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Mobile Information Systems In Australian Utility Companies

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Abstract

This research has investigated a broad range of issues associated with the use of mobile information systems in Australian utility companies. In particular, special consideration has been given to the existing infrastructure, business processes and information systems used in the participating organisations to support its field workers. This research has used a Technology, Organisation & People (TOP) multi-perspective model to conduct five case studies obtaining various technical, organisational and personal issues associated with the adoption of mobile information systems. These findings will help other large organisations to better manage their geographically distributed assets and workforce.

Keywords: *Mobile Information System, Mobile Workforce, Workforce Enablement*

1 INTRODUCTION

Utility companies such as water and power generators and distributors in Australia are often responsible for critical infrastructure. Australia's large area and rugged landscape means that organisations of essential services such as utilities are usually large and are required to manage assets dispersed over large areas both in metropolitan and regional areas. Thus, a significant proportion of employees is required to operate remotely, often travelling hundreds of kilometres to complete one maintenance job. These are referred to as the field workers.

The current asset maintenance-related systems such as work event management systems are backboned by the geographic information systems (GIS). However, these information systems have not been extended to the field workers, which caused many delays in dealing with emergency cases. For example, the length of some pipelines is measured in Kilometres. Without the ability to obtain accurate GPS location from the centre system in the field, the field workers may need to drive along the pipeline to visually inspect the fault. Often when they reach the fault area, the inability to obtain the infrastructure design diagrams and other asset history information may result in wasting of effort by digging in the wrong place for example. In order to resolve these instances and better manage their assets, many utility companies in Australia have explored the mobile information systems during the last few years.

In order to understand the problems and challenges that these organisations are facing, a number of case studies were conducted to investigate the issues associated with the design and implementation of mobile information systems ranging from technical, personal and organisational issues. These findings may help the existing organisations improve their current mobile information systems and help the new comers speed up their mobile information system development process.

2 MOBILE INFORMATION SYSTEM TREND OVERVIEW

With the increasingly popular wireless communication and the processing power of mobile devices such as smartphones and Ultra Mobile PCs, an increasing number of organisations are aware of the possibility to extend their traditional client and server based information systems from desktop to mobile devices. However, many researchers such as Norrie et al (2007) point out that it is not a straightforward process because mobile information systems require platforms that not only deal with the challenges of data distribution and dynamic networking, but also entirely new forms of interaction

and information delivery. Furthermore, Bierig and Goker (2006) suggest that while taking the advantage of the wireless communication channel, organisations must be aware of its existing infrastructure and information delivery channel (such as the corporate network) to ensure the consistency of information delivery and compatibility of all information systems.

Location-awareness technology (usually through GPS) has been adopted in many fields. For example, See (2007) suggests that logistic fleet management using mobile communication infrastructure with the GPS technology enables real-time transportation status information transfer. As mentioned previously, utility companies rely on the GIS system to manage its distributed assets. Thus, it is anticipated that these companies will benefit from the latest location tracking technology. However, Tummala and Jones (2005) argues that despite the already considerable value of this technology, one aspect in which it can be improved is enhanced methods of adding and managing context-specific content tailored for individual needs. For example, a field worker will require a range of information (map, asset diagram, maintenance procedure, etc) other than the GPS coordinates. Goker et al (2004) further point out that people's information needs change as they encounter new situations. Meeting these information needs in a personalised and context-sensitive manner is one of the challenges that organisations are facing when adopting mobile information systems.

Despite of the recent improvement to the mobile devices, it is still true that the modern mobile devices have not reached a same level of processing power as the desktop computers used in the office environment. Especially, limitation such as input and display, battery life, etc imposed by the physical hardware has not satisfied users' needs. Zhang et al (2006) suggest that mobile handheld devices are often featured with small screens, possibly making presentation of most Web pages or data aesthetically unpleasant, un-navigable, and in the worst case, completely illegible. Thus, the success of mobile information system also relies on the ability of organisations tailoring the information in a readable format through a mobile-friendly client (referred as "hands-free" by Afonso and Silva, 2004).

It must be noted that mobile information systems for personal use and for corporate use share some commonalities. However, the study by Papavassiliou et al (2002) shows that one of the most critical design elements of corporate mobile information systems is their applicability in large scale deployments. The corporate mobile information must be able to ensure a reasonable performance level when serving multiple (possibly in hundreds) clients from different remote locations simultaneously.

3 LITERATURE REVIEW AND RESEARCH DESIGN

Research Question: What are the issues that Australian Utility companies are facing during their mobile information system adoption?

Pointed out by Bonigk and Lubinski (1996) that the mobility of users, devices, and information produces new challenges for processing of globally distributed information. Consequently there is a need for developing an adequate research framework for the selection, access and exchange of information in a mobile computing environment. In this research, the research design has taken considerations from various studies.

The aim of this research is to examine how Australian utility companies adopt the mobile information system in their daily operations. Given the scope (utilities companies in Australia), the initial research design was inspired by Chau and Turner (2006)'s case study on the utilisation of mobile handheld devices for care management in Australian aged care facilities. With a similar research topic, but in different fields, this particular case study has addressed the mobile information system adoption from three perspectives: End-user, Organisational and Technical, also known as the TOP framework.

It is felt that the TOP framework by Mitroff and Linstone (1993) is an adequate approach to categorise issues in this study. Mitroff and Linstone (1993) argues that any phenomenon, subsystem or system can be analysed from what they call a Multiple Perspective method – employing different ways of seeing, to seek perspectives on the problem, often referred as the TOP model:

- The technical perspective (T) sees organizations as hierarchical structures or networks of interrelationships between individuals, groups, organisations and systems.
- The organisational perspective (O) considers an organisation's performance in terms of effectiveness and efficiencies. For example, leadership is one of the concerns.
- The personal perspective (P) focuses on individual concerns. For example, the issues of job description and job security are some of the main concerns in this perspective.

Despite of the relevance of the TOP framework, the TOP perspectives are too broad to develop precise research issues to be investigated in the participating organisations. In this study, the research issues were emerged from various research paper. The Ngai and Gunasekaran (2007)'s review for mobile commerce research has summarised the important research issues from leading journals and conference proceedings in the field of mobile information system adoption. The relevant research issues were used in this study (as shown below):

- Location-based services;
- Wireless user infrastructure;
- Mobile handheld devices and user inter-face;
- Mobile middleware;
- Security issues;
- Wireless and mobile communication systems;
- Wireless network infrastructure;
- Development of m-commerce applications and guidelines;
- M-commerce behavioural issues (consumer behaviour, acceptance of technology, and diffusion of technology);
- M-commerce economics, strategy, and business models

Additional issues were emerged from other research paper. For example,

- User-context: Goker and Myrhaung (2008) suggest that the external environment, user knowledge and operation scenario of the mobile information system users must be considered.
- Training: Jen and Chao (2008) suggest that user training is a key to keep the balance between the additional efficiencies derived from mobile information system use against the increased anxiety as a result of changes.

Thus, in accordance to the literature on mobile information systems (as exampled above), the following TOP model has been created. Many similar issues were combined.

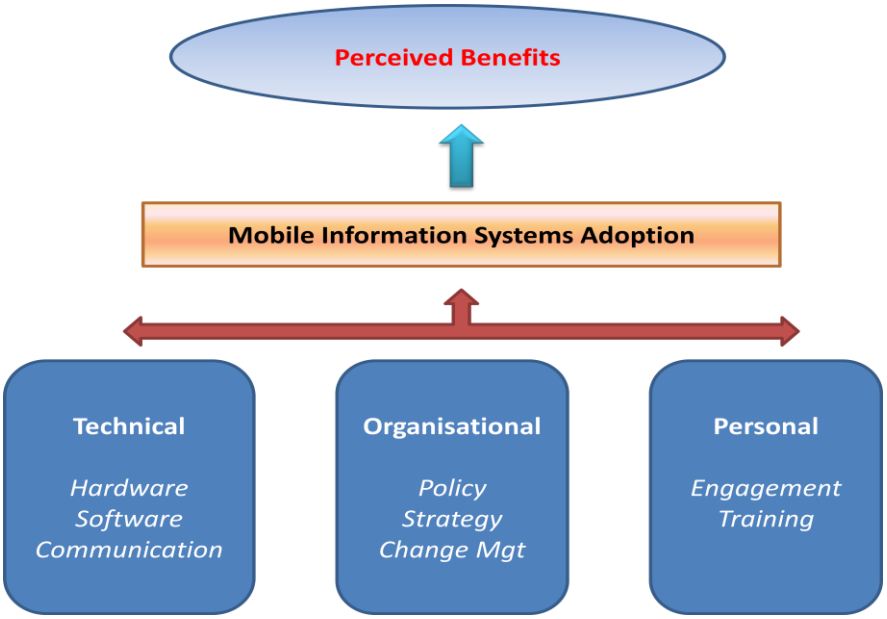

Figure 1: TOP Model – Developed for this research

The above TOP model is used during the data analysis stage which contributed to the research model development. However, it must be pointed out that the TOP perspectives are not necessarily exclusive to each other. Findings may present issues across all three perspectives. Findings are presented and discussed below. Due the confidentiality reason, all company and system names were removed.

Based on the proposed TOP model with several research issues, this research has conducted five case studies with several large Australian utility companies including Water and Power distributors to explore the issues associated with their mobile information system design and development processes. These participating companies have developed and field tested their mobile information systems in one or many organisation function areas with experiences ranging from 1 year to 5 years. It is difficult to classify their adoption in any maturity models as all of these organisations are early adopters in this field. For each case study, a number of interviews were conducted including 2~3 field workers, area manager and the manager of IT (or Chief Information Officer). The interview is a semi-structured.

4 FINDING AND DISCUSSION

4.1 Case Study A

Company A manages the vast majority of one Australian state's water and wastewater assets. Company A is responsible for supplying water and treating waste water for:

- 300 cities and towns
- Wastewater to 100 cities and towns
- 102 of 109 Water Operating Areas
- 91 of 116 Wastewater Operating Areas.

4.1.1 Technical:

Hardware

Company A uses personal data assistant (PDA's) because they have 'Instant On' capability. It is through that these PDAs are lightweight, economical, convenient and very portable. It is acknowledged that PDA's do have processing limits that have to be overcome. However, comparing to laptop computers,

PDAs are relatively cheap. Company A's experience to date with these type of PDAs has shown useful lives of 3 years and an attrition rate lower than expected. It is also found that battery life significantly reduced after about 2 years' continuous use.

Software

Company A has developed a Windows Pocket PC-based SAP client in-house for accesses to their corporate SAP system. At this stage, the main mobile application has been designed for ease the work event management allowing remote users entering the job details from their networked PDAs.

Communication

Company A is using GPRS. The CDMA / 3G network was not available in Australia when Company A built their mobile information system. Coverage issues with the GPRS network are not insurmountable. It is found that the transistion cost (mostly hardware) to move from the GPRS network to the advance (recently introduced) 'Next G' and/or '3G' is very help. Since it requires additional investment, the company has decided not to adopt the new communication technology.

Company A has not tried to cap its data communications costs as currently data communications costs are not big enough to worry about except for the odd device that somehow runs up its own high cost for a month. Company A suspects that this is inappropriate use by an PDA user with internet surfing, but cannot prove it as the telecommunication provider does not provide a detail usage log other than the total amount of data usage.

4.1.2 Organisational

Policy and Control

Company A's experience has shown PDA's can be tricky to master and use and can frustrate the average user. PDA's do not permit the governance (such as security policy, access right management) that the organisation can build into a PC. Users try to get other things working on their PDAs (e.g. games) and this can compromise how well they work for the corporate application (some instances that the self-installed games crashed the corporate application were reported).

Change Management

Company A has identified a number of key change management issues which should be considered when implementing mobile information systems. Some key points in the change management strategy are listed below:

- Involve everyone early – including the highest level managers in the organisation;
- Keep the managers in the loop when rolling out training;
- Ensure all functional departments having user representatives involved in the design;
- Engage the change agents in the organisation. These people are critical to the success of major change brought about by the use of mobile technologies and applications;
- Culture - Beware the differences in 'The way things get done around here"; and
- Talk to the business process experts when developing mobile information systems.

4.1.3 Personal

Engage users

Company A's approach to involve the users when developing the screen designs for the PDA's has proved very useful. Data quantity and integrity from users improved immediately. Employees were happy to see the end of a lot of paperwork.

Training and education

Company A did not have a formal change management strategy. The use of mobile information system is purely voluntary. Currently the company has about 70% voluntary participation. However, training class as provided for these users. The Initial training sessions took (1.5 days) approx 10 hours to train a user.

4.1.4 Perceived benefits in using mobile information systems

The major benefits that Company A as a corporation has realised from the use of mobile technologies in the field include:

- Improved data quality and completeness.
- Consistent work order processes adopted for the first time ever!
- Better work monitoring leading to more efficient scheduling and allocation of all work (less inefficient travelling for field crews).
- Immediate updating of information for customer service.
- Reduction in data entry operatives around the state – with the orders being fully updated as the work is done at any time of the day (not just in office hours).
- Better cost allocation for all work.
- More accurate KPI reporting.
- Reduced paperwork for the field workers.

4.2 Case Study B

Company B is responsible for managing rural water resources for a half of Australian largest state. Company B's responsibilities include:

- Headworks – Dam and Weir Management
- Licensing - Surface water and groundwater licences, establishing Water Supply Protection Areas, Stream flow Management Plans and Groundwater Management Plans
- Irrigation – agriculture districts

4.2.1 Technical

Hardware

Company B is currently using rugged PC Tablet IExplorer (Tough Corp). IExplorer PC Tablet has a larger screen than Panasonic Tough Book which IT Manager found has problems in dusty environments, screen is easier to read in direct sunlight than the Panasonic Tough Book. Although the Tablets are more expensive than PDAs, Company B founds that the life span is much longer than PDAs.

Software

Three mobile information systems have been developed: (1) Total Irrigation Channel Control which is using radio frequency to regulate the water flow for irrigation by opening and closing of flume gates remotely. A Melbourne based software vendor provides the solution for the Total Channel Control system; (2) A special tool was developed as a mobile application to allow field workers to plan and record meter installations, including not only their location, but also a range of textual data and sketches. This application synchronises with corporate databases to allowing project managers to plan their resource tracking, meter procurement and installation and program reporting; and (3) Another mobile computing project being trialled is a tracking program which allows via a web page to constantly track the whereabouts of field crews and individual fieldworkers for occupational health and safety reasons. With this system, Company B is able to know the whereabouts of its fieldworkers at all times,

is useful information for a lot of reasons such diverting field crews and individuals to critical incidents that require urgent attention, being able to truly cost out the labour costs for specific projects.

Communication

Company B is currently using Telstra CDMA network (for real time access in a very limited manner because the data communication costs are found very expensive. Company B is looking to move to the Telstra NextG mobile network in future but there are some security problems to be resolved first.

4.2.2 Organisational

Change Management

Company B has considered a change management strategy to be critical because mobile information systems will have impact significantly on the way fieldworkers have traditionally worked. This strategy is still under-development.

4.2.3 Personal

Engage users

Generally speaking mobile technologies and applications have been embraced by Company B's field workers. Especially, the change management strategy has specified that Company B's fieldworkers should be involved in the development of mobile applications to ensure that their end user requirements have been met and they have ownership in the mobile applications being used in the field.

Training and education

The software specific training is provided. Since the main applications are running on windows-based desktop environment (on laptops), no specific mobile device-based training is provided.

4.2.4 Perceived benefits in using mobile information systems

It is acknowledged that significant time savings have been realised in Company B through of mobile information systems. It is estimated that these mobile information systems have freed up fieldworkers from previous paperwork which used to take 1 ½ days of each field worker's time. In general, IT Manager believes that the use of mobile technologies have empowered the Company B's field workforce to perform their tasks more efficiently and effectively.

4.3 Case Study C

Company C is a state large regional urban water authority, which has similar responsibilities as Company B's.

4.3.1 Technical

Hardware

Company C is currently using 48 Fujitsu Tablets and PDAs Palm pilots but are moving to a smart phone with the right set of features and capability in line with the change of the mobile email client from Lotus notes to MS Outlook.

Software

Company B has developed a mobile information system for remote operators to perform data entry for sites not serviced by telemetry. Data such as some water levels, piezo-electric readings for dam walls etc are input in response to downloaded scheduled questions. The driving aim is to replace all paper recording mechanisms for field workers. This will reduce data double and triple entry thus reducing

errors. The technology uses WiFi and SQL server DB synchronisation and an in-house VB application to achieve this.

A mobile dispatch system has been purchased for Company C's maintenance fleet. It is based on Fujitsu tablets and an externally supplied commercial application. The tablets provide access to a number of functions including GIS integrated with dispatch.

Communication

Company C is currently using a combination of wireless networks, Telstra CDMA, WiFi and State Radio Network when out of range of Telstra CDMA network in remote areas (This occurs very occasionally because of the extensive coverage of the CDMA network). Company C is currently trialling the NextG network using retail version of data cards. Company C has found the coverage of NextG network to be better than the CDMA network in its trials.

Company C is aware of the potential for data communications costs of mobile technologies to blow out. Company C believes there is need to utilise capped plans and negotiate an appropriate business solution with Telstra that will meet their data communication needs while at the same time containing the costs. In order to manage and contain its data communication costs, Company C has controlled the use of bandwidth by locking down mobile client devices through the use of firewalls and VPNs.

4.3.2 Organisational

Change Management

Company C considers change management to be a very important issue as the use of mobile technologies in the field and in general will have significant impact on its employees. Company C is currently working on specific strategy for mobile information system adoption.

4.3.3 Personal

Training and education

Formal in house training has been conducted to facilitate the adoption of mobile information systems by Company C's employees.

4.3.4 Perceived benefits in using mobile information systems

It is acknowledged that the use of mobile information systems in the field has allowed Company C to do things that could have been done before. Key mobile information systems have become critical applications for Company C in order to meet its compliance and reporting obligations to the Essential Services Commission.

4.4 Case Study D

Company D provides electricity related services to around 600,000 customers across one Australian state. These customers purchase their electricity through the government regulated tariff structure. Company D is a partially government-owned organisation.

4.4.1 Technical

Hardware

Currently Company D is using a range of mobile devices including:

- Rugged Panasonic Tough Books for fieldwork
- PDAs Blackberry mobile calendaring and email for 70 managers
- Standard laptops used by engineers for diagnostics.

Company D has decided to adopt the Panasonic tough books as the primary mobile devices. Previously 120 Business PDAs were purchased, not rugged and consequently were found to be not robust enough for the field working environment.

Software

The mobile applications currently used by Company D include:

- Video used for pole inspections
- Maintenance management system

These mobile applications are commercial applications. According to Company D, these applications are highly configurable which reduced the cost of in-house development.

Communication

Company D is using the Telstra CDMA network for its mobile data communications. CDMA data cards are used login into the secure corporate network using checkpoint VPN. In the move from the CDMA network to the NextG network, Company D will negotiate with Telstra – the telecommunication provider, for an appropriate business solution which will meet their mobile data communication needs and contain costs

4.4.2 Organisational

Change Management

IT based business change is considered as the major challenge particularly with the entry of transactional data in the field as historically this information has been recorded and entered in an adhoc manner by the field workforce. The use of mobile devices will enforce discipline in the entry of transactional data.

Phased approach has been taken to the adoption of mobile devices in the field initially focusing introducing non confrontational mobile applications such as providing electronic manuals on PDAs. Field workforce like this, as gives them more room in their truck and they do not have to carry around a lot of cumbersome manuals.

4.4.3 Personal

Training and education

Mobile computing will involve major business change for Company D's field force. Company D has a field workforce of 3000 most of whom are in their mid 40s and have been with the organisation all of their working life. IT literacy was found to be much higher than anticipated and there is eagerness by their field workforce to adopt IT including mobile technologies. In terms of training and education Company D are reasonably well set up with a division providing training and education internally and externally to other organisations.

4.4.4 Perceived benefits in using mobile information systems

The major benefits which Company D is expecting to realise from the use of mobile technologies include:

- Reduced paperwork
- Greater time can spent out in the field
- Allows field work force to be more responsive.

4.4.5 Case Study E

Company E is a state-wide electricity distributor. Core business for Company E includes:

- Delivering electricity from the high voltage network through poles and wires to residential property or business
- Installing, maintaining and reading meters
- Billing retailers on a monthly basis for use of the electricity distribution network
- Recording consumer transfers between retailers
- Providing an emergency response in the event of blackouts
- Repairing street lighting

4.4.6 Technical

Hardware

Company E is currently using Mobile Phones, PDAs and Laptops in the field. Company E has purchased 200 Panasonic tough books – 150 for use in the field and 50 as backup spares which can be deployed immediately if one laptop fails in the field.

Software

Three mobile information systems were developed to support various users including:

System A – Registered electricians are able to book online for properties to be connected to the SA State Power grid (350 electricians have registered with the system and 150 are active users of the system).

System B – jobs are rostered and prioritised in real time and accessible on line by the Company E's field workforce.

System C– unplanned work, covers the whole of the state utilising mobile applications in the field using Panasonic Tough Books mounted in white maintenance trucks (needs to able to withstand extremes of temperatures sub zero to 40C, and up to 60C in the cabin of a maintenance truck). With the outage management system, one screen with a list of prioritised unplanned jobs is presented to the field worker.

Communication

Company E considered three different mobile network providers (3 Network, Optus, Telstra CDMA network/Next G network). Company E's mobile network coverage is achieved by a combination of Telstra CMDA network. satellite and WiFi. ETSA is using WiFi to upload and download data - documents, updates (software, information) such as maps etc for field workers once their mobile devices are within range of a depot.

4.4.7 Organisational

Policy and Control

One of the key reasons to choose the Panasonic Toughbook (Tablet PC) is that the regular security and access policies can be applied to these tablet PCs (under the same Windows environment). Through the VPN, the organisations can control the individual mobile devices in a same way as they control the desktop units in the offices.

4.4.8 Personal

Engage users

Company E included field staff in the original mobile information system design from the beginning of the project. They were also involved in testing when the systems were delivered. The field crews have been very positive about the introduction of mobile computing. Having them involved from the design stage was important, as they feel they have helped develop the system and own it in some part. They genuinely see it as being able to help them do their work and remove some of the paperwork and admin side of their roles.

Training and Education

Training was conducted in a series of sessions, max 8 people at each. Once Company E was ready to actually roll the mobile information system out into the trucks, Company E sent at least one, two where possible, of the project team out with the field crews for the full day to observe and assist in the use of the system, and fill in any of the knowledge gaps that emerged.

4.4.9 Perceived benefits in using mobile information system

The use of mobile information system is enabling Company E to meet customer expectations and more importantly meeting customer service obligations as failure to do so can result in severe penalties with extended lost of power. So to a large extent their outage management system is driven by customer service and compliance obligations.

5 CONCLUSION

This paper has conducted five case studies in Australian utility companies (including both Water and Power Suppliers). Using the TOP model, the researchers are able to categorise the issues emerged during the design, development and implementation of mobile information systems. These findings are useful for other organisations that are considering taking mobile information system initiatives or improving their current mobile information systems.

The key technical findings are:

- Primary Mobile Information System of Interest – Work Event Management;
- Software Deployment Approach in Utilities companies – mainly in-house development;
- Mobile Network Coverage Information- Popular Choice: Currently CDMA, moving towards Telstra's NextG network; and
- Popular Mobile Hardware Choice – Laptops / Tablets with wireless communication.

The key personal and organisational-related findings are:

- The adoption of mobile information systems has been driven largely by compliance and customer service obligations;
- Mobile data communications must be contained through careful design of mobile applications and controlled usage of mobile devices;
- The impact and the associated change management issues of the adoption of mobile technologies must not be underestimated and needs to be managed carefully;
- Organisations are realising significant efficiencies and effectiveness through the innovative and smart use of mobile technologies;
- If adopted wisely, mobile technologies quickly become an essential part of the day to day operations of an organisation; and
- Training is essential to speed up the adoption of mobile information systems.

This research has shown that many Australian utility companies are aware of the importance of the mobile information system use in their daily operations. Among which, the primary focus is placed on

the use of mobile information systems for achieving better efficiency in the field workforce. The current popular application is work-event management. Despite of the functionalities of mobile information systems, the current adoption of mobile systems is considered to be relatively under-utilised. Benefits such as reducing paper work and are regarded to be low-level. Advance usages such as dynamically routing workforce according to the current locations and mobile knowledge management were not found in any participating organisations. Thus, it is suggested that these organisations should exploit the value of mobile information systems innovatively (e.g. discovering more m-enabled business processes) in order to achieve better efficiency.

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