidence to perform actual activities using the PDA/Phone. Overall, respondents reported high/very high levels of confidence in actually being able to use these technologies. For example items 1 and 2, on the attached scale, scored an average 9 out of 10; the average for the scale overall was 8 (Figure 4).

The individual's self-efficacy was measured toward the end of the trial, therefore no longitudinal changes can be reported. The individuals responded by indicating how certain (confident) they were in the level of their ability to perform each of 12 questionnaire items using the BEIMS wireless technology. They were required to indicate their response using a 10 point Likert scales where 1=Definitely Not Confident and 10=Absolutely Confident.

Figure 0 Summary of Individual Self-Efficacy Responses
(Average Response per questionnaire item on a 10 point Likert Scale)

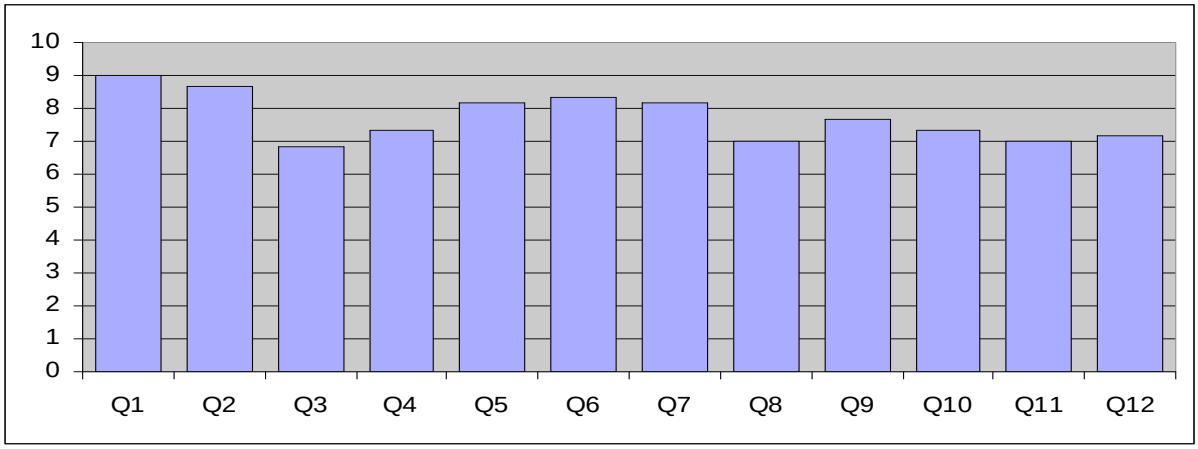


Figure 4 displays the average response for each of the questions, suggesting a high to very high confidence level that individuals experienced using the trialled wireless technology

End Project Discussion Forum

As a result of the success of the pilot study and staff feedback, management initiated phasing in the use of PDA's for all maintenance across all campuses. As a result of the technical difficulties

and managements interpretation of the success of the pilot study, prior to the pilot completion, all pilot study participants were invited to an end of pilot open forum discussion. The participants were invited to be open and frank about their experiences to enable the project and research teams and opportunity refine some of the technologies, and research tools used during the pilot study. All pilot study participants were keen to attend and share their experiences, both positive and negative.

Conclusion

Overall, in these four critical areas, respondents reported they were quite confident and in general satisfied with the technologies they were using. Valuable insights were also gained with respect to staff attitudes with respect to adoption and use of these innovative technologies. However, the sample size is noticeably small, the data is not generaliseable outside the present sample; and – consequently - there is plenty of scope for more exploratory research in all four areas as part of the on-going Study.

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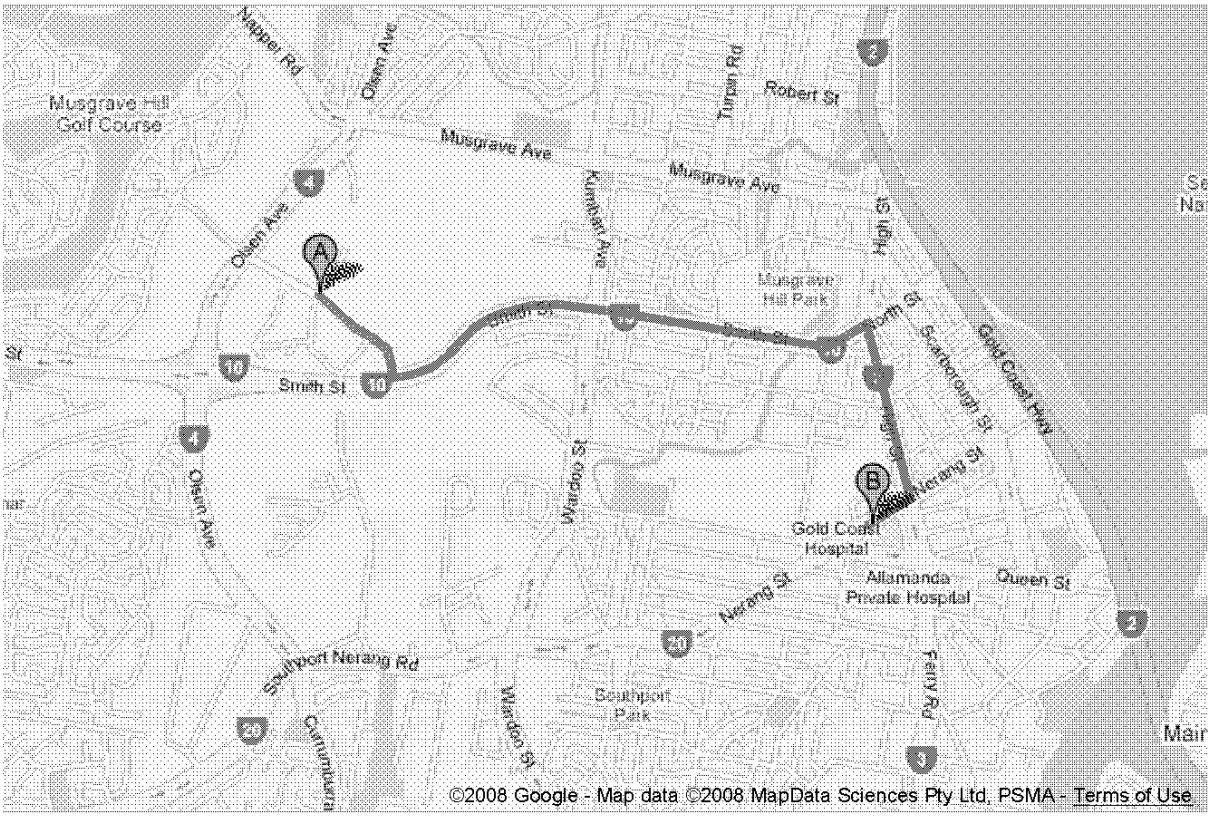
Appendix 1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Turpin Rd
Robert St
Kumbari Ave
High St
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Short St
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