Measuring Up To Success

Creating a Benchmarking Service for the Australian Construction Industry

Edited by Graham Brewer

CRC Construction Innovation
BUILDING OUR FUTURE

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Office: Cooperative Research Centre for **Construction Innovation**
9th Floor, Level 9, QUT Gardens Point
2 George Street, Brisbane Qld 4000 Australia
Telephone: +61 7 3864 1393
Email: enquiries@construction-innovation.info
Web: www.construction-innovation.info

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Authors and Contributors

Project Leader

Graham Brewer

Project Leader for **Construction Innovation** Projects *Benchmarking Information and Communication Technology Uptake and Integration in the Australian Construction Industry* and *Critical Success Factors for ICT Mediated Supply Chains*. Other research interests include the alignment of business management objectives with supply chain partners; ICT integration; project team dynamics and knowledge management within temporary project organisations; public-private partnerships, public infrastructure funding.

Project Team Members

Professor Swee Eng Chen

Research interests involve the understanding of project performance from a complexity perspective; the application of systems theory to the management and economics of the building procurement process, with particular reference to buildability, quality and environmental issues; project team dynamics and knowledge management within temporary project organisations.

Marcus Jefferies

Research Masters undertaken at the University of Newcastle involved the study of "Risk Analysis and Critical Success Factors of Build-Own-Operate-Transfer (BOOT) projects", case studying major infrastructure projects in Sydney including the Olympic Stadium and the SuperDome at Homebush Bay. Research interests include sustainable procurement innovations particularly Public-Private Sector Partnerships. Regular contributor to CIB Working Commission W92 "Procurement Systems".

Professor Dennis Lenard

Professor Lenard is the Director of the Business and Industry Development Research Programme in the Cooperative Research Centre for **Construction Innovation**. Professor Lenard is the Director of the Centre for Infrastructure and Property at the University of Newcastle, Australia, where he specialises in International Property Investment and Construction with a particular focus on Public Private Partnerships as a Funding Mechanism for Infrastructure Development. He has held many senior positions in the Profession and Industry and was the founding director of the Centre for **Construction Innovation** United Kingdom in 2000–2001. He is the immediate Past Chairman of the International Cost Engineering Council.

Willy Sher

Research interests include computer applications for managing construction processes, professional development, and skills development and tracking as educational processes. Before coming to Newcastle he worked in the Department of Building and Civil Engineering at Loughborough University (United Kingdom). There he managed several externally funded research projects including RAPID, RAPID2K, Best Practice in Building and CAL-Visual. He worked at the University of the Witwatersrand (South Africa) in the Department of Building and Quantity Surveying prior to this. Before becoming an academic he worked as a construction-computing consultant, an estimator, a planner and as a site agent.

Researchers

Kathryn McCabe

Research interests include the application of human factors principles to the construction industry, information and communications technology integration and uptake. Currently engaged in the completion of a Master of Applied Psychology.

Judith McCann

Research interests include integration of information and communications technology in the construction supply chain, particularly document management and data visualisation. Currently engaged in the completion of a Master of Human Factors.

Project Affiliates

Professor John Bennett

Professor of Quantity Surveying, University of Reading, UK.

Robin Drogemuller

Project Leader, Design Science, Commonwealth Science and Industry Research Organisation, Australia.

Kay Janis

Relocated to the US. Previously Assistant Director, Industrial Policy at the Queensland Government Department of Public Works.

Dr Stephen Kajewski

Acting Head, School of Construction Management, Queensland University of Technology.

Professor Derek Walker

Professor of Project Management, Royal Melbourne Institute of Technology.

Preface

This report was prepared as a scoping study for the Cooperative Research Centre for **Construction Innovation**. Its brief was to unearth and review the best examples of benchmarking methodology from around the world and conceptualise a survey mechanism that was tailored to the needs of **Construction Innovation**, with the intention of surveying the uptake of Information and Communication Technology (ICT) in the Australian Construction Industry. It was undertaken by a team of researchers from the School of Architecture and Built Environment at the University of Newcastle.

The authors would like to acknowledge the editorial contributions of Professor John Bennett, International Visitor to **Construction Innovation** and Kay Janis from the Queensland Department of Public Works, the cross-project assistance extended by Professor Derek Walker at Royal Melbourne Institute of Technology and Dr Stephen Kajewski at Queensland University of Technology, and the support of program leader Robin Drogemuller from CSIRO.

Executive Summary

The challenge of overcoming uncompetitive business processes in the construction industry has been a common trigger for research worldwide. Much of this research concentrates on improvements achieved by organisations from their Information and Communication Technology (ICT) investments. This report proposes a web-based commercial benchmarking service that will:

- Provide a mechanism by which construction firms can measure the performance resulting from their ICT use compared to that achieved by similar firms
- Provide case studies of best performance.

The report describes the currently available survey techniques and benchmarking concepts suitable for establishing performance improvements resulting from ICT use and evaluates them for accuracy of output, value for money and ease of implementation. The report then proposes a versatile survey mechanism that will be used in the first instance to undertake a survey of ICT use in the Australian construction industry.

The mechanism relies on a web-based survey to collect information, an electronic database of the survey results that compares and analyses data, a report generator, and a user interface to access the results. The construction industry participants would have access to this mechanism via the website, where they can complete the survey questionnaire and later access relevant benchmark performance indicators. Industry best practise cases would also be available on the website.

The report further suggests how the web-based benchmarking tool could be used in other **Construction Innovation** research projects to benchmark performance in the Australian construction industry in terms of a range of key performance indicators in addition to ICT use. The survey mechanism could be applied to any kind of research subject as its unique data collection, analysis and reporting features would make it applicable to a variety of research and analysis uses. The report then recognises that the **Construction Innovation** gives the Australian construction industry a new ability to address industry-wide issues in a coherent way that would otherwise be impossible. Its dual role as a rallying point for progressive elements in the industry and as a clearinghouse for innovation in the construction industry make it the obvious home for the proposed web-based benchmarking service to be developed on a commercial basis.

1. Introduction

Construction projects depend on the sharing and communication of large amounts of information. Integrated project information is a key factor in improving quality, cost efficiency and shortening delivery times (Sarshar, Betts and Ridgeway, 1999). These three factors are the driving force in raising the performance of construction projects, and in such an information dependent industry, effective use of Information and Communication Technology (ICT) will make a major contribution to improving performance.

To date most firms in the industry have been unenthusiastic about sharing information with each other. There are many reasons for this including issues of legal ownership of intellectual property, the need for commercial confidentiality and preserving competitive advantage in a highly competitive environment. A benchmarking process that can ensure confidentiality provides an established method for monitoring change within organisations and across the industry as a whole. It can help dispel myths and generate a template for organisational best practice that does not conflict with the need for a competitive construction market.

Organisations are improving their internal processes through ICT implementation to compete in a market that is rapidly becoming more global. These developments will be helped by benchmarking the performance improvements achieved. If this is accomplished, individual organisations and the industry at large will be able to monitor performance improvements over time, compare themselves with competitors and supply chain partners, and access information relevant to their own performance. Perceptive and considered use of such information has the potential to revolutionise the business practices of construction industry participants and to promote a culture of knowledge sharing and cooperation without the risk of compromising competitive advantage.

2. Current Practice

2.1 ICT in the Construction Industry

2.1.1 Background

The construction industry is typified by its fragmented and adversarial culture. This results in substandard practices when compared to other production related industries. Construction industry researchers have identified several recurrent themes in attempts to improve current use of ICT. These include inadequate capturing, prioritising, structuring and communication of client needs (Tucker, Mohamed, Johnston, McFallan and Hampson, 2001), the fragmentation of the design and construction processes (Sturges, Egbu and Bates 1999), poor communication between parties (Lubit, 2001), lack of data re-use (Egbu, 2000), development of sub-optimal design decisions (Egan, 1998), and lack of integration, coordination and collaboration between various functional disciplines involved in the life cycle aspects of projects (Tucker et al 2001). These are the issues confronting the construction industry at present, however, their impact on the Australian construction industry is largely unmeasured.

2.1.2 Uptake and Integration

As international competition intensifies, significant numbers of construction organisations have made strategic decisions to invest heavily in Information Technology (IT) with the aim of gaining competitive advantage (Betts, 1999). Many organisations, according to Love et al (1996) were dissatisfied with their IT investments. Brynjoflsson (1993, cited in Construct IT 2001) suggests that this could be due to the difficulty of measuring the operational benefits.

Concurrently, the term Information and Communication Technology (ICT) was finding its way into the vocabulary. It was first used in 1997 in a report to the UK government that highlighted changes in the technology environment (Stevenson, 1997). Information Technology was defined as the development, installation, and implementation of computer systems and applications. This was contrasted with ICT, which was defined as the technology used to handle information and aid communication. ICT encompasses the information to be communicated as well as the technology to be used and so raises softer cultural issues that influence the nature of professional and other relationships.

IT has been the focus of many research projects, but generally they fail to completely explore the information being communicated and concentrate too much on the technologies being used. ICT shifts the focus away from technology towards finding the best way to communicate information. In light of these issues, in order to benchmark ICT in the construction industry, two areas of research

must be considered. Firstly, the degree of ICT uptake needs to be quantified to indicate the type and quantity of technology operating within an organisation. Secondly, the level of integration of this technology into organisational processes needs to be evaluated. Surprisingly, the integration of IT into organisational processes in construction has not been researched in any depth.

2.2 Benchmarking

According to the Cooperative Research Centre for **Construction Innovation** (Lenard, 2002), benchmarking is a method of improving performance in a systematic and logical way by measuring and comparing performance against others, and then using lessons learned from the best to make targeted improvements. Any behaviour or process can be benchmarked as long as the appropriate data is available. It involves answering the following questions:

- Who performs better?
- Why are they better?
- And what actions must be undertaken in order to improve performance?

Benchmarking seeks to help organisations identify best practice and understand how it is achieved so they can improve their own performance. It has been defined as the continuous process of measuring products, services and practices against the toughest competitors or those companies recognised as industry leaders (Keans, 1989, cited in Bendal, Boulter and Goodstadt, 1998, pp.66) and the natural evolution from the principles of Quality Measurement and Total Quality Management (Bendal, Boulter and Goodstadt, 1998). According to Bendal, Boulter and Goodstadt (1998), the primary emphasis in benchmarking is on quality in all aspects and functions of an organisation's operations, not just on improving the provision of a service or product to the customer.

Benchmarking is often dependent on the individual or organisation carrying out the benchmarking process. In benchmarking tools of corporate and property investment owners, Forrest and Kingsley (2001) noted that the performance indicators measured were quite different, although both aimed to establish similar best practices. Therefore, if the intention is to benchmark different sectors within the industry it is vital to clearly identify the process and the key variables being benchmarked.

There is a plethora of benchmarking studies in other industries. Most supply chain companies outside the construction industry have at some stage analysed and compared their processes with other organisations in the hope of improving profits and reducing costs. The *Xerox Company*'s benchmarking exercises revolutionised their business practices and their profit margins. Even within the construction industry there are numerous examples of benchmarking (refer to Appendix II), the more important of which are described below.

- Back and Bell (1995) attempted to benchmark process performance improvement due to IT implementation at the project level. In particular

the SCENIC (Support Centre Network for IT in Construction) case studies focused on benchmarking IT use at the construction project level and looked at IT use in integrating project information.

- The Gallicon (DETR, 2001) consortium undertook an intensive benchmarking study to evaluate the impact of a specially developed database on civil infrastructure and housing projects. They identified common indicators of efficiency, performance and effectiveness. Although useful in assessing the derived benefits of using this particular database, the results generated from this study are difficult to generalise to the industry as a whole.
- Stewart and Mohammad (2001) examined the application of the benchmarking concept to the complex process of IT implementation in construction. They suggested that benchmarking IT at the project level is essential to assess the extent to which IT can add value to the planning, design and construction processes.

However, the common approach adopted by the construction industry in evaluating its own performance is to measure the success of an organisation or project on the basis of three variables: time, cost and quality. **Construction Innovation**, reported in Lenard (2002), developed a benchmarking mechanism based on these three variables that could be applied to any project. The aim of the project was to identify organisational performance across a range of critical success factors, enabling attention to be focused on strategic strengths and weakness.

As such, there is already considerable experience of benchmarking in construction. In summary, benchmarking means more than just measuring performance. Its purpose is to improve performance by comparing different organisations to identify relative strengths and weaknesses. By systematically comparing the processes used by the different organisations, benchmarking helps each organisation involved in a benchmarking study to identify ways of improving performance.

2.3 Survey Practice

To accurately measure a company's performance, the data collection method of a benchmarking tool must be able to extract data that is relevant and representative of its users. With the aim to minimise costs, while maintaining integrity of the data, several methods of data collection were considered appropriate for this type of analysis. Due to the potential size of the group to be researched and the aim to lower costs, a survey must be used that can be quickly delivered and responded to, and which provides immediate and effective data collection and comparison. Hence, an automated and self-contained survey process is desirable. The following three survey types were identified as the most conceivable, considering the research group's available resources:

- Postal survey
- Computer Assisted Telephone Interview (CATI) survey
- Web-based survey.

Each survey type is reviewed in order to distinguish which has the best process to meet the benchmarking tool's needs. Particular attention is paid towards web-based surveys, as the research group initially considered this survey type the more feasible option.

2.3.1 Postal Survey

Aside from one-to-one verbal opinion surveys, the postal survey is the most widely used data collection method for surveys. It typically consists of a blanket mail-out to a previously identified group of respondents and tends to be fairly simply structured in terms of the number and complexity of questions asked.

Postal surveying is often seen as an inexpensive option. However, when considering nation wide surveys of large populations, the costs of manual data handling, collation, input and storage become more imminent. Response rates for postal surveys vary. Reports of high response rates compared to those from web-based surveys has been noted (Mehtas and Sivdas, 1995, cited in Boyer et al, 2002), as has contradictory evidence of low postal response rates in general (Chernatony, 1990). In the case of postal surveys, Chernatony describes how, with proper planning, insufficient response rates can be raised (1990). This suggests that postal response rates depend upon the quality of the action plan behind the survey.

Postal surveys tend to take less time to develop in terms of printing, compared to electronic survey methods, but more time in terms of data input, collection and comparison because it is a manual process. This may prove problematic as a large population will use the benchmarking survey. Also, the database of survey information will need to be kept up-to-date, requiring the survey to be repeated at regular intervals of six or twelve months using the same respondents. It is important that the time and effort spent on data collection and comparison be kept to a minimum, as it is more ideal if the mechanism is designed to be as self-sufficient as possible. Therefore, this survey type does not properly suit **Construction Innovation's** project requirements properly.

2.3.2 Computer Assisted Telephone Interview Survey (CATI)

A CATI system allows direct entry of data from telephone interviews into a computer file. It concurrently facilitates the interview process at several levels. Interviews are carefully planned and scripted with various paths being possible depending upon the respondent's responses. The data is simultaneously entered into a database and can be concurrently coded for subsequent analysis. Interviews can also be monitored for quality control purposes, such as interviewer performance. At all times the system provides the interviewer with a continuous overview of the questions asked and responses received.

The typical procedure is to send a letter of introduction that outlines the purpose of the survey and the mechanism by which the respondent has been

chosen. A follow-up letter is then sent to confirm availability of an appropriate respondent. This will also set up a definite appointment time for the phone interview. Much of the success of CATI surveys is due to the human factor of personal contact. This can also be a powerful tool in persuading reluctant respondents to participate, though interview protocols have to be meticulously designed to avoid charges of coercion and unethical behaviour. Command functions can be incorporated into the survey programming to obtain richer, more focused data, which are dependent on the user's response; for example, *if, then, go to*. When compared to postal surveys the CATI system is a more sophisticated questionnaire mechanism.

One of the major attractions of CATI surveys is their high response rate, especially when compared to postal surveying. A response rate of 70% is considered very low for a CATI survey, with most surveys returning 90+%. It must be noted that this is achieved by careful preliminary groundwork, as spontaneous use, such as cold calling, does not work. Thus, as in postal surveys, the same attention must be paid to planning the effectiveness of the survey.

CATI facilities require a trained staff of interviewers. Although the staff need not consist of subject specialists, they do need to understand the sense and context of the replies that they receive. This requirement raises costly staffing issues. To be a cost effective resource, a CATI facility needs to either be used constantly, ensuring maximum utilisation of the interviewers, or staffed intermittently with casual staff. Updating the database by a re-survey of the population would require costs pertaining to staff involvement and telephone calls, as the initial setup costs of the CATI system are taken care of, and there would be little maintenance costs of the system. However, casual staff require organisers to provide constant training or the quality of work and reliability of casual staff comes under question. Also, it is unlikely that one survey would justify the expense of setting up a CATI facility. This could be offset by its use for other **Construction Innovation** related surveys, and alternatively, the survey could be subcontracted to a specialist external organisation. In sum, despite the sophistication of this survey type compared to postal surveys, the CATI system requires more ongoing costs as it is not a self-sufficient process.

2.3.3 Web-based Survey

Web-based surveys utilise the Internet to facilitate the distribution and collection of survey data. An Internet survey can be entirely conducted electronically with respondents providing responses over the World Wide Web. The process can utilise email to contact participants, advertise the availability of the survey, and provide a hyperlink to its website. Since this is a contemporary method of data collection, a literature review on the current research and features of this survey type is provided (Appendix III). The following points are taken from the review and display how web-based surveys have advantages over print and CATI survey methods:

- There is a lower cost overall than print surveys, especially for large survey groups, as electronic communication and data analysis costs are cheaper than printing, postage and manual data-entry costs. The major cost of web surveys is required in the set-up stage due to database and website design. The ongoing costs are limited to the cost of email transactions,website hosting (which due to the availability and range of different telecommunications sources can be quite cheap) and database and website maintenance. Web-based surveys require less human supervision compared to CATI, thus no costs associated with hiring and training support staff.
- Participant authenticity is obtained through secure username and password. This also guarantees participants that their responses are kept secure and unknown, as username and password can be electronically, hence anonymously, generated and dispatched.
- Web-based surveys, have an automatic data collection process that guarantees data control and security. In this process there are less data entry errors than print surveys, ensuring better data quality.
- Web-based surveys can be hosted in a secure and separate browser window which closes automatically on completion to ensure it is not left open on the user's desktop. An automatic save and shutdown of the questionnaire (timed logout) can be administered to ensure the questionnaire is not left unattended and open on a person's desktop for too long. Web-based surveys can be afforded the same level of security as online banking applications.
- Email systems can provide notification if survey email is received or opened. This feedback can be automatically handled by the mechanism, via a follow-up email being sent, so that little human intervention is required.
- Provision of feedback has been found to motivate respondent participation (Martin, 2000). Web-based surveys can provide 'help' information on the web interface, aiding the user in completing the questionnaire correctly; for example, alerting the user by error messages when an incorrect action is committed, and offering suggestions. Also, a thankyou note can be displayed on the web interface upon the survey's completion.
- Web-based surveys have a more user-friendly interface than print or CATI. Despite the lack of personal contact compared to CATI systems, web questionnaires can be completed at the user's leisure and without the interviewer's influence. Although this also applies to post surveys where questions and answers can be visually reviewed, web-based surveys can be more structured, with inferential and adaptive questions, and be simpler to complete. For example, in print there may be instances of "*if YES, go to question 12 or if NO go to question 10*", while in web-based questionnaires, the interface can change according to the user's answer, whereby the user is automatically guided to the next question.

- Web-based surveys can be used across different operating systems. The only technical requirement is the standard of the web browser to facilitate the questionnaire. This standard will be congruous with browsers that support other secure web applications, such as online banking, purchasing and email. Since these web applications are considered typical and widespread, it is taken for granted that the user will have a browser that can facilitate these activities, and thus the survey mechanism.
- Survey turn-around time is less compared to print (Boyer et al, 2001), and delivery of web-based surveys is faster and more reliable than mail surveys (Chou et al, 2000). This affords the participants the convenience of quick completion and submittal.
- There are fewer incomplete responses in web-based surveys compared to print (Boyer et al, 2001). This aids the quality of the survey research.

The web-based survey method has been criticised because not all participants in a target population may have access to the required technology. In the present study, the population in question is being targeted for its use of information technologies, and it is reasonable to assume that most suitable respondents have access to the Internet.

It is likely that respondents will not have immediate access to all of the data required to complete a survey. In this situation, Internet surveys are the sensible option as they allow respondents to save a partially completed response and return later to finish it. Furthermore, given the large quantity of the survey, it is wise to keep the survey in electronic format, as it is less likely to be misplaced.

The literature review revealed that although web-based surveys, at times, have lower response rates than other survey types, there are also conflicting discussions on this matter, suggesting that these findings may be biased (Appendix III). It is proposed that a successful web-based survey relies on a few factors: a well-designed and appropriate survey, proper targeting of the audience group ensuring the target audience has access to suitable technology to participate, and establishment of a bond with the participants through good communication. Also, by considering the human factors involved, such as approaching and enlisting help from strangers, researchers will be able to understand how a survey can be well received.

The findings of this review have convinced this research team that a web-based survey is more feasible for **Construction Innovation** than print or CATI methods, as it is more self-contained and maintains minimum costs. It is envisaged that significant attention should be paid to the survey's distribution plan to ensure a high response rate. Finally, as it is the general aim of the study to encourage use of ICT, it would be odd to use conventional manual data collection methods.

3. Web-based Benchmarking

3.1 Rationale

The construction industry is changing. With information technology, organisations are able to complete projects on the other side of the world with partners they may never meet. Within Australia, construction organisations are operating in remote locations often far from central offices. Kajewski (2000), among others, has realised the need for web-based project platforms and information transfers, and the need for the construction industry to embrace these methods as other sectors have.

With the emerging globalisation of the construction industry, Australian companies now have to compete with major international organisations for local contracts. If the industry is to gain a competitive advantage in these situations then some measure of industry performance designed to identify best practice is desperately needed. Other countries have already made a start; European benchmarking initiatives are already underway, such as the DTI International Benchmarking Study, and many of these initiatives are focusing on the use of ICT in organisation processes. A pilot survey of ICT use in an organisation based on the DTI International Benchmarking Survey is provided at the end of this report (Appendix I). It is envisaged that the ICT uptake and integration survey will follow a similar format and structure.

The growing consensus in the literature is that there is a need to integrate the various members of supply chains and project teams. It is also accepted that the most effective facilitator of this integration in today's market is ICT (Tucker, Mohamed, Johnston, McFallan and Hampson, 2001). Widespread change is unlikely in the immediate future, but by benchmarking ICT use and the extent of its integration into the industry's processes it will be possible for industry participants to gauge where they stand in relation to each other and with the rest of the world.

Benchmarking methodologies are primarily tools that encourage a culture of continuous improvement in organisations. As competitors provide challenges within marketplaces, they also provide insights into how process costs can be reduced and efficiency increased. Benchmarking through objective competitor analysis allows companies to measure processes, products and services against competitors and best practice companies in other industries.

This demonstrates a need for Australian construction organisations to have a common reference point against which to measure their performance in key areas. **Construction Innovation** as the key driver of innovation, cultural change and knowledge transfer in the Australian construction industry is in an ideal position to meet this need and act as an industry sentinel, monitoring improvements and recognising best practices. The research undertaken during

this project suggests there are many issues that can be benchmarked to the benefit of individual organisations.

3.2 Survey Mechanism

The research suggests that using a web-based data collection mechanism is the best approach for **Construction Innovation**. The proposed benchmarking survey mechanism incorporates a web user interface, a database of benchmark performance indicators and a results generator. The information collected through the surveys is automatically entered into a database that is designed to automatically analyse and compare the information and generate benchmarking performance indicators when required. The construction industry partners will access performance indicators via a website and in the form of automatically generated reports and graphics. The subject specific module for this project is ICT integration and uptake. **Figure 1** displays a model of the conceptual structure of the mechanism.

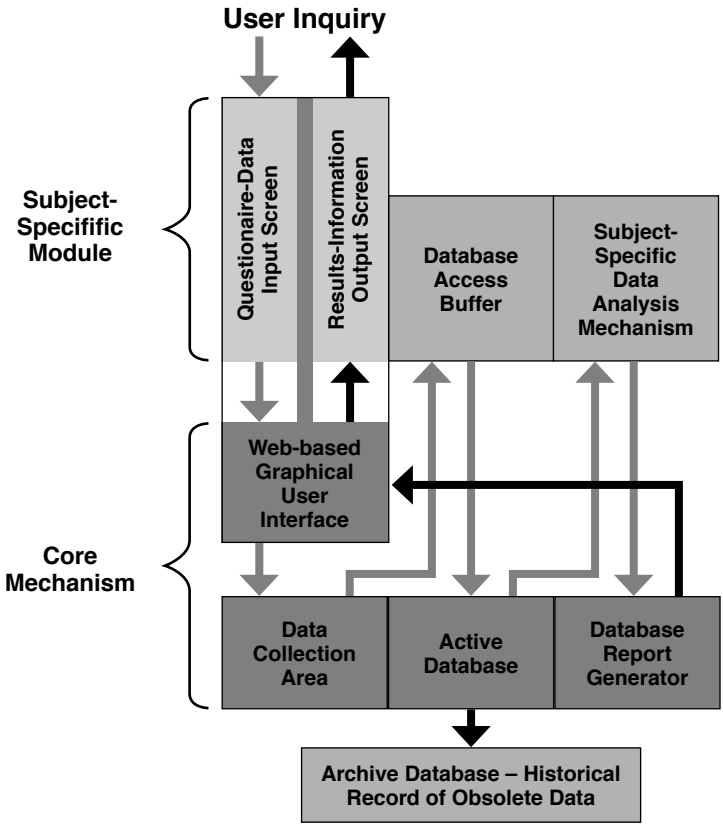

Figure 1. Conceptual Model for Survey Mechanism

Important features of this model include:

- The data is collected via an online questionnaire.
- User enquiries, questionnaire input and reporting of results are all executed through a web graphical user interface, shown in **Figures 2, 3, 4** and **5**.
- After analysis, access to the resulting information will be through the website in the form of graphical results (**Figure 4** and **5**) and report format. All results will be able to be printed and saved.
- Best practise cases can be identified through data analysis.
- Organisations will be able to compare their own benchmarks against best practise cases and industry benchmarks.
- A buffer mechanism is included to screen the raw data being entered into the system. This is an essential feature and protects the integrity of the database because:
  - it prevents the same participant from making multiple entries
  - it prevents the entry of trial runs that would corrupt the integrity of the database
  - it allows (via a user name and password) the user to save a partially completed response to the questionnaire, allowing them to complete it at a later date.
- The database is divided into two parts, the active database (data not more than two years old) and the archive database (data older than two years). They serve two distinct purposes:
  - the active database allows users to compare their organisational practice with current industry and sector norms, and best practice examples
  - the archive database allows users to compare the issue under consideration with past performance, allowing a longer-term view of it. From this trends can be identified, the diffusion of innovation can be mapped, and evidence of the effectiveness of initiatives to improve performance can be found.
- Notwithstanding the need for confidentiality, the database identifies organisations that demonstrate best practice in aspects of their performance. These best practice organisations can be the subject of a case study if they are willing to participate. This will be published in a dedicated area of the website.
- Benchmarks are categorised by subjects and accessed in this manner. The data analysis mechanism is subject-specific and analysis can be performed differently for each subject. The type of results generated are dependent upon the nature of the subject being accessed.

The subject-specific module can be changed according to research demands, whereby it can be used for other types of research. Altogether the survey mechanism is not just for benchmarking purposes; it can be applied to any kind of research subject as its unique data collection, analysis and reporting features make it applicable to a variety of research and analysis uses. **Construction Innovation** is able to apply it to other areas of research, as it has potential use in other **Construction Innovation** projects. This is discussed later in the report.

Initial population of the database will occur by approaching **Construction Innovation** project participants and the main construction industry bodies. It is important that a large population is approached to complete the questionnaire in order to establish a high quality information database, so that when benchmarking analysis is undertaken it is an accurate representation of the industry.

The participants involved in populating the database will be sent emails containing hyperlinks to a website where the questionnaire can be filled out. It is envisaged that all data will be collected via the website questionnaire, but if it becomes evident from the response rates that the database is not adequately resourced to provide accurate benchmarks, it may be necessary to provide other survey forms, such as a print survey, to ensure the quality of information in the database, as the database is a new initiative.

It is proposed that case studies will be linked to the database through the website so that users can get detailed information about how best practice is achieved. It is also proposed that the website will encourage collaboration and communities of interest amongst industry participants in the spirit of helping each other improve their own company's performance.

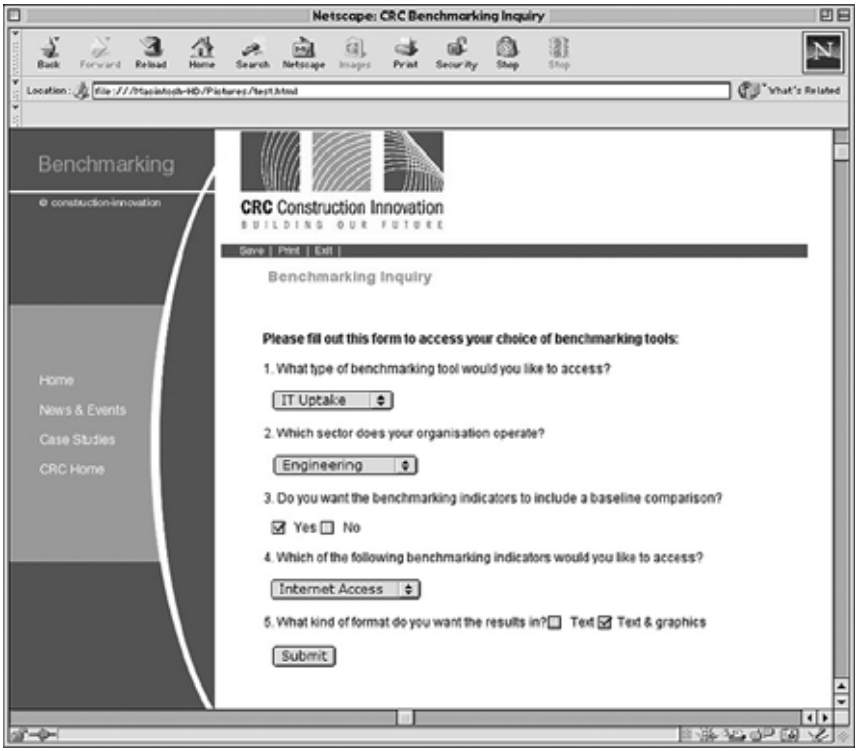

Figure 2. The Inquiry Window

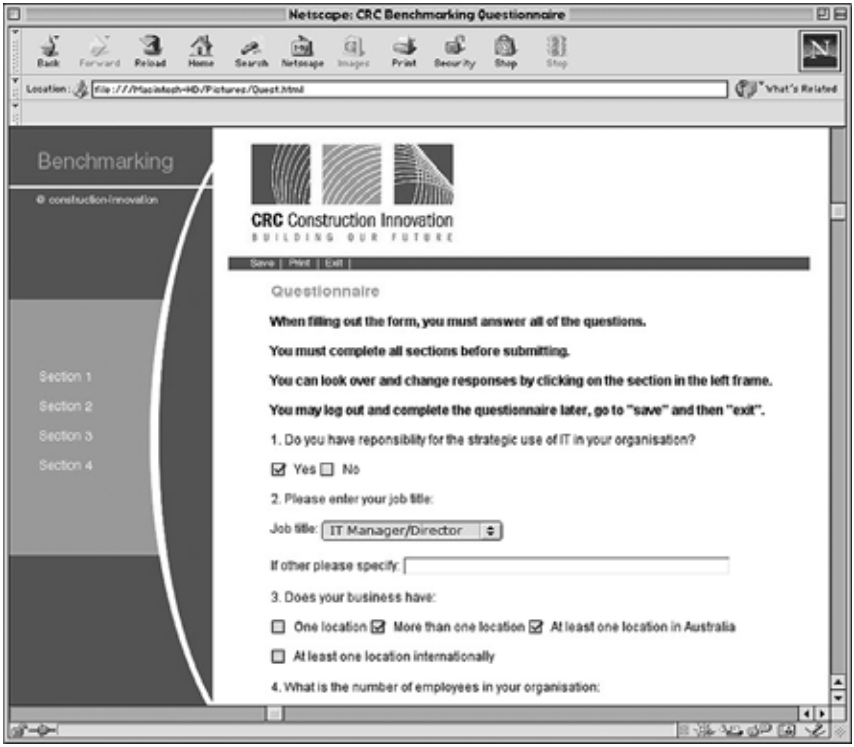

Figure 3. The Questionnaire Window

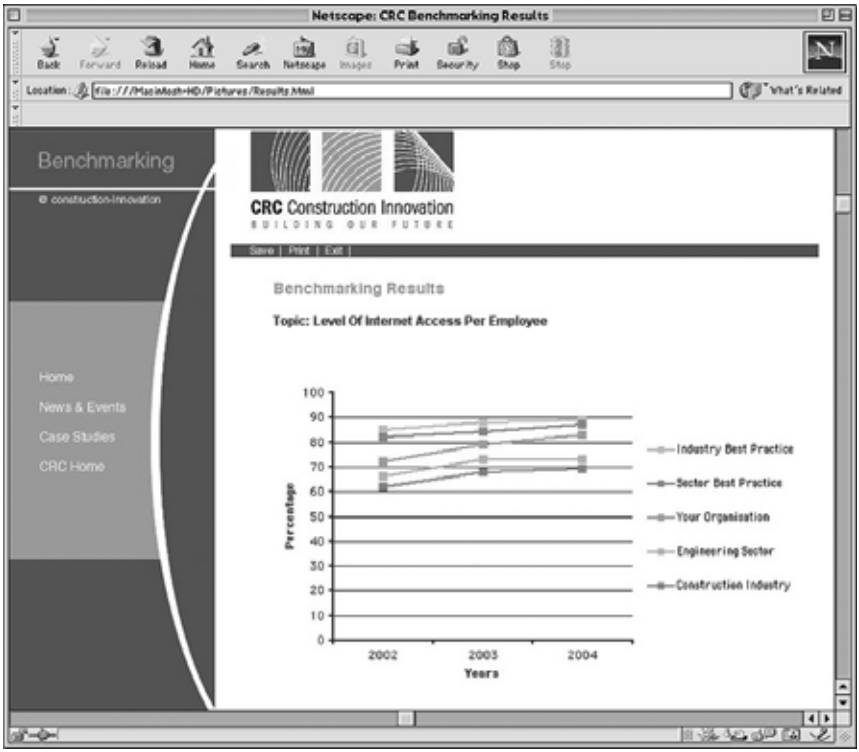

Figure 4. Results from the Archive Database

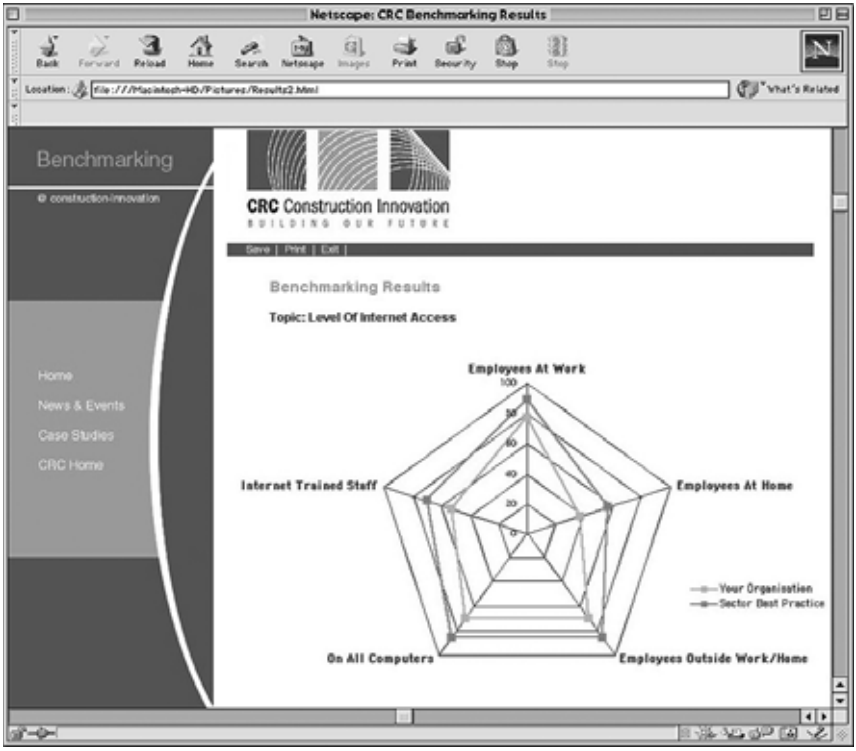

Figure 5. Results from the Active Database

3.3 Potential for Links with other Construction Innovation Projects

The mechanism's usefulness extends beyond the scope of a pilot study of ICT use. Synergies have been identified with the following **Construction Innovation** projects and in each case, benefits can be derived by changing the subject specific module.

2001-016-A Critical Success Factors for ICT Mediated Supply Chains

This project is intended to identify those issues of critical importance to individual organisations for the successful engagement with and integration into electronically mediated supply chains. It is believed that these success factors will differ in detail for each individual organisation but by examining a number of supply chains, patterns will emerge. This will enable generalisations to be made that will be of value to similarly placed organisations within other supply chains. The proposed survey mechanism will aid the collection of data for this project. Furthermore, the outcomes of this project will undoubtedly enrich the quality of the study, especially the ICT integration subject module.

2001-008-C Project Team Integration: Communication Coordination and Decision Support

This project investigates the potential for ICT to integrate construction teams. One of the project components benchmarks the use of Internet-based Construction Project Management (ICPM), e-tendering and e-archiving of project information to identify barriers and enablers to the adoption of ICPM. Many of these issues will be addressed to some extent by the ICT integration module and it is envisaged that its' outputs will be of value to this project, by broadening available data to identify a baseline of best practice. Furthermore, ICPM-specific lines of questioning can be developed for inclusion into the ICT integration module.

2001-007-C Managing Information Flows with Models and Virtual Environments

This project is developing interfaces and applications that will use Industry Foundation Classes (IFC's) linked to 3D object models of projects. One of the major issues is to identify the specific applications in use within the industry, the way in which they are utilised and their distribution in industry sectors. The proposed survey mechanism is ideally suited to this task, especially during the initial phase when the widest possible range of participants will be accessed.

2001-004-A Knowledge Management and Innovation Diffusion

This project maps the diffusion of innovation through an organisation. Its particular focus is on supporting IT infrastructure with the intention of assisting in change management processes that involve knowledge generation and knowledge management. A fully developed survey mechanism for this project already exists. This report's proposed survey mechanism could be used to extend the survey to suitable parties not already included in the study.

4. Proposal

The creation of a web-based **Construction Innovation** benchmarking survey mechanism will allow for the development of a series of benchmarking standards that will meet the needs of a wide range of potential users. The mechanism has the same underlying operating principles and reporting procedures while dealing with diverse topics of corporate, business and functional interest. It is a flexible tool that will be able to respond to new research demands as they are identified by **Construction Innovation** research projects.

At the heart of this tool is the core mechanism where the data collection and database reside. Attached to this is the first subject specific module that analyses organisational ICT use. Closely related subject modules that survey ICT integration and innovation diffusion could come in a second wave of development from existing **Construction Innovation** projects. Such is the versatility of the system that subsequent modules can be developed either in response to specific industry requests or be championed by research interest groups, particularly from within **Construction Innovation** programs.

4.1 Benefits

The proposed survey mechanism and associated modules bring benefits on three levels:

- Industry-wide common good benefits
- Subscriber specific benefits
- **Construction Innovation** benefits.

4.1.1 Industry-Wide Common Good Benefits

Until now, there has been no national initiative to collect, collate and disseminate a comprehensive range of data specifically for the construction industry. With the establishment of this project, the industry, for the first time, will have access to a common set of statistical benchmarking tools that enable comparison of individual practice with a snapshot of industry norms. Specific reports by functional sector, size of organisation, geographical location, supply chain affiliation, etc. will be generated by user specification. Potentially, the data gathered will yield a huge variety of factors that can be analysed in response to a user's requests to provide information about relationships between, and within, statistical groups.

While the primary function of the proposed survey mechanism is statistical in nature, it also facilitates the benchmarking methodology of best practise case studies. The identification of best practice organisations, with their consent, provides other industry participants with relevant information about how best practice is achieved in specific processes through detailed case studies. This may in turn help organisations who are seeking greater involvement with benchmarking to identify potential partners for specific benchmarking studies.

It is believed that this mechanism will encourage the creation of an active benchmarking community in Australia. The UK experience has shown that with committed sector leadership, a thriving group of benchmarking clubs can develop, whose interests are diverse and wide-ranging in scope and scale. Benchmarking clubs are groups of organisations who agree to cooperate in undertaking benchmarking studies of selected processes that they all use. In general, such benchmarking clubs begin by studying processes that are not regarded as fundamental to competitivity, so that they are willing to be open about their performance and the way they work. Experience shows that all the organisations involved in a benchmarking club benefit from such joint work because all have distinct strengths in some aspects of each process, and all have something to learn. As confidence in the benchmarking process and the integrity of fellow benchmarking club members grows, more sensitive and significant processes can be made the subject of benchmarking studies. In this way, the benefits can become very significant as the organisations involved develop significant advantages over competitors outside the benchmarking club.

4.1.2 Subscriber Specific Benefits

It is expected that, once an effective survey mechanism used by **Construction Innovation** partners has been established, it will be made available commercially on a subscription basis. Having made a commitment to engage with the benchmarking survey mechanism, subscribing participants would be prompted to update their organisation's data on a regular basis throughout the duration of their subscription. This action would automatically allow them to re-benchmark themselves, ensuring that they are benchmarking against current best practice.

To benchmark against old information is at the very least misleading, and more probably inherently dangerous. It may well encourage stagnation and a lack of competitiveness. The proposed survey mechanism will ensure that **Construction Innovation's** database is automatically updated, therefore all subscribers would be measuring their performance against current performance. It is envisaged that the database will not contain any active data which is more than two years old.

4.1.3 Construction Innovation Benefits

The implementation of this benchmarking project would position **Construction Innovation** at the forefront of best practice in Australia. Obvious comparisons could be drawn with overseas initiatives such as the Centre for Construction Innovation, the Construction Best Practice Programme, and M4I in the UK.

The proposals in this report build on international experience, and take it forward to provide the Australian construction industry with a leading-edge, specifically designed benchmarking survey mechanism. This will raise the profile of **Construction Innovation**, both nationally and internationally, inevitably leading to international comparisons being made with Australian practice. This

proposal will deliver the most comprehensive set of construction industry data yet collected in Australia and provide a mechanism for keeping it up-to-date so it remains of continuing relevance to current problems and opportunities.

It is expected that **Construction Innovation** partners will want to use the mechanism to benchmark important aspects of their own performance and that of their suppliers.

Construction Innovation research as case studies, if their performance makes them a suitable subject, will help make the website richer in best practise information and knowledge. These will naturally be hosted in an area of the website dedicated to showcasing examples of best practice in a way that will further help to raise the profile of **Construction Innovation** and its research. It is envisaged that the benchmarking and surveying activities will create an income stream from:

- Subscription fees from organisations using the benchmarking database
- Fees from commercial third parties allowed access to parts of the database.

It may also be possible to offer a consultancy service to help organisations answer specific questions by using the database and case study material. Similarly, a consultancy service could be offered to groups of organisations to help them carry out benchmarking studies of specific processes that they want to improve.

The mechanism is modular in design, making it able to be extended or adapted for other research purposes when the circumstances arise. These circumstances include changes in the industry structure, an increase in the scope of information surveyed and new areas of investigation. At least some of these changes will require additional funding from **Construction Innovation** or from commercial activities based on the survey mechanism. This flexibility will ensure that the information contained in the database remains appropriate to the needs of its users.

The living nature of the mechanism ensures that changes can be made to the questionnaire without rendering the database obsolete. New lines of questions may be introduced as a result of new research, for instance, arising from other **Construction Innovation** projects. These questions will run in parallel with the existing set of questions. This will allow comparison with previous datasets, while preparing for the next iteration of the instrument when the old question sets have been replaced.

Analysis of the active database and the process of archiving historical databases will allow the mapping of industry-wide change over time. From this, changing patterns of use and integration can be plotted, indicating the diffusion of innovation in the areas that have been surveyed.

The negotiation of reciprocity agreements with international partners should be encouraged to allow international comparisons to be made. Indeed, this potential may help guide the format of subject-specific modules wherever useful links can be identified. This will enable the usefulness of the mechanism to be extended beyond these shores and raise the profile of **Construction Innovation** on the international stage.

5. Conclusions

The research described in this report supports the idea of a survey mechanism that will produce a benchmarking database. It is proposed that the benchmarking database should be set up by **Construction Innovation** and supported by case studies of best practice drawn from **Construction Innovation** research projects. Initially, this will enable **Construction Innovation** partners to benchmark their own performance and that of their suppliers. Once the benchmarking database and supporting case studies are operating in a robust manner, they can be used as the basis of a commercial benchmarking service. This course of action is supported by the following conclusions:

- International experience has shown that centralised benchmarking initiatives have acted as a spur to industry-wide performance improvement.
- Exposure to best practice case studies has been shown to trigger organisational re-engineering.
- Access to industry performance values in the form of Key Performance Indicators has provided a direct measure of organisational performance improvement.

The proposed mechanism has several advantages over those used elsewhere:

- The survey, being web-based, is flexible, extendable and has low running and set up costs overall.
- It allows new users to input a dataset describing their organisation's performance and to receive as output a report comparing this to the industry's performance described in the database.
- Database reports will be tailored to the user's requirements by the user's selection of comparator groupings, or by automatic comparator groupings by the report generator.
- The database will be a living resource, constantly being updated as each new dataset is added.
- Periodic culls of old datasets will ensure that the active database contains data that is less than two years old, ensuring that comparisons will be made only with the latest industry practice.
- The user subscription structure will be arranged to encourage updating of user datasets.

The mechanism at the heart of this system is inherently modular, enabling new areas of interest to be benchmarked using the same core processes. Although it has been conceived as an industry-wide survey mechanism, self-selecting subscriber groups and individual statistical tools can be created that are more focused in scope, such as to an individual project level. This facility will be of use to other **Construction Innovation** research projects that need to benchmark the impact of their work.

As a result, this research strongly indicates that the implementation of this mechanism should be championed centrally, outside of the normal project agreement structure. This conclusion is supported by the following:

- The universal utility of the survey mechanism means that access to it should be available for all researchers within **Construction Innovation.**
- The sense of ownership should reside with **Construction Innovation** rather than with a particular project team. This will serve two important purposes:
  - It will help establish **Construction Innovation** as the repository of high quality industry wide data for the Australian construction industry.
  - It will ensure the confidentiality of commercially sensitive information entered into the database.

Providing low-cost access to quality benchmarking data that is relevant to all sectors of the industry will give **Construction Innovation** an important means of influencing a wide range of construction industry participants.

The most innovative and influential benchmarking schemes have resulted from being championed by leading industry bodies and receiving substantial support from major industry players. Until now, these conditions have been absent from the Australian construction industry stage. With the formation of **Construction Innovation**, a unique opportunity has been created to provide true leadership and relevance across the entire construction industry.

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Appendices

Appendix I

Pilot Survey

To complete this survey, please select the appropriate answer(s), using the parameters provided where appropriate. Where the response "other" is applicable, please indicate its nature in the space provided.

The results of this survey will be entered into a database where your responses will remain secure and confidential. Submitting this form will be taken as consent to participate in the study.

You are not obliged to identify yourself, or your organisation, in order to participate and to receive your results. However, the survey is intended to identify examples of "best practice" across a wide range of indicators, with the intention of carrying out detailed case studies on those organisations. If you are willing to be included in this part of the study please include full contact details in the following boxes.

Name		I agree to the inclusion of my organisation in the best practice case study program.	
Position			
Address 1			
Address 2			
Town/City		Please Tick Box	
State			
Code			
Telephone			
Mobile			
Email			

Your Organisation

A. Please provide details of your main office location.

Town/City	
State	
Code	

B. Which of the following types of activities are carried out here?
(Please indicate all relevant activities)

Architecture	
Engineering	
Main Contracting	
Property Management	
Materials/Product Supply	
Trade Sub-contracting	
Specialist Sub-contracting	

C. How many people work at this workplace?

1-5 employees	
6-10 employees	
11-50 employees	
51-200 employees	
200+ employees	

D. What is the organisation's annual turnover?

$

Hardware and Software

1. Do you use personal computers, terminals or personal digital assistants (PDA's) in your organisation?

Yes	No

2. Please supply the following information related to applications and utilisation.

Software type	Percentage utilisation	Planned introduction 2-5 yrs	Do not use or need	Applications used
Word processor				
Generic spreadsheet applications				
Email software				
Generic database applications				
Administration (e.g. bookkeeping)				
CAD				
Estimating software				
Project programming applications				
Structural Analysis software				
Structural Detailing software				
Structural Workshop Documentation software				

3. Please supply the following information related to hardware and utilisation.

Equipment type	Percentage of total staff	Percentage in office	Percentage onsite
Own PC or terminal at work			
Shared access to PC or terminal at work			
Own email address at company			
Own mobile phone, financed by company			
Own PDA, financed by company			
Shared access to PDA			

4. Please indicate the levels of "home" working in your organisation.

	Now	In 2 years	In 5 years
Staff Time %			

Design and Graphics

5. Please indicate whether your organisation carries out any design work.

Yes	No

6. Please indicate which of the following methods are used in your organisation and their utilisation rates.

Techniques/software for design	**Percentage design time utilisation**	**Has this increased over the last 2 years?**
Drawing by hand		
AutoCAD		
AutoCAD Architectural		
ArchiCAD		
Microstation		
Other...		
	(Sum = 100%)	

7. Please indicate how your organisation obtains paper copies of CAD drawings.

Reprographic process	**Percentage utilisation**	**Has this increased over the last 2 years?**	**Has this decreased over the last 2 years?**
Photo reproduction of hand-drawn masters			
Pen plotter			
Inkjet plotter			
Export data to reprographic specialist			
Don't use paper copies			

Automation of manual processes

8. Please estimate the extent to which the following operations are automated by the use of computers at your local workplace.

	N/A	1-33%	34-66%	67-99%	100%
Bookkeeping					
Invoicing					
Work descriptions					
Technical calculations					
Quantities					
Scheduling/resources					
Materials control					
Costing/budgeting					
Tendering					
Marketing					
Rent administration					
Maintenance planning					
Other …					

Data transfer and telecommunications

9. Please indicate the proportion of the following documents that your organisation transfers digitally within your workplace.

	N/A	1-33%	34-66%	67-99%	100%
Concepts/Briefs/Sketches					
Detailed/Final drawings					
Specifications					
Personnel Information					
Costings/Estimates					
Tender enquiries					
Tender documents					
Structural calculations					
Orders/Invoices					
Q.A. Documentation					
Contract Documentation					
Other …					

10. Please indicate the proportion of the following documents that your organisation transfers digitally to other organisations.

	N/A	1-33%	34-66%	67-99%	100%
Concepts/Briefs/Sketches					
Detailed/Final drawings					
Specifications					
Personnel Information					
Costings/Estimates					
Tender enquiries					
Tender documents					
Structural calculations					
Orders/Invoices					
Q.A. Documentation					
Contract Documentation					
Other …					

11. Please indicate which of the following connective infrastructures are used by your organisation.

Internet via modem	
Internet via permanent connection	
Intranet/LAN	
Extranet/WAN	

Internet access and use

12. Please indicate the proportion of your organisation's staff who have access to the Internet.

Access type	Percentage of total	Percentage of office staff	Percentage of site staff
Internet from own computer			
Internet from shared computer			

13. Does your organisation have a Home Page on the Internet?

Yes	No

14. Please indicate the features that it includes.

News	
Presentation of the company	
Presentation of projects	
Services, orders	
Other...	

15. Has your organisation used an Internet Project Website for storage and transfer of project documents and communications?

Yes	No

16. Please indicate how often your organisation has used a Project Website.

Occasionally	
In less than half the projects	
In half the projects	
In more than half the projects	
In almost all projects	

17. Please estimate the proportion of business (buying or selling or other transactions) that your organisation carries out Electronically over the Internet.

	N/A	1-10%	11-20%	21-50%	51+%
Accessing on-line product data					
Ordering on-line product data					
Obtaining new work orders					
Procuring sub-contracted services					
Communicating with statutory bodies					
Other …					
Expected use in 2 years					
Expected use in 5 years					

Intranet

18. Does your organisation have an Intranet?
(A web environment only available internally)

Yes	No

19. Please indicate the uses for which your organisation uses its Intranet.

Links to organisation's homepage	
Links to mobile phones	
News about organisation	
Organisational procedure manuals	
Project information	
Personnel information	
Quality information	
Other ...	

The role of ICT in your organisation

20. Please indicate whether your organisation has an ICT strategy? (This means an agreement on the goals of the company for its use of ICT and the means of achieving these goals).

Yes – in written form	
Yes – in oral form	
Yes – in both written and oral form	
No – but one is needed	
No – it is not necessary	
Do not know	

21. Please indicate the percentage of your organisation's annual turnover that is invested in ICT (hardware, software, communications, support staff and staff development)

22. Please indicate any investment that your organisation has made in its ICT infrastructure in the last two years (hardware and software, communications and training, but not operating or maintenance costs or salaries for IT staff)

Nature of investment	**Value**	**Year**

23. Please estimate how your organisation's attitude to ICT investment has changed, or will change in the future:

	Increase investment	**Constant**	**Decrease investment**
In the last two years			
In the next two years			
Between the next two to five years			

24. Please indicate the way in which your organisation evaluates the return on its ICT investments.

	Value	**Evaluation period**
Accounting (Internal rate of return)		
Accounting (Net present value)		
Qualitative (e.g. ConstructIT)		
Other….		

25. Please rank the following causal factors in triggering ICT investments.

Reason	**Not important**	**Slightly important**	**Quite important**	**Very important**	**No opinion**
Customer demand					
Employee demand					
Competitive advantage					
More efficient technical work					
More efficient administrative work					
Technical leadership					
To develop new products/ business					
Other …					

26. Please indicate the ways in which ICT has impacted on your business.

Changes	N/A	Reduced	No change	Increased	Not sure
Tender documentation errors					
Construction errors					
FM documentation errors					
Documentation quality					
Speed of work					
Complexity of work					
Meeting QA requirements					
Meeting administrative needs					
Other changes …					

27. Please indicate what effect ICT has had on productivity within your organisation over the last two years.

Productivity	N/A	Reduced	Unchanged	Increased	Unsure
General administration					
Materials administration					
Property administration					
Project management					
Design					
Site management					
Purchasing/ selling					
Other …					

28. Please indicate your opinion of the level of ICT skills and training for the following types of newly qualified staff.

Staff	Too low	Sufficient	Excellent	Too general	Too detailed
Construction managers					
Structural engineers					
Civil engineers					
Architects					
Quantity surveyors					
Surveyors					
Building technicians					
Engineering technicians					
Architectural technicians					
QS technicians					
Surveying technicians					

29. Please indicate the three areas of priority in which your organisation plans to increase its use of ICT over the next two years.

Document handling	
Product models	
Accounting systems	
Costing and cost control	
Technical calculations	
Property information	
New business models	
Project management	
Project Webs	
CAD	
Electronic trading	
Internet information searches	
Virtual reality	
Portable/Mobile systems	
Other …	

30. Please indicate the top three areas in which the use of ICT has benefited your organisation.

Better financial control	
Better communications	
Better quality of work	
Work productivity	
Increased sharing of information	
Faster access to information	
Developing new business	
Reduction of staff	
Satisfying customers	
Working from home	
Handling large volumes of data	
Data mining	
Knowledge capture	
Attraction to new staff	
Others …	

31. Lastly, please indicate the three greatest impediments to the increased use of ICT within your organisation.

Initial investment level too high	
Continual need to upgrade	
Incompatible software within the organisation	
Too much information generated-wasted resource	
Legacy applications-early adoption has encumbered organisation with inappropriate applications	
ICT use generates inefficiencies-high staff development requirement	
Greater ICT know-how required across the organisation	
Reduced security	
Lack of executive commitment	
Difficulty of measuring benefits	
Culture-large proportion of non ICT-literate staff	
Culture-belief that old ways work best	
Lack of data exchange standards-incompatible communications with trading partners	
Others …	

Thank you for participating in this survey. Your personalised report will be delivered to you presently.

Appendix II

Benchmarking Literature Review

The following pages provide a list of the most significant benchmarking studies from around the world that have been taken into account in preparing the proposals in this report (Table 1). The list compares each study with the proposed benchmarking mechanism project in terms of the main similarities and differences.

Title/Author	Goals/Aims	Method	Similarities	Differences
Building and Construction Industries Supply Chain Project Tucker, Mohamed, Johnston, McFallen & Hampson (2001) CSIRO	Uses best practice to identify concepts, innovations and initiatives that are working in supply chain management.	Survey via email with small numbers.	Are looking to identify key performance indicators and are benchmarking supply chain management practices. Supply chain management is facilitated by the integration of business process which is inturn facilitated by IT.	Although there is an overlap, fundamentally the projects at this stage are looking at different levels of complexity. This study is looking at processes rather than IT specifically. We are looking at much larger numbers of organisations and individuals.
International Benchmarking Studies UK Department Trade and Industry	Enhance knowledge or ICT usage and to benchmark the UK against other countries, identifying strengths and weaknesses in organisations of all sizes.	Completed telephone interviews with approximately 7600 businesses of all sizes.	Aims are basically the same. Study assesses both the usage of ICT and its integration into business practises.	The study is not limited to the construction sector.
On-line and Remote Construction Management (ORCM) Kajewski & Pahos QUT & CSIRO	Development and evaluation of an on-line project platform to reduce time wastage and costs associated with information transfers.	On-line databases accessible to project participant to allow communication between geographically isolated project participants. Use of case studies to assess the success of the on-line techniques.	Encouraging web-based project management and the use of IT. Also attempts to benchmark the project to determine cost effectiveness to technologies.	Primarily focused on remote project management, not IT uptake and integration.

Title/Author	Goals/Aims	Method	Similarities	Differences
Case Study of the National Museum (Acton Peninsula) Project Keniger, Hampson & Peters (2000)	The application of the alliancing method of project delivery; and the use of IT in the design, construction and project management.	Case study approach using surveys with project participants assessing project alliancing and IT. Case was benchmarked against the Australian industry standards.	Case study approach to benchmarking with an emphasis on IT.	Is small scale compared to the scope of the present study which aims to collect similar information on a much larger scale.
IT Construction & Real Estate www.itbof.com	Provide a common IT platform for construction and real estate companies for improved market communication, greater efficiency, lower costs, and higher quality.	Use IT as support to change management processes. Requires active cooperation between all parties. Is not about the immediate needs of the construction industry.	Long-term perspective for management change regarding IT. Requires industry participation.	Is not a live data site. Does not look at the industry as a whole, is more a tool than a data reservoir.
Construction Industry Trading Exchange (CITE)	Create an "open, neutral exchange" via a web-based "one stop shop" for the procurement of goods and services.	Project process: feasibility> design> construction> operation with participants involved for different periods at different times. Has various capabilities: design and document management, tendering, purchasing and progress to date functions.	Is a web-based approach with a heavy emphasis on being a neutral exchange. Aim to introduce web-based trading into construction management practises.	Does not seem to involve the long-term storage of company information for use in comparison. It is more a virtual shopping centre and lacks best practise capabilities.

Title/Author	Goals/Aims	Method	Similarities	Differences
Computer use in New Zealand Construction Doherty (1997)	Attempts to measure computer usage and main roles, what is used and how much this has changed in the last five years.	Survey of quantity found that a "large minority of businesses do not use computers or use them only casually". Concludes that there is an apparent need for businesses to better manage their use of IT.	Looking to measure IT with a long-term perspective.	The range of IT issues have limited interpretation capabilities. The survey is based primarily on the IT barometer and therefore does not address the less tangible aspects of IT diffusion in organisations.
KPI Study – Blackpool Sea Defence Centre for Construction Innovation (2001)	Benchmarking study for assessment of project performance.	Determined key performance indicators and compared company levels with industry norms. Benchmark levels were set for future performance.	Benchmarking study uses similar KPIs to assess project success.	Does not incorporate IT uptake and integration which is a key factor in the present study.
Impact of IT on the Canadian AEC industries Rivard (2000)	Aims to assess the current and planned use of IT and its impact within the housing sector.	Adopted a slightly modified version of the IT Barometer. Found that many business processes are also entirely computerised with the intention to make them even more so, with the exception of design information, which still tends to	Analysis of usage of IT with an organisational and temporary organisation perspective. Also looking at the same group of industry participants.	In comparison this is a short-term project. Is not as focused on the integration of IT into organisational practises and culture. Does not have local (organisation), intermediate (temporary organisation) and global (construction industry) perspective.

Title/Author	Goals/Aims	Method	Similarities	Differences
		remain in traditional form. Although these changes have raised the productivity and speed of work, they require more advanced skills to use them.		
Summary of IT use in Turkish Construction Industry Isikdag (2002)	Aims to assess the use and the priorities of the Construction industry regarding IT use and implementation.	Survey of IT usage and IT topics of interest via literature review. Participants identified what they thought were topics of priority. Interviews based on answers to questionnaires.	Long term the project aims to identify critical issues in the Construction Industry, the temporary organisation and the organisation as a whole.	Is not a live database like ours, and our platform is not limited to IT benchmarking long-term.
Evaluation of IT investments Anandarajam, Wen (1999)	Aimed to identify a more industry specific measure of IT investment that better captures the intangible benefits of IT and present this information in a manner that practitioners can understand.	Survey method- but with the separation of tangible and intangible benefits. The usual Likert scale has been removed as it is considered too objective. Framework was developed in order to identify hidden costs in the project lifecycle.	Is looking at more than just quantities in relation to IT.	This is a small-scale version which is focused on financial rather than business process advantages of IT. Is not web-based or long-term.

Title/Author	Goals/Aims	Method	Similarities	Differences
Innovation Indicators in Building AEGIS (1999) Commonwealth Dept of Industry, Science and Research	Aim to map the industry to illustrate the dynamics of growth and development. Looks at the collective infrastructure needed for further development of the industry.	Assessment of various options and issues such as sampling, survey length, target population, confidentiality and various other issues.	Is a long-term approach. Identifies business environment, use of technologies and barriers to information technology.	Are not measuring performance within and between organisations and temporary organisations. Have no web-based platforms.
Awareness and Usage of Information Standards in the UK Construction Industry: A survey by the SIENE Network. Ingirige & Aouad (Salford University)	The aim of the investigation was to stream-line information standardisation interpretability. Aim to review current projects and benchmark them.	Survey and case study method, accompanied by a discussion of different information standards.	Large-scale benchmarking study which aims to unify the industry. Is looking at more than just IT usage.	Is not an actual database that can be accessed by industry and participants.
Innovation in Building and Construction Construction Industry Branch, Science and Research Canberra Cebon, Newton & Noble (1999)	Evaluation and commentary on the state of the Construction Industry and the need for policy to be based on empirical evidence.	Provide a detailed account of indicator of innovation, innovativeness and the measurement of innovation outcomes in construction.	Share a similar vision for the Construction Industry and realise the benefits of harnessing innovation and organising the industry.	Is not specifically focused on IT, and lacks the benefits for individual organisations. Also is not a benchmarking exercise, rather it is guidelines for future research and development.

Title/Author	Goals/Aims	Method	Similarities	Differences
www.ITCBP.org.uk	Best practise self-assessment tool for the UK construction industry.	Provides case studies and various packages to improve organisation practices through on-line assessment.	Is a benchmarking approach to increasing organisation productivity and practices. Aims to improve the UK construction industry through access to these resources.	Good prototype for the aims of the present study.

Table 1. List of Significant Construction-Related Benchmarking Studies

Appendix III

Web-based Surveys Literature Review

Surveys utilising the Internet and World Wide Web technology are part of the electronic data collection group. This group includes survey methods such as email, disk-by-mail, and computer assisted personal interviewing, and is another means of data collection apart from print surveys, such as fax, mail, and pen-and-paper. The following discussion provides arguments for and against web-based surveys, a comparison with print surveys, findings from current research and recommendations on how to develop a successful web-based survey.

Features of Web-based Surveys

The advantages of web-based surveys is that they are able to incorporate better research features into the data collection process, such as adaptive questions, user-interface design, quicker data entry and better data control.

Survey questions that do not result in any adaptation or inference are known as Standard questions, whilst Inferential questions define a set of questions that are based on the answers to the previously asked questions (Pitkow and Reker 1995). In online surveys there is more room for inferential questions as the interface changes as per answer selected and the response is more controlled as the user does not have to physically refer to another question. For example, "*if yes, go to section 3 on the next page...*". Adaptive questions can help reduce the number and complexity of questions for the participant.

In terms of user interface design, utilising web technology presents opportunities for the survey to be presented in a number of message formats. Multimedia, such as images, video and audio clips can also be incorporated. This raises issues when it comes to ensuring users have the correct software to play the video or audio. However, multimedia is only one of the features of incorporating web technology, and should only be used where appropriate. The user interface can be designed to provide structured responses via point and click methods, pull-down-menus, buttons, and faster data entry and data control. The data entered in the questionnaire is controlled by the interface; for example, the user must type something in the given text field or will not be able to proceed to the next question. These in-built control devices can recognise if no text is entered and what type of text, such as numbers, and can also alert the user if an error has been made, while providing information on how to correct it. In web surveys, the question material can be formatted and presented in a more user-friendly manner than other survey methods as surveys: can be completed in the participant's own time, have automatic submittal of information, can provide instant feedback, have good user interface design which can be more enjoyable, and can be considered a novelty to complete.

The set-up of web-based surveys is longer and requires more effort than print-based surveys due to software development. However, data entry for the survey initiators is greatly simplified and faster in web-based surveys, as software used can automatically tabulate and track data eliminating data entry errors. Overall, web-based surveys offer a time-efficient approach for large target groups, but most importantly provide better data security than print survey methods in terms of data collection and entry. Web users can be provided with usernames that are generated randomly and automatically by the supporting software. The software can automatically insert these usernames into the email messages with a hyperlink to the web survey. This guarantees secure entry to the website and participant authenticity. It also provides anonymity when they complete the online survey. Email systems available also provide information on whether the email has been received and 'opened', enabling researchers to better evaluate participants' responses.

Web-based surveys are less established than other forms of electronic surveys, especially so compared to print surveys. A common dislike of web-based surveys is that participants must make their email addresses available, and other privacy issues arise as participants may not be able to disclose company information, or may not wish to disclose personal information. In these cases the survey content should reflect these concerns.

Current Research

Electronic surveys are generally comparable to print surveys except for a few advantages and challenges that researchers should evaluate (Boyer et al, 2002). One of the biggest challenges is the lower response rate compared to print surveys (Boyer et al, 2002 and Klassen & Jacobs, 2001). However, this may be because people respond negatively to untargeted electronic survey methods, and do not like "being spammed" (Boyer et al, 2002, p. 359). Targeting audiences and establishing bonds with participants is a means to overcoming this. Klassen and Jacobs report that in web-based surveys higher response rates occur with self-selected groups or convenience samples (2001). Also, a bond can be achieved by email introduction and/or pre-notification that the survey is being sent, by providing a feedback and/or a thankyou notification after the survey is submitted, and by providing a reward to the participant, for example, a copy of the research outcomes.

Boyer et al (2002) provides a summary of the comparisons between print and electronic data collection over the years (**Table 2**). The comparisons provide mixed results of the success of electronic and web-based data collection. For example, Klassen and Jacobs report low internet and email response rate, while Kiesler and Sproull report that the electronic methods yielded a higher response than print methods. However, Klassen and Jacobs did report that although the Internet surveys in their study received a lower response rate, they admit that a

large proportion of the Internet survey target group declined to participate due to a number of reasons. These included the inability to disclose company policy, technological limitations (no email), not wishing to release email addresses and/ or because a French language alternative was needed and was not offered (survey location, Ontario, Canada) (2001).

Authors	Survey Methodology				Topics Examined			Findings
	Paper/ Mail	Fax/Disk by mail	E-mail	Internet	Response rate	Quality of response	Design issues	
Kielser & Sproull (1986)	•			•		•		In organised setting electronic response rates are favourable
Walsh et al (1992)			•	•	•			Self-selected respondents on web are higher quality than email respondents
Schuldt & Totten (1994)	•		•		•			Response rate to electronic method is lower than traditional methods
Mehta & Sivadas (1995a, b)	•		•	•	•	•		Pre-notification greatly helps response rates – helps to avoid "spam effect"
Tse (1998)			•		•			The email response rates are lower than traditional methods
Couper (2000)				•			•	Electronic surveys should consider users of the system in the design phase
Cheyne & Ritter (2001)				•		•		Newsgroups on web can lessen negative response bias
Rogelberg et al (2001)				•		•		Internet respondents provide better information due to positive attitude
Crawford et al (2001)				•	•		•	Low internet response rate due to poor design
Klassen Jacobs (2001)	•	•		•				Low internet response rate; low mail item response rate

Table 2. Summary of Print Versus Electronic Data Collection Comparisons (Boyer et al, 2001)

Their findings suggest that more attention needs to be paid to the design of the electronic survey and in researching the target audience. Boyer et al also notes that in many of the cases presented in the table, the surveys were conducted on university campuses or using students, and that there has been little application of electronic data collection methods in business research (2001). Hence, the table should only be used as an indication of the positive and negative features of print and electronic surveys. It also implies that it is difficult to measure and compare different survey methods, as each situation (survey type, audience, format) is different.

Overview of Web-based Surveys

The following table compares the features of web-based surveys. It is assumed that email communication is used to introduce the participant to the web survey.

Advantages	Disadvantages
Lower cost overall than print surveys, especially for large survey groups, as electronic communication and data analysis costs are cheaper than printing, postage and manual data entry costs. Major cost is survey software set-up, email communication and website hosting.	More cost and time involved for set-up of survey software compared to print methods.
Participant authenticity through secure username and password.	Participant authenticity, as anyone with the password/username can complete questionnaire, yet this is the same concern for print surveys.
Email systems can provide notification if survey email is received or opened	Survey sent without email pre-notification can be received unfavourably (Boyer et al, 2001)
Provision of feedback has been found to motivate respondent participation (Martin, 2000).	Difficult to construct database/sample frame of email contacts as participants do not like to disclose their email address for personal and business reasons.
More user friendly interface than print or computer assisted telephone interviewing.	Participants may not have access to or adequate technology to host website, or even have email addresses.
Ability to be used across different operating systems.	Participants' web browsers must be of a certain standard to view, access or support survey as intended
Survey turn-around time is less compared to print (Boyer et al, 2001)	
Fewer incomplete responses compared to print (Boyer et al, 2001)	
Better data quality compared to print due to better structured questions, use of adaptive questions and favourable user interface	
Delivery of web surveys is faster and more reliable than mail surveys (Chou et al, 2000)	
Data security and control due to automated data collection process	
Less data entry errors than print surveys	
Convenience for participant of quick completion and submittal	

Table 3. Advantages and Disadvantages of Web-based Surveys

Recommendations

Although current research shows that web-based surveys have lower response rates, the conflicting discussions earlier in this book suggest that these findings may be biased. A successful web-based survey relies on a few factors: a well-designed and appropriate survey, proper targeting of the audience group, ensuring the target audience has access to suitable technology to participate, and establishing a bond and/or good communication with participants. By considering the human factors involved with approaching and enlisting help by strangers, researchers will be able to understand how a survey can be well received.

Glossary

CATI	Computer Assisted Telephone Interview
CI	Construction Industry
ICPM	Internet-based Construction Project Management
ICT	Information and Communication Technology
IT	Information Technology
M4I	Movement for Innovation

This book provides the rationale for the development of an Australian construction industry benchmarking initiative. It reviews excellence in benchmarking from around the world, drawing on best practice to propose an on-line benchmarking mechanism that can be applied to a range of business performance issues. The authors apply the mechanism's format to the topic of Information, Communication and Technology (ICT).

The Cooperative Research Centre for **Construction Innovation** is a national research, development and implementation centre focused on the needs of the property, design, construction and facility management sectors. Established in 2001, **Construction Innovation** is developing key technologies, tools and management systems to improve the effectiveness of the construction industry.

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