Minimising the effect of user obstruction to the deployment of information technologies for mobile computing applications within Africa

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Abstract

One reason why Mobile computing has expanded dramatically over the past few years, is that it is an application which can be used to leverage existing competencies and skills vested in field-based resources. In this way mobile computing can increase the efficiency of a business like a utility which has its assets geographically dispersed, often on a national basis. However, one of the haunting challenges in managing information technology activities is to overcome the frequent obstruction by users' unwillingness to accept and use new technology-based solutions. This paper will evaluate mobile computing in its situational aspect of a utility against the inferences of a recognised technology acceptance model (TAM). In this way, recommendations can be made for ensuring that the effect of user obstructions to the new technology-based systems can be reduced.

Introduction

The availability of such technologies as GPS, wireless communication, PDAs and pen-based systems coupled with compact Geospatial Information Systems (GIS) and database components has created an exciting environment for researching new GIS applications. GIS can be the enabling paradigm that unifies this wide array of technology in a form that can be readily used for empowering a mobile workforce. The IDC has identified the mobile worker and the usage of intelligent wireless mobile computing devices as "the third paradigm of computer usage" [T Schultz, 2002]. Many software applications are being developed for mobile computer platforms, e.g. the Personal Digital Assistant (PDA), sometimes using rapid application development tools, but often not profiling the actual intended user in the software design.

Mobile computing applications have become an important topic for both research and practice. At Wits University research has been conducted at a large telecommunications utility (Telkom), into the collection of its network asset information, and the on-going maintenance of the accuracy of this data. Although the adoption of mobile computing has accelerated in recent years, the success of new mobile initiatives is not obvious. Whilst mobile computing technology assimilation by the targeted users is an important determinant as to whether the implementation does meet its objectives. In this paper, the author will make recommendations for mobile computing implementations against the background of these current research outcomes, with an African situational perspective.

Mobile Computing

A significant pay-off for mobile computing comes about through lowering the Total Cost of Ownership (TCO) of the technologies deployed and lifting the Total Benefit of Ownership of the mobile application.

<u>Lower Total cost of Ownership:</u> Five years ago it was estimated by Intel Corporation [Intel whitepaper, 2002] that the total cost of ownership difference between a notebook computer and a desktop in the USA was approximately $4000. By the year 2000 it had declined to less than $1000 and so the question was posed as to how much extra value does one need from a mobile computer user to make up this $1000 TCO differential. Depending upon the total cost of employment of the user itself, Intel estimated that only one extra hour of production per week justified that TCO difference. With PDAs it could be the same, or less, so lowering the total cost of ownership is definitely feasible. In "Tapping the Power of the Mobile Enterprise", [Extended Systems whitepaper, 2002], some tips for determining the TCO are provided, covering direct costs of the

necessary software licences and their maintenance, hardware costs, data security and access measures, as well as staff training and device deployment costs. However there is no warning in the white paper on the negative impact of user obstruction to this deployment.

Higher Total Benefit of Ownership: It has been proven that mobile 'IT-connected' users are more productive, assuming that these mobile users correctly use the technology inherent in the application. When Intel management investigated its mobile computing initiative, it learned that mobile users realise productivity improvements of between three and eight hours per week. This analysis is borne out in most utility industries as well. According to a study conducted by the Gartner Group, [Gartner Published Survey positions, May 2001], business users with a mobile computer, and who spend only up to 20 % of their time out of the office, realise a minimum annual benefit of 20 to 25% of their annual cost of employment through increased productivity and efficiency. Clearly field workers, who spend more time out of an office, can expect higher gains in productivity.

The Paper Chase: Today there are several organisations with field workforces that continue to perform daily operations using the traditional paper-based, clipboard system. In its network data collection project, Telkom has commenced collecting its network inventory data using paper 'sourcing sheets', but enhanced through the use of digital camera/video technology to supplement the lack of knowledge that some workers have about the nature or type of particular field network equipment. Paper-based processes have long been the *de facto* method for data collection and information management, however, in today's competitive markets this is quickly becoming outdated. Field workers are responsible for exchanging millions of pieces of paper containing information often vital for an organisation's performance. This seemingly limitless supply of paper and information poses a large potential for error and delay as the paper forms make their way through the system and back to the office for filing, or manual entry (data capture) into the central computer system databases. Research shows that some 70% of all errors in corporate databases can be attributed to the manual entry of paper-based data. [NEC whitepaper, 2002]. The Gartner Group found that the time wasted by the average worker on paper-related tasks was 30% of each day, (regardless of their industry)!

As raw data continues to become a more quantifiable business asset, the time it takes to accurately gather and process this data is critical. One factor that is driving the adoption of mobile strategies for utilities like Telkom, is the availability of powerful new handheld devices and personal digital assistants (PDAs). Their small, light weight form factors, fast processors and improved data storage capacities have made these devices the ideal tools for fast data collection. Coupled with the fact that these devices support pen-based touch screens, colour displays, smaller keyboards and wireless communications capabilities, they are particularly appealing to field service professionals. These devices can be customised to support specific field applications like data collection, so that the data collectors can easily perform their tasks, perhaps in the Telkom case, doing away with the requirement for a video camera facility. Companies today need mobile solutions that provide field workers with a simple-to-use, highly configurable mobile application to replace paper forms and slow, error-prone, costly methods of collecting data and communicating it back to a central location. Some research has shown that deploying the technologies as proposed, provided it has a simplified, but usage-driven user interface; then acceptance by field personnel is obtained.

The Human – Computer Interaction (HCI): The development of mobile computers able to communicate via wireless technology has brought a completely different perspective and approach on how humans communicate with computers. Interaction with mobile computers is vastly different as compared to desktop computers. Desktop computing takes place in a static environment where the user is presented with a large high-resolution user interface and information is stored either locally on the computer, or may be accessed via a data network. [Cobb, 2002] states that "usability" is important for any mobile computing application or device, but it is even more important with capability-constrained devices with limited display or input. Thus usability analysis should encompass any wireless / PDA application project from start to completion. Design and architecture frameworks for tackling these issues when designing applications for mobile devices have been proposed [Cheverst, 1998] and prototypes have been built and tested [Davies, 1998].

Provided that the constraints to mobility are carefully considered [M Satyanarayanan, 1998], the pay-offs for mobile computing applications are clear and the University has embarked on many different related research projects, particularly involving the use of these applications by field workers utilities.

Technology Acceptance

The question posed in this paper is "How can we minimise the effect of user obstruction to the deployment of information technologies for mobile computing applications within Africa?" For this to occur, these new technologies must be accepted and used by employees in organisations for whom these applications have been targeted. According to some modern research, no measure of technology can sustain long-term performance gains unless accompanied by improved and sound business processes, as well as acceptability by its users. Thus for mobile computing and its technologies to be used to increase the performance of persons charged with implementing field applications at utilities, we need to ensure that the business processes are modified to smooth the progress of the assimilation by users of the technologies. One way forward is to ensure that the software application designed has complied with the 'Technology Acceptance Model' (TAM). In his paper, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology"; MIS Quarterly Sept 1989, Fred Davis presents a scientific methodology for testing the usability of information technology solutions. This methodology primarily focuses upon the use of a "Technology Acceptance Model (TAM)"; see Figure 1 below. The model postulates that the behavioural intention (BI) to use a new IT system is determined by two constructs pertaining to the user. These constructs are: perceived usefulness (U), i.e. the user's perception of the degree to which using the new system will improve that person's performance in the workplace; and perceived ease-of-use (EOU), i.e. the user's perception of the amount of effort that is required by the user to use the new technology-based system.

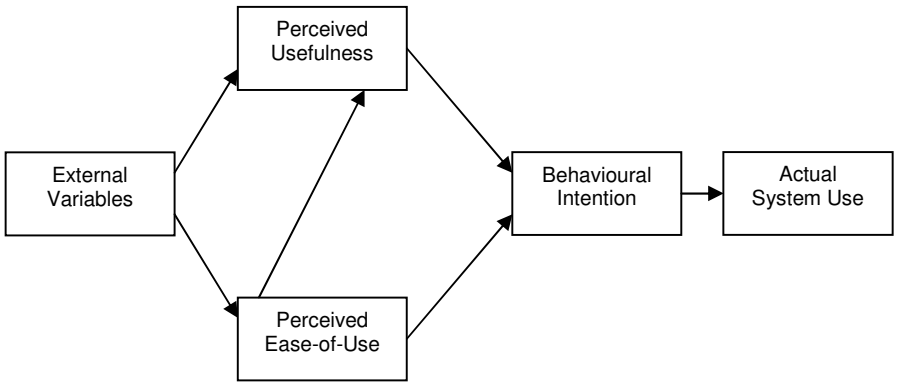

Figure 1: The Technology Acceptance Model (TAM)

In their follow-up paper, "Toward Pre-prototype Acceptance Testing of New Information Systems", IEEE Transactions on Engineering Management, February 2004, Davis and Venkatesh highlighted the importance of predicting technology acceptability by users early in the design cycle, as much prior research in IT adoption has demonstrated the ability to successfully predict system success only after the users have acquired sufficient direct experience with the new system.

Mobile computing: a challenge hypothesis

For mobile computing applications to be implemented successfully, i.e. to ensure that the effect of user obstructions to the new technology-based systems for these applications in Africa can be reduced, we need to take cognisance of this IT adoption model and also provide an incentive for field workers to easily utilise the system designed for their use.

The CeTAS Research Group at Wits University has conducted research recently to use wireless, mobile computing, and geospatial information technologies to implement a handheld computer

prototype for collecting outside plant information at utilities (telecommunications and electricity). [Ref: R van Olst and B Dwolatzky; "Using I.T. to improve the efficiency and accuracy of Network Data Collection"; IEEE AFRICON Conference Proceedings, September 2004]. As a component of this research, user questionnaires were designed to test the acceptability to the user of the prototype for the tasks involved with data collection. The targeted users of this prototype currently apply paper templates that are systematically filled in on site by field workers from the utility to collect this information. Two samples of field workers from different geographical regions were selected for the technology acceptance survey. The survey questionnaire was designed in accordance with the recommendations of the paper "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology"; MIS Quarterly Sept 1989; by Fred Davis. The Davis questionnaire, modified for use in this mobile computing (electronic data collection) application, is included in the appendix to this paper. The first six questions (1 to 6) were intended to survey the users' perception of the 'usefulness' of the technology-based mobile computing application, whilst the last six questions (7 to 12) were intended to survey the users' perception of 'ease-of-use'. The analysis of the survey data was firstly compared with the basic Technology Acceptance Model, i.e. specifying that Behavioural Intention to use the technology was determined by the degree of 'Perceived Usefulness' of the technology and its 'Perceived Ease-of-Use'.

The results for each construct and for each sample are shown below (Table 1):

Behaviour / Usage Determinant	Distribution Average (out of 7)	Standard Deviation
Perceived Usefulness (S#1)	6.28	0.96
Perceived Ease-of-Use (S#1)	6.30	0.84
Perceived Usefulness (S#2)	6.22	0.62
Perceived Ease-of-Use (S#2)	6.28	0.77

Table 1: Technology Acceptance testing

As is indicated in the table, there is no discernible difference between the two samples. Both showed a high acceptance of the new technologies. The fact that the standard deviation for the sample that had prior introduction to the new technologies was higher than that of the sample that had no prior introduction can probably be explained by the fact that the first sample were now apprehensive about the work process changes that had been tested with them, whilst the other sample had only heard about the likely changes and had not experienced them to the same degree.

It was thus postulated that by employing a 'usage-centred' system design with a focus on increased productivity for the user of the mobile computing application, then 'extremely likely' answers to the perceived usefulness part of the questionnaire will be obtained in a user survey. Employing a 'user-centred' system design with a strong focus on human-computer-interaction (HCI) constructs in the design would result in 'extremely likely' answers to the perceived ease-of-use part of the survey questionnaire. [Kyaw Moe; M Sc (Eng) thesis, December 2004].

Application software design and development did not always have a concern for users or a focus upon the usability of systems. Nowadays the user population for information systems is so different to that of the past that more and more attention is required to user and usability needs than ever before. User-Centred system design methodology is one that focuses on users and their needs in as effort to design usable systems. There are two key components of user-centred design; user analysis and task analysis. The deliverable from the former component is an audience definition that describes skills and abilities of target users and job characteristics of the user group. These user profiles also include the willingness and preparation for learning, and the expectations and interest of the users. Task analysis on the other hand, is a method of determining how the target users actually perform their work. A deliverable from this component is a list of current tasks, and future tasks (given the expected impact of the new system), including scenario modelling.

The emerging view of IT systems as tools is referred to as Usage-Centred system design. Since good tools support work, making someone's job easier, faster, simpler and often more flexible, what is really important is building software systems around *uses*, rather than users. So usage-centred system design focuses on the work that users are trying to accomplish and on what the system will need to supply as a user interface to help them accomplish the work. The following questions are addressed carefully in the development of usable systems using usage-centred design:

- Who are the users and how will they relate to the systems?
- What tasks are users attempting to accomplish through the system that is being designed?
- What do these users need from the system in order to accomplish their tasks and how should the system be organised?
- What are the operating conditions under which the system will be used? and
- What should the user interface look and feel like, and how should it interact with the user?

[Ref: "What do Users want? – Engineering Usability into Software"; L. Constantine, Windows Technical Journal, June 2000]

By deploying these design methodologies in a new application for field workers based upon mobile computing technologies as mentioned in this paper, one can be more assured of the user population of the application deriving the benefit originally planned.

Conclusion

To summarise the business case for mobile computing, the benefits of the proposed technology deployment, incorporating PDAs and wireless access, are quantitative (e.g. cost savings) and provide better responsiveness, better accuracy and better timeliness of network asset information. Also by having access to the corporate databases from field remote locations, the mobile user is assured of accurate and reliable information as stored in the corporate repository. This ensures that mobile workers can be certain that they have the correct tools and information (geospatial and other) for the task at hand. When implementing a mobile computing application, for example to facilitate the collection and maintenance of information about the utility's field assets, one must examine related workplace and end-user results, especially technology acceptance by the users of the application. Consideration of usage-centred and user-centred design methodologies should ensure that the application will be acceptable to the users and thereby achieve the goal of minimising the effect of user obstruction to the deployment of the mobile computing application.

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Perceived Usefulness & Perceived Ease-of-Use Questionnaire

1. Using the Mobile computing application in my job would enable me to accomplish tasks more quickly.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

2. Using the Mobile computing application would improve my job performance.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

3. Using the Mobile computing application would increase my productivity.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

4. Using the Mobile computing application would enhance my effectiveness on the job.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

5. Using the Mobile computing application would make it easier to do my job.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

6. I would find the Mobile computing application useful in my job.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

7. Learning to operate the Mobile computing application would be easy for me.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

8. I would find it easy to get the Mobile computing application to do what I want it to do.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

9. My interaction with the Mobile computing application would be clear and understandable.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

10. I would find the Mobile computing application to be flexible to interact with.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

11. It would be easy for me to become skilful at using the Mobile computing application.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	

12. I would find the Mobile computing application easy to use.

likely							unlikely
extremely	quite	slightly	neither	slightly	quite	extremely	
7	6	5	4	3	2	1	