BSITE: MOBILISING CONSTRUCTION

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# Table of Contents

Table of Contents............................................................................................................ i

List of Figures.................................................................................................................. ii

PREFACE.......................................................................................................................... 1

EXECUTIVE SUMMARY .................................................................................................. 3

INTRODUCTION ............................................................................................................... 4

- Project Statement.......................................................................................................... 4
- Introduction................................................................................................................... 4
- Specific Project Deliverables....................................................................................... 4
- Research Premise......................................................................................................... 4
- Case Study Methodology ............................................................................................ 6
- Utilisation uptake.......................................................................................................... 24
- Procedure .................................................................................................................... 24

  Comparative grid – intermediate results ..................................................................... 26

Appendix A - Ethics Application ..................................................................................... 30

Appendix B - Survey ....................................................................................................... 31

INTERVIEW AGENDA .................................................................................................... 31

  PART 1: RESPONDENT DETAILS ................................................................. 31
  PART 2: CHALLENGES ......................................................................................... 31
  Challenges .................................................................................................................. 31
  PART 3: AIMS AND OBJECTIVES ................................................................. 31
  Business Drivers ......................................................................................................... 31
  Service Levels and targets ........................................................................................... 32
  Legal & Liability ......................................................................................................... 32
  Works Order Management .......................................................................................... 32
  PART 4: RISKS AND CHANGE MANAGEMENT ......................................... 33
  Risks ............................................................................................................................ 33
  Adoption & Education ................................................................................................. 33
  PART 5: OTHER COMMENTS ............................................................................... 33

Appendix C - List of respondents and professions ......................................................... 34

Authors ............................................................................................................................ 37
List of Figures
Figure 1 Overall Project Overview................................................................. 5
Figure 2 Case study structure ..................................................................... 6
Figure 3 Workflow chart .............................................................................. 7
Figure 4 Inspection work order ................................................................... 8
Figure 5 Work order from the previous system ............................................ 8
Figure 6 From reactive to proactive maintenance ........................................ 9
Figure 7 Paper based work closure ............................................................... 12
Figure 8 New Field Mobile work order and closure .................................. 14
Figure 9 Five main themes: interview agenda ............................................. 15
Figure 10 Interview coding book ................................................................. 16
Figure 11 Cross analysis of 5 interviewees .................................................. 17
Figure 12 Respondent groupings by roles and views ................................. 18
Figure 13 Challenges ................................................................................ 19
Figure 14 Risk and change management .................................................... 21
Figure 15 Towards paperless work ............................................................... 23
Figure 16 Field Mobile data entry grid ......................................................... 25
Figure 17 New technology acceptance grid ............................................... 25
Figure 18 Comparative grid – intermediate ............................................... 26
Figure 19 the impact of peer learning in ICT adoption .............................. 27
PREFACE

The Cooperative Research Centre for Construction Innovation (CRC CI) is a national research, development and implementation centre focused on the needs of the property, design, construction and facility management sectors. Established in 2001 and headquartered at Queensland University of Technology as an unincorporated joint venture under the Australian Government's Cooperative Research Program, the CRC CI is developing key technologies, tools and management systems to improve the effectiveness of the construction industry. More than 150 researchers and an alliance of 19 leading partner organisations are involved in and support the activities of the CRC CI.

BSITE: Mobilising Construction is a collaborative effort between RMIT University, BSITE International Ltd. and the City Council of Greater Dandenong (CoGD) located in the Melbourne metropolitan area. The project here described began in November 2005, and this document reports on both strategic planning for software development and on the system evaluation by Council staff at pre and post implementation.

The City Council of Greater Dandenong (CoGD) Roads & Drains Asset Management Services serves the community by managing the City’s roads, drainage and footpath network; parks and recreational and sporting facilities to achieve improved safety, functionality and asset life for the community/ratepayers. It also supports Council’s operations by managing and maintaining Council’s fleet.

Asset Management Services is responsible for managing the maintenance of the city’s 594 km of roads, 750 km of piped drains, approximately 27,000 drainage pits, 101 km of open drains, 46 bridges and major culverts, 990 km of foot / bikepaths, 50,000 street trees, 72 sports grounds, 102 play grounds, 450 hectares of open space and approximately 200 plant items. Asset Management Services also provides a 24-hour 7-day-a-week emergency service and is responsible for all inspections related to vehicular crossings, road and nature strip openings and pre-building footpath inspections.

So, in summary the following categories of maintenance and operation must be dealt with:

- **Roads**: Road maintenance, obstructions, spills, street sweeping
- **Drains**: Blocked drains & pits, flooding, collapsed, lid missing
- **Paths**: Footpaths, bikepaths, footbridges, ramps, crossings, path sweeping
- **Signage**: Council signs, new signs, sign replacement, community signs
- **Furniture**: Street furniture, fire hydrants
- **Development Permits**: Asset protection permit, vehicle crossings, road opening

Maintenance takes place both cyclically as well as reactively in response to requests by ratepayers and other members of the community. All potential maintenance must be inspected, before prioritisation of the work and then assignment of the work to the appropriate crew. Subsequent to the work being completed it must be closed off by the Operations Coordinator and, for reactive maintenance requests, also closed off by administrative staff in the City’s customer request system.
Within this context, the City of Greater Dandenong (CoGD) is evaluating software and solutions that assist in:

1. Streamlining customer requests, field inspection, asset management & job dispatch processes.
2. Managing job dispatch and data submission from field staff working in the road maintenance team.
3. Providing a framework for leveraging the technology investment in other parts of the Council.

Some anticipated benefits include:

- Reduction of operational cost as a result of more efficient processes.
- Reduction of public liability as a consequence of timely work completion.
- Improved work satisfaction for administrative staff and crew members.
- Improved customer service as an outcome of reduced action cycles.
- Avoidance of double handling because of single point data entry.

BSITE International Ltd.’s solutions enable organisations to structure, automate and record the transfer of communications between people across multiple locations and organisations. Their systems integrate the use of SMS, email, fax and voice to deliver interactive communications to any device, at any time.

The field service challenge results from:

- Roads Management Act compliance pressure
- Need to know current site or resource status
- Manual data collection + double entry
- Difficulty in monitoring & thus in timely re-deployment of resources
- Time delays in reporting cycles

The BSITE solution should allow:

- Request, collect & update job data between office & field using mobile devices
- Fast, simple and easy to use
- Ensures accountability & transparency
- Reduces paperwork and data entry costs
- Removes delays in reporting cycles

The City of Greater Dandenong’s Asset Management Division uses BSITE’s application to:

1. Generate works orders from Conquest - the CoGD asset management system
2. Deliver works orders to road crews in the field
3. Crews record time against works orders
4. Crews record maintenance and related comments against specific works orders and assets
5. Validate data entered on the device by field teams prior to database submission
6. Submit data directly into the CoGD asset management system Conquest
EXECUTIVE SUMMARY

SUMMARY:
This research project aims to benchmark the utilisation level of a specifically developed integrated web and mobile communications software product developed by BSITE International Ltd.- that product is known as Field Mobile. The project was to undertake a road maintenance case study and has been carried in collaboration with the City of Greater Dandenong (CoGD) – Asset Management Division over a field trial period of 12 weeks.

This report documents the field trial of the software and provides an independent assessment of its practical utilisation and accrued benefits.

The study is broken into two key stages of analysis:
- Pre-implementation
- Post-implementation

This report determines the process efficiencies attained by businesses utilising the software. The report concludes with recommendations as to the uptake of similar asset management applications to similar Asset and Facility Management organisations. Results will also be disseminated through academic publications, an industry brochure and lectures.

KEYWORDS: hand-held mobile computing, technology uptake, innovation diffusion, action research, asset management.

FINDINGS:
This research provides a model for the uptake of mobile computing by asset management organisations. The model is based on diffusion theory, change management and peer learning, and quantitative grids were used to measure the uptake rate of newly-introduced technologies in a local government organisation located in the Melbourne metropolitan area.

FUTURE DIRECTIONS:
Further research opportunities include:

- Implementation of similar technologies in building maintenance.
- Applications development on building information modeling [BIM] for building inspection.
- Data mining and utilisation for life cycle modelling.
- Potential linkages for follow up CRC-CI projects with industry partners.
INTRODUCTION

Project Statement
This research project aims to benchmark the utilisation level of a specifically developed integrated web and mobile communications software product developed by BSITE on infrastructure maintenance programs over a field trial period. The project will also measure the process efficiencies attained by organizations utilising the software. The study examines and documents field trials of systems development and implementation, and recommendations are made for asset management organisations intending to implement similar applications.

Introduction
The continuous growth and reliability of services and computer devices in the past few years offers new possibilities to asset management industries for innovative and effective means of utilising handheld devices to optimise organisational performance. Management, admin staff and field workers should benefit through these facilities by having rapid access to data and develop historical records. However, care has to be taken when procuring a communication solution by considering data transmission, reliability, interference problems, coverage range, service availability and the likely cost factor. However, a purpose-built application developed for this study is here described.

Specific Project Deliverables
The project deliverables are:

1. Review of the software utilisation based on performance and feedback from trials of the software with the Asset Management Division of the Council of the City of Greater Dandenong.
2. Outline of the research methods used in the data gathering and analysis phase.
3. Draw conclusions about the relative success of the software in meeting the objectives outlined by the client based on the qualitative field trial data.
4. Draw value propositions as to the business impact the system has had in terms of time savings, data quality and performance indicators.

Research Premise
“Field mobile systems are to significantly simplify and streamline asset management processes.”

The focus of this study is to evaluate the development and implementation of specifically developed asset management systems which link office with on-site activities. Expected immediate improvements for the CoGD Asset Management Division include:

More accurate reporting information (for compliance purpose, in particular compliance associated with the Roads Management Act).
Improved work satisfaction for administrative staff and crew members.
Increased speed of reporting cycles (to enhance customer service)
Avoidance of double handling because of single point of data entry.
The upskilling of workforce through using new technology.
Expected long-term improvements for CoGD Asset Management Division include:

- Reduction in labour costs through increased operating efficiencies.
- Reduction of operational cost as a result of more efficient processes.
- Reduction in administrative costs.
- Reduction of public liability as a consequence of timely work completion.
- Reduction in costs tied up to inventory management.

The report is divided into two parts - each study analysed the technology adoption process and collected relevant information from a variety of personnel employed by the City of Greater Dandenong Asset Management Division. This information included interviews with stakeholders, and system pre-implementation questionnaires and system post-implementation questionnaires were carried out. The study included interviews to ‘Field Mobile’ development team, management and administration staff as well as staff or crew members. The data quality and system usage assessment were undertaken qualitatively over a 6 month period on a longitudinal study. The following Figure 1 illustrates the overall research structure which this report forms part of.
CASE STUDY METHODOLOGY

The case study method was chosen as it has previously been shown to provide value in organisational research. A case study is an empirical inquiry that investigates phenomenon in a real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin 1994). This means that by using the case study method we have been able to cover contextual conditions and occurring phenomenon (i.e. system development and its adoption process within a particular organisation (Yin 1994)). As a result, the case study as a research strategy comprises a method with the logic of design incorporating specific ways to collect, analyse and interpret data. In this sense, the case study is not just a data collection tactic or merely a design feature alone, but a comprehensive design strategy (Stoecker 1991 in Yin 1994).

The components of the method during stages 1 and 2 of this report include (1) pre- and (2) post-implementation studies. The applied methods would allow the research team to establish and report on clients briefing of system analysis and to evaluate its use. The study includes the following stages:

3.1 Scenario description: what is the current situation?
3.2 Scenario description: what is the new situation?
3.3 Stage 1: Pre-system development.
3.4 Stage 2: Post-implementation system.
3.5 Value propositions.

Figure 2 Case study structure

The above Figure 2 illustrates the stages in which this study was carried. Both stages are described in more detail in the two following sections.
3.1 SCENARIO DESCRIPTION: WHAT IS THE CURRENT SITUATION?

The workflow diagram below describes the changing situation including the shift towards proactive maintenance from today’s reactive maintenance situation (Figure 3 Workflow chart - columns 1 and 2).

Figure 3 Workflow chart

Although currently there are several asset management systems already in the organisation, both are database applications not linked to site or to site crew members, and workorder completions are recorded on paper and on-site. The above workflow diagram is described in more detail as follows:

3.1.1 Customer requests (Figure 3 Column 1)

The current situation is that the CoGD utilises the 'Customer Request Management Systems' (or CRMS) to record all customer service requests at the call centre. Each request is allocated to a Business Unit for investigation. All requests relating to Roads, Drains, Trees, Street Furniture Signs, Line marking etc are allocated to the Operations Centre for inspection prior to action. This approach is also known as 'reactive requests'.

3.1.2 Inspections - Operations Centre (Figure 3 Column 1)

Administration staff print out a CRMS for inspection and the Operations Coordinator issues these hard copies to the appropriate inspector. Inspectors then visit the site and inspect the asset described in the CRMS to determine what, if any, actions are required and then update the hard copy. When they return to base the Operations Coordinator programs/schedules any required work. The hard copy containing the inspection and action details are then submitted to admin. staff to update in the CRMS.
3.1.3 Work prioritisation and work order dispatch (Figure 3 Column 2)

A work program is then prioritised and programmed manually by the Operations Coordinator. A summary spreadsheet for the week is created to provide an at-a-glance breakdown of the work for each crew. This prioritisation and spreadsheet summary is updated by the Operations Coordinator prior to the close of business each day. The work order is then issued in paper form to each crew member when they start work at 7.00am each morning.

3.1.4 Work order and fulfilment (Figure 3 Column 3)

At the end of each day, the paper work order is completed by the driver for each crew and submitted to the Operations Coordinator to approve and close off the work. The following figure 5 clearly illustrates one of the short comes of the paper-based system as the quality of the data coming back to the office normally incomplete, unreadable, late and in some cases the form gets lost.

![Figure 5 Work order from the previous system](image-url)
3.1.5 Customer request administration (Figure 3 Column 1)
The Operations Coordinator then submits the approved paper work orders to the administration team to update the customer request status in the CRMS. This is undertaken on a periodic basis – approximately once per month.

3.2 SCENARIO SETTING: WHAT IS THE NEW SITUATION?

The introduction of the Road Management Act has imposed a higher duty of care and responsibility in terms of Council acting as a Road Authority and managing the road assets under its control. This would include column 4 from the following figure.

![Figure 6 From reactive to proactive maintenance](image)

The above flowchart indicates both the reactive and the programmed flow of operations. It also illustrates process transitions towards a paperless inspection and work closure process. Numbered columns indicate process stages including current reactive maintenance (1), activities established by the work programmer (2), then the input from Field Mobile to link office to site (3). It is expected that overtime maintenance forecasts will be identified and programmed (or preventive) maintenance programs established.
3.2.1 Drivers for the uptake of field mobile.

Several driving factors have been identified by CoGD Asset Management Division for the introduction of technology linking office systems with crew members who work on-site. Amongst the most important drivers include the recently introduced Roads Management Act which is a statutory obligation in relation to the inspection of roads by end of FY 2006; as well as a strong push from within Council for the City of Greater Dandenong to improve its practices and service to the community. The underpinning agenda was that of moving towards a *paperless organisation*, working more *efficiently* and most importantly of all, shifting its operations from *reactive* to *proactive*, and can be summarised by the following:

- Additional detail of data being collected.
- Reducing costs of administration
- Better understanding of asset maintenance and total lifecycle management of assets.
- Increased visibility for council on cost of maintaining assets.
- Timely upload of information enabled increased visibility of data to customer service agents and the ability to provide more up-to-date information to ratepayers.
- Increased accuracy of collected data through the utilisation of data validation rules and correlation of numbers.
- The reduction in errors caused by incorrect data entry and attribution of time to the wrong sites.
- Increased visibility of resources being utilised on the roads to reduce inventory levels.
- Reduced costs associated with data entry.
- Increased utilisation of field staff through the ability to update work orders in real-time and deploy resources to work that is at a nearby location.

3.2.2 New requirements

The CoGD Council has been required to develop a detailed road management plan which includes:

- Details of maintenance intervention levels and regular road inspections to inform Council of the state of its road network.
- Details of when and how maintenance was carried out on reported defects, and to retain that information against the asset for future reference.

As a first stage, the CoGD Council began to act upon the first part of its requirements with the implementation of a cyclical inspection program. This involved:

- The appointment of 3 inspectors trained both in the use of technology that records the above details out in the field (including required remedial works) and also trained to upload the information to Council’s Asset Management Systems [Conquest software] (refer to Figure 3).
- Training the Works Programmer in the use of Conquest to generate Works Programs.

In this first stage of the required plan the City of Greater Dandenong has completed its first inspection of its entire road infrastructure.

The second stage of the plan was the implementation of Field Mobile system developed for crew members and site workers whereby crews are prompted as to the exact information to be collected. The application requests are selected from a drop-down menu.
3.2.3 What does the system do?

The system essentially links and streams structured information between offices and crew members in real time.

Work assignment and prioritisation is done in the office and work-orders are sent to crew members expected to do the job on-site via an SMS system. The mobile device would receive and sort all information in different modes such as prioritisation, location or accessibility to site – for example, a time of the day when the job would not be too disruptive to drivers.

Once the job on-site is completed the job has to be closed on the mobile device. If the system is out of signal range the SMS message is saved locally and it is sent as soon as the device is within range.

The quality of data collected is expected to have a significant improvement once the system is in full operation. Data storage and accessibility for accurate data mining is expected to improve Council’s service to the community and to make their service more accurate and transparent when it comes to disputes or court cases. Ratepayers would also be able to log on-line to track progress of their road repair comments and complaints.

3.2.4 What are the business benefits?

It is expected that there will be immediate and long-term business benefits. This study provides some possible scenarios as to what are/will these benefits be. The following Figure 7 shows a simulation model that has been prepared for this study. As a follow up aspect to this study the development of a fully populated model is here suggested. Firstly to test the validity and reliability of the collected data and secondly to investigate if such and interface provide a decision support tool to move towards proactive maintenance. The boxes from 1 to 6 show different aspects of the simulator including the following:
Figure 7 Paper based work closure
From the above Figure 7 we can subdivide the following diagrams:

Refer to Figure 7, insert 1:

Key variables:

- Average time of inspection result delay
- Average time of repair result delay
- Average repair time
- Average inspect time
- Repair requirement by CoGD
- Average number of inspectors
- Average number of crew members
- Average time to generate inspect order
- Average time to generate work order

Figure 7, insert 2:

- Sum of finished work
- Sum of finished inspections (ins)
- Sum of finished in smart track (smt)

Figure 7 insert 3:

- Current requests
- Weeks, 17, 18, 19
- Summary of finished work in smart track

Figure 7 insert 4:

- Time reference current
- Summary of smart track inspections

Figure 7 insert 5:

- Work results delay rate
- Inspection results delay rate

Figure 7 insert 6:

Detailed daily data

It is expected that efficiencies on avoiding double data entry will also reflect on improved business benefits to the CoGD. Other key benefits include accuracy on time and qualities of the job done. This is expected to have serious implications for dispute resolution. Another key benefit is the improved service to the community, as the status of reported jobs will appear on the system screen, thus enquiries can be answered on the spot. This is because the system now contains real-time asset information updated at the time and place that the work is performed. The time spent re-entering information into the Conquest system is now eliminated and administrative resources are now minimised. Due to the real time work allocation capability, travelling time can be reduced as the Operations Coordinator can continue to allocate new work-orders and update allocations without the need for crews to return to the operations centre.
Faster information updates to the Conquest system allows customer queries to be tracked easily by call centre staff with real-time information available to relevant stakeholders. This efficiency gain delivers reduced reporting cycles and more rapid turnaround times without additional labour costs. Additionally the data integrity and therefore quality of the collected information has increased due to the validations, rules and standards implemented in the mobile (Java-based) PDA application - which will ensure a consistent level of collected information.

Note that at this point in time no historical data is available and for full implementation of a modelling system such as ‘systems thinking’ time and historical data collection is an imperative.

3.3 SYSTEM UPTAKE AND TOOL UTILISATION BY CREW MEMBERS

As part of the implementation each crew member received full training on the use of the operation system on hand-held PDA device but more importantly was the explanation as to the impact of their input into improving a service to de community. Small groups of up to 10 and One to One was given to all crew members. The hand-held device also includes a utilisation manual with screenshot plus on-line support.

The operation and interface for system was designed so that it would not affect the way in which crew members go about their work - the aim is to provide clear accurate and up-to-date information for both the crew and the organisation via the quickest means possible using today's technology. A series of screens are to guide step by step on job allocation and closure.

![Figure 8 New Field Mobile work order and closure](image)

The above Figure 8 illustrates the main steps for a crew member to view and close work orders – ‘View Work Orders’ to ‘Submit Jobs’. The PDA screen would display Action ID, Workorder Start, Workorder Finish, Location, Street directory reference system (i.e. Melway), Asset Description, Action Description and Estimated Quantity Unit (this field has the option to validate against real quantity used). A screen for adding comments or attaching pictures is also available. Thus achieving ‘simplicity’ was an imperative during the interface design and development stages. It is expected that over time the system will learn more about individual users routinary information. To conclude there is no doubt that all development efforts at this stage were made to achieve ‘simplification’.
3.1 STAGE_01 – PRE IMPLEMENTATION

Stage_01 of the case study developed a series of ten interviews (10) with organisational decision makers from CoGD. The aim of this part of the study/system development stage was to elicit views and expectations of the new system from the people who drove its development and implementation. Interviews were carried out at a briefing consultative stage and elicited predictions and expectations of the uptake of Field Mobile applications. At this stage the study aimed at mapping the opinions from the directive board systems development team. Results were reviewed and patterns emerged as to alignment and differentiation across the development board. A series of follow up meetings where carried out to validate the results.

3.1.1 PROCEDURE

A series of consultative meetings with CoGD strategic personnel took place between February and April 2006. Interview results fleshed out operational objectives behind the development and implementation of the new system – the main themes under discussion included (1) barriers, (2) expectations, (3) fears and (4) incentives. Themes where discussed in relation to the overall objective for CoGD which is to move towards a paperless system and in specific the use of mobile computing systems such as Field Mobile. The approach underpinning the study is that of Qualitative Data Analysis (QDA) as the research technique (Seidel 1984). QDA provides insights into applied studies of knowledge, attitude measurement and learning.

3.1.2 STAGE 1 RESULTS

Result analyses include the following modalities:

Stage_01: Ethnographic analysis (Seidel 1984) and Stage_02: Repertory Grids analysis (Gaines and Shaw 1995), including the following three grid elicitation and result stages:

1. System introduction: summary grid comparing all participants at pre-technology introduction.
2. System training: summary grid comparing all participants after training sessions took place.
3. System utilisation: summary grid comparing all participants after using the new system on the field.
(See appendix for full interview and grid coding).

3.1 CONTENT ANALYSIS

Results from the interview transcriptions where grouped into five main themes (refer to Figure 7). They were then coded and highlighted to assist review and content analysis using Seidel’s model for interview analysis (Seidel 1984). Emergent themes at level two were summarised into 12 sub-themes which emerged from the interview agenda prompts.

Figure 9 Five main themes: interview agenda
All transcribed interviews were coded in Adobe Acrobat Professional™. Codes where then assigned colours indicating main themes, reference to respondents and researcher’s comments and data was also coded. Content in the overall interview text refers to any of the five cluster themes which were identified and underlined. All transcribe paragraphs were numbered in a legal fashion. The following is a screenshot of the coding and content reviewing process. Once transcriptions were saved in a desktop computer, access to data was restricted, and were only accessible to the principal investigator. Recordings of interviews were then destroyed and the transcripts rendered anonymous. The procedures for ensuring confidentiality and anonymity are recommended practice and requisites of RMIT Ethics Committee.

The above figure 10 illustrates the coding procedure. Seidel (1984) refers to this as the ’code book’ which summarises the segments identified from the initial interview schedule and key coding and key words were then assigned to textual segments. Once all transcriptions where coded, comparative sorting occurred (see above figure). It was then possible to identify a series of “relevant” or “common underlying” themes resulting from the interviews. Developing a code book and searching for segments is an iterative process and for this study the first level of the code book was structured as the original interview schedule.

Colour coding was structured as follows (for full text, refer to appendix):

- Background information – such as experience
- Case study information
- Programming specific questions
- Information visualization
- Data display formats
- Strategies of Company IT development
At initial Level_01 search identified relationships between the full interview transcript and the interview schedule. This activity was important because questions were not answered in the same order as the interview schedule. At various levels Seidel (1984) highlights this aspect in his exploratory interviewing technique – especially as mental cues in the mind of the respondent do not necessarily follow the respondents own cues. In the case level_02 refers to the themes identified as main (or cluster) themes. Cluster elicited by the respondent. These cluster themes represent key areas of concern as viewed by the interviewees and contain twelve themes. Level_03 identifies differing attributes that relate to individual views. It aims to provide a framework to compare and contrast interviewees’ views and expectations towards the system. In the context of this study, “themes” represent issues of concern out of the interview agenda and voiced by the interviewees. Professional roles, location and work activities are grouped in the following Figure 11.

Figure 11 Cross analysis of 5 interviewees
RESULTS: INTERVIEW RESPONDENTS

Interviews with 10 key personnel of the City of Greater Dandenong, Asset Management Division were carried out on a one to one basis over 4 sessions on two particular dates. Interview respondents included:

- Asset management coordinator
- Business unit leader
- Business systems analyst
- Information management services
- Road damage inspector
- Operations coordinator
- Asset management systems
- Roads and operations
- Roads and drains coordinator
- Administrative support.

The study identifies differing attributes that relate to individual views. It aims to provide a framework to compare and contrast interviewees’ views and expectations towards the system. In the context of this study, “themes” represent issues of concern out of the interview agenda and voiced by the interviewees. Professional roles, location and work activities are grouped in the following Figure 11.

Figure 12 Respondent groupings by roles and views
For full coding and interview description refer to the attached Appendix. The following comments were selected to reflect viewpoints and to provide insight into concerns and expectations.

“What this is enabling us to do (with new system) is to get the guys to a point where they can be more efficient with little extra effort we can now have them to record what are they doing, where are they doing it including all and more importantly is the level of detail needed as to when the project was completed now logged into the system. This means that they (crew) have now moved from being the weakest link in the game to become the strongest in the system.” as there is a stronger link between office and site.”

[Works Business Leader]

The above quote illustrates the relevance of having a paperless system which now has been extended from the office to site.

“Once the data was entered electronically we were looking to complete the cycle electronically and that is what we were looking at this is important to us because every time we were going back to the paper based system (communication between office and site) we where defeating the purpose of the system.”

[Works Business Leader]

The paperless and automation plan was originally envisioned over five years ago. Now that office and site are part of one integrated system things are perceived as being completed. From now onwards data and log book/files will be collected. It is expected that over time extrapolations will be elaborates as to preventive maintenance and life cycle, this would include short, medium and long term maintenance evaluation.

Figure 13 Challenges

In terms introduction a timely and tactful introduction of the system is paramount:

“You need to be very careful on how you tackle the adoption processes, if you try too quickly they will complain, there is no doubt about that, and there are a range of issues like no wanting to be told how to operate something in front of their mates, there might be also industrial issues, for example they might want more money because they are learning a new thing and they might be in their own right but there are a whole range of unexpected issues.”

[Works Business Unit Leader]

Optimistic appreciations on the introduction of the system:

“All it’s going extremely well. I will be very surprised if we get something negative out of it and, if you talk to some of the guys who have tried and it is a second,”
operating the system quickly becomes a nature. Because initially it is an initial
Initially there is a reaction to this but after a while when they (crew) realise that
this makes their job easier and even with the possibility to increase their salary
down the track I am sure they all will be happy about it.”

[Works Business Unit Leader]

“Contact (at the moment) is mainly by voice mobile. The problem is that you do not
always get all details. Especially when people leave me a message and then I need
to find out more and solve and organise the problem for them. This is common a
case of miscommunication (all data in the new system is viewed on the screen).”

[Dispatch of Work Orders]

The following quote highlights the envisaged opportunities and skills development for to the
staff:

“This it is another opportunity for our staff to advance their skills and bring their
input into what we do, instead of being just blue collar workers on the tools.
Cutting edge technology it gives will give our staff something to tell at home and
tell their friends and family some of the good positive initiatives that are
happening.”

[Business Unit Leader]

The following quote highlights the importance of peer learning and peer technology
introduction. It is expected that by having peers sending the right message on the field to
their peers is a powerful and safe approach for the acceptance of the system:

“So we are hoping that by firstly introducing the system to crew members that are
more receptive to the technology. It is expected that they will be leaving a good
message and hopefully will encourage others to embrace it.”

[Coordinator and Works Programming]

A contrasting view to the above:

“To start I think it is going to be a struggle for the guys because I have guys that
can not read or write English, I got four of them, they are learning how to read and
write a bit better if. If you give them a computer I think they are going to freak -out
and I am afraid that this is what will happen. It is up to me show to them the
benefits.”

[Coordinator and Works Programming]
“This is going to have a positive impact because there is nothing to write and the guys only need to tick and that it is going to be the big benefit. It is when you are trying to explain to the guys BSITE and what is happening that they get confuse. You just keep it simple. Lets make it calmly and rise interest but it is also important no to make a big deal out of it

[CREWMEMBER]

4.1 POST IMPLEMENTATION STUDY

As for Stage 2 of the case study analysed the technology adoption process as by peer introduction and collected relevant information from a variety of personnel and crew members – all employees of CoGD Asset Management Division. The following figure indicates the two stage case study carried out.

In stage_02 attitudes were discerned qualitatively through a Likert - scale type questionnaires applied to end-users over peer introduction, training and usage of the new system. Results are presented as a series of grids – also know as Repertory Grids (Gaines and Shaw 1995). Web Grid™ software was used to analyse responses as it offers the ability to analyse qualitative and quantitative data (Gaines and Shaw 1995). The software was chosen on the basis of fitness for purpose as for being a familiar to the research team.

Data collected from paper time sheets provided to RMIT by CoGD. This could include:

Observations on the data contained therein
The average number of completed fields
The accuracy of data collection
The potential errors created by data entry of the information

Speculation as to whether data has been entered ‘on the job’ or after returning to base (i.e. is it accurate or authentic?)

The average processing time taken to get the paper data into electronic form (this was only occurring once per month – sometime less frequently than this).

Lack of correlation between data entered in the sum columns and the totals entered.

The lack of complete information

The lack of an authentic sign off or authorisation mechanism (many timesheets were submitted unsigned).

Data comparison that took place including key findings, for example:

Additional detail of data being collected.

Timely upload of information enabled increased visibility of data to customer service agents and the ability to provide more up-to-date information to ratepayers.

Increased accuracy of collected data through the utilisation of data validation rules and correlation of numbers.

The reduction in errors caused by incorrect data entry and attribution of time to the wrong sites.

Increased visibility of resources being utilised on the roads enabled a reduction of inventory levels.

Reduced costs associated with data entry.

Increased utilisation of field staff through the ability to update work orders in real-time and deploy resources to work that is at a nearby location.

3.6 BENEFITS

The following are the envisaged benefits:

Crews can receive jobs at any time without returning to the office.

Complete, accurate and current information is available in Conquest.

No writing.

Reduced paper usage.

Improved Customer Service - accessible current information.

Eliminates double handling.

Eliminates misinterpretation.

Provides an opportunity for multi skilling.

Move away from reactive request: Council is also utilising the above technology to record inspections of defects reported via its Customer Request System and reporting of recommendations for remedial works if the defect meets with the intervention level set by the Council.
Where a defect does not meet with the intervention level "No Action" is recorded.

As for the CoGD Asset Management Division the expected benefits are as follows:

- Council has a clear picture of the state of its road network.
- Council can now better utilise its budget.
- Improved Customer relations.
- Asset information is now at the "click" of a button instead of searching through reams of documents and files.
- The works programmer can now generate programs quicker via Conquest.

While there are already clear benefits to Council after implementing the electronic inspection program the CoGD is still have an obligation to meet the second part of the Roads Management Act.

The above figure 15 illustrates improvements in the quality of data. It is expected that over time the more detailed entered information can be used to predict materials life cycle and will assist to move towards proactive maintenance.
SURVEY

Interview with 7 crew members employed by CoGD - Asset Management Division was carried on a one to one basis as introduction and training sessions were carried out.

Interview respondents included:

- Operations Coordinator (1)
- Crew Roads (2)
- Plant Operator (2)
- Information Management (2)

In the grid coding operators are identified with an [O] and crew members with an [C].

Utilisation uptake

An study was conducted when implementing the first technology trail. The study has tested technology adoption procedures and gather preliminary data on the use of hand-held computers for job notification and time collection within the current job dispatchment environment. The information sought is a combination of qualitative and quantitative information at pre and post software implementation stages [for full questionnaire refer to Appendix B].

Pre and post-implementation questionnaire respondents included:

- Operations coordinator roads
- Operations coordinator drains
- Operations coordinator
- Plant operator

Procedure

Participants were required to answer a series of questions about their every day work and comparisons with new ways of working in a mobile and paper less environment. Each interviewee was asked to comment on past experiences with hand-held computers. The interviews were predetermined prior to commencing and each respondent was asked a similar set of questions pertinent to road maintenance job allocation and reporting procedures. Interviews did not exceeded 1 hour in duration and none of the questions were of personal nature.

Where possible and practicable, all questionnaires and interviews were conducted in person, and undertaken on the work site of the respondent. These semi structured interviews and data gathering exercises form the basis for the evaluation framework, which in turn will inform the approach and analysis for the case study. Interviews, questionnaires and associated documentation is being analysed both, qualitatively and quantitatively using Gridsuite® cluster analysis software. At this stage a multiple choice attitude measurement questionnaires was distributed over a trial period.
The above Figure 16 indicates cluster analysis of seven respondents. Clusters or groups are organised vertically and horizontally. For example, a strong cluster affiliation is indicated by the “B” rectangle with participants 06, 04 and 07 matching at 100%. On the other hand, statement 33 (My data entry efforts assist me and my workmates to better communicate) only links at 70% with the rest of the statement (indicated with the letter “A”).

The above Figure 17 indicates another cluster analysis of respondents and their attitudes toward the Field Mobile System. Respondents 06, 02 and 04 make a cluster – or a similar group – as they match at 90% and 95%.
“Diffusion is the spread of an innovation throughout a social system over time.”
(Howard and Moore, 1988, pp 344)

The above figure 18 indicates attitudinal change and the change process over time where levels 1 and 2 indicate most attitudinal variation and levels 3 and 4 less attitudinal or viewpoint variation. The origin of diffusion of innovation started with Trade’s publication in 1903 called “The Laws of Imitation”. Forty years later, Ryan and Gross (1943) commenced the next approach and edited on the spread of hybrid-corn use among Iowa farmers. The outcome of their results provided a rough structure of the diffusion model and represents a classic example. Everett Rogers in his pioneering book “Diffusion of Innovation” was first edited in 1962 which refers to the work of Ryan and Gross where he releases a systematic synthesis of the diffusion model. Rogers describes diffusion as the process by which an innovation is communicated through certain channels over time among the members of a social system over time (Rogers, 1962; Rogers, 2003).
5. CONCLUSION

This study has shown the influence of peer learning when developing and introducing new technologies. This model should be considered by managers and HRM. Formal training and advice will always be provided however, the introduction of new work practices should be handled with care and formal training procedures could destroy and introduction agenda – if not dealt with care. Figure_9 maps the above comments, the diagram is to formalise observations from this the case study. The model aims at highlighting the impact of peer training as to providing insight into the adoption process of new technologies.

Learning and change management
Simplicity of use and familiarity with mobile phones has assisted in the process of getting field workers utilizing and gaining confidence with the system. 'Hands-on' training support has been provided to the crews to assist with the uptake of the technology, this has been augmented with peer introduction it was also provided on the device itself and a hard copy form. The innovative approach to both software and hardware selection has assisted in supporting the comprehensively planned change management process undertaken in this case by the council to support the project roll out.

Business processes
The full integration of the handheld devices with the council's asset management software system has revolutionised the information flow across the whole of council and enabled the existing business processes to be streamlined. The new system links the maintenance and work order management process directly to the life cycle and maintenance of the asset itself. Traditionally the work order/job management process for field crews has been separated from the record and maintenance of the asset. The new system provides direct linkage between these tasks. This linkage delivers benefits including: Reduced data entry and
double keying of data, increased data accuracy, faster reporting cycles and real time access to information on assets, more efficient business processes.

**New Wireless Technologies***

The availability of new wide area wireless data technologies such as GPRS/3G has made it possible for systems such as Field Mobile to be developed, established and utilised. Importantly, the design and functionality of wireless handhelds/PDA's and smart phones has enabled extensive functionality to be provided to remote users through easy to use software that utilises simple touch screen interfaces for field input. The selection of new ruggedised PDA devices have assisted the use by Field teams as the equipment can withstand harsh operating environments and all-weather conditions.

Reducing efforts for data entry can be achieved with inquiries being processed electronically. Data provided by the client – i.e. road damage reports – inspection is carried and registered into the system without manual data entry and error causing while re-entering. Access as to the status of all jobs can be displayed on the screen as to when repair is expected. This feature is to particularly increase level of service to the community.

Reducing overall processing time can be achieved by cutting down the time spent on data entry and having the chance to resend electronically, so there should be a reduction in the overall process time. In order not loosening track of incoming inquiries within the organisation they have to be monitored as there is no more calling, printing and faxing to be done.

Improving process-quality by storing and processing important data can be improved by doing it electronically. Avoid ability of not readable fax documents or not available data that causes errors in data entry.

Improving the Council's image can be achieved by the increase of client satisfaction and decrease of processing time.
BIBLIOGRAPHY [Need to review]


Appendix A - Application

HRESG
Building 220,2.36
Bundoora West Campus
HRESG-B: 574-10/04

Wednesday, 8 June 2005
Dr Guillermo Aranda – Mená
C/- School of Property, Construction
and Project Management

Dear Guillermo

Re: Human Research Ethics Application Approval

The Design and Social Context Human Research Ethics Sub-Committee received your amended ethics application entitled: “E-business adoption in construction (CRC Construction innovation)“.

I am pleased to advise that the Chair has now approved your application as level 2-risk classification.

This now completes the Ethics procedures.

You are reminded that you are required to complete an Annual/Final report, which should be forwarded to the Secretary of the DSC HRESG – B at the above address not more than 12 months from date of this letter.

Should you have any queries regarding your ethics application please seek advice from the Chair of the sub-committee Assoc. Prof. Heather Fehrion 9925 7840, heather.fehrion@rmit.edu.au or contact me on (03) 9925 7877 or email heather.porter@rmit.edu.au

I wish you well in your research.

Yours sincerely

Heather Porter
Secretary
Design and Social Context
Human Research Ethics Sub-Committee
Operational Unit - Bundoora
Appendix B - Survey

RMIT: Cooperative Research Centre for Construction Innovation
Field Mobile Uptake and Utilisation Questionnaire

Dr Guillermo Aranda-Mena
Phone: 9925 9512
Fax: 9925 2230
Email: guillermo.aranda-mena@rmit.edu.au

February 2006

INTERVIEW AGENDA TO SENIOR MANAGERS CoGD
[CRC for Construction Innovation]

PART 1: RESPONDENT DETAILS

What is your role within the organisation?
What are your key areas of responsibility?
How long have you worked within the organisation?
Do you spend the majority of your time doing? Field operations, management or administration.

PART 2: CHALLENGES

Challenges
1. What are the greatest challenges in communicating and managing information currently facing your department?
2. Where do the greatest inefficiencies in communicating and managing information exist?
   - In the field
   - In the office
   - Communicating between the field and the office
3. Is time wasted in communicating with field staff?
4. Is time wasted in collecting information from the field?
5. Is unnecessary work created or duplicated?
   - Across teams or people
   - Administration
   - Miscommunication
6. What is current staff moral like among your team?
7. Are managing data and information important in your role?
8. Do poor processes for managing data and information make your job difficult?

PART 3: AIMS AND OBJECTIVES

Business Drivers
1. What do you think are the main reasons for adopting mobile technologies developed by BSITE within the CoGD’s operational context?
2. What impact will mobile technologies have on the performance of your division?
3. Do you think data will be more accurate with the new system?
   - Less data entry
   - No rekeying of data by admin staff
   - More accurate inventory management
   - More accurate asset lifecycle costing
4. How, if at all, do you think the technology will reduce costs?
   - Administrative staff and administration
   - Less printing, paperwork, photocopying etc
   - Easier to coordinate external resources e.g. Cutting, Signage etc.
5. How, if at all, do you think the technology will increase productivity?
   - Less time spent entering data for admin staff
   - Lets crew know what info is important to organisation
   - Reducing travel times by better work allocation
6. How does receipt of real-time information from site benefit your organization?
   - Work management and allocation
   - Knowledge of location of crews
   - Accurate reporting to stakeholders/customers
7. How does the technology assist to expedite delivery of work?
   - Crew has ability to plan and structure their own work
   - Better resource utilisation
   - Easier to co-ordinate multiple crews working at a single location
8. Are there any other benefits you foresee?
9. How, if at all, do you see this type technology as benefiting other industries?
   - Other construction businesses
   - Maintenance and repair organizations

**Service Levels and targets**
1. What goals does the CoGD have regarding improving performance and service targets?
2. How is your organisation/division going to measure such improvements?
3. What are the metrics to be applied when reviewing the use of mobile technologies?
4. What criteria will you use to judge the success of the Field Mobile solution? Which of these are the most important?
5. What are the goals of the project and how are these translated into success-measures for implementing the software? [The interview will review a range of metrics including time; specification; satisfaction levels for the customer, developer, team, and users; cost; resources; quality; and risk which applied to field mobile].

**Legal & Liability**
1. Can you identify any gains that mobile communications software provide in order to support potential issues with legal disputes?
2. Do you see this technology assisting in clarifying enquiries & disputes (e.g. ratepayers)?
3. Are there any potential impacts of the system relating to legal/public liability e.g. OHS?

**Works Order Management**
1. Do you think being able to assign work to crews that are out on the road will reduce traveling time?
2. How will the new work assignment process allow you to better manage your crew resources?
3. How will the new works order system allow you to get jobs completed faster? How does this relate to jobs that involve multiple crews
4. How can timely data assist your division to organise works order dispatch and resource allocation process?
PART 4: RISKS AND CHANGE MANAGEMENT

Risks
1. What do you think are the main risks associated with the use of mobile technologies (developed by BSITE) within the CoGD’s operational context?
2. What are the risks associated with implementing these types of technologies?

Adoption & Education
1. Do you think change and adoption of new technologies is important?
2. What do you think others in the organization think about adopting new technologies?
3. How important are cultural and training issues in getting are successful outcome when implementing a new technology solution?
4. Is it critical to adopt mobile technology? If so, please indicate why?
5. Do you think the technology will be easily adapted/accepted by crew members and others users such as inspectors, operations managers and other personnel?
6. What are the training implications (time and cost) for implementing mobile technology?
7. Do you envisage any risks or problems associated with the use of the Field Mobile technology? How can these risks be mitigated?

PART 5: OTHER COMMENTS
1. Do you have any other comments?

Thank you for your participation.
## Appendix C - List of respondents and professions.

### Field Mobile Interview Proposal

**Key Personnel**

The following provides a list of Key Personnel for consideration in the RMIT survey, they have been involved in some way with the development & implementation of the BSite Project, it includes their roles in the City of Greater Dandenong and a list of Key Points on which they can provide views and opinions.

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AUTHORS

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Guillermo is currently a Lecturer in Property, Construction and Project Management at RMIT University, Australia. He holds a PhD in Construction Management and Engineering from The University of Reading and a Masters of Science in European Construction Engineering from Loughborough University of Technology, both in the United Kingdom. In 2003 Guillermo was appointed Post Doctoral Research Fellow at the University of Newcastle, Australia, working on a Cooperative Research Centre for Construction Innovation research project in Digital Architecture ‘BIM Planning Workbench’ in collaboration with the CSIRO, Ove Arup, Rider Hunt, Woods Bagot Architects and John Holland Group.

His research interests include the use of BIM (‘Building Information Modelling’) as an enabler for design collaboration in Architecture, Engineering and Construction and the uptake of ICT by Small Construction Enterprises – ‘Mobilising Construction’ and ‘the Paperless Builder’. He is also principal investigator of three CRC-CI projects including Business Drivers for BIM. In May 2006 Guillermo was appointed as Conjoint Academic to the School of Architecture, University of Newcastle, Australia and has been actively publishing and presenting his research output.

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He coordinated the Center’s building technology research program and chaired the Technical Coordinating Committee under the US Department of Housing and Urban Development (HUD) Building Technology Research program. Dr. Wakefield is a Principal Investigator for the Industrializing the Construction Site project (Phases I, II, III, IV, V, Stage V extension) and a lead author of Industrializing the Residential Construction Site series of monographs prepared for the Office of Policy Development and Research, HUD. Dr. Wakefield is also Co-Principal Investigator of two National Science Foundation projects in the U.S.