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NEW ZEALAND
Te Whare Wānanga o Wairaka

URC RESEARCH REPORT

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1. What are the research questions?

What is the current availability, usage, and perceived impact of information technology on practice in the architecture, engineering and construction (AEC) industry in New Zealand?

What is the readiness of the New Zealand construction industry to adopt BIM/IDDS developments in industry processes?

2. Rationale

The construction industry worldwide is currently making a shift towards greater integration throughout the design and construction process. Building Information Modelling (BIM) is widely available, and the focus for many international organisations has moved on to Integrated Design and Delivery Solutions (IDDS). The underlying motivation for this shift is the improvements in productivity, product quality and sustainability that can be gained through complete prototyping of a building in a simulated system, before construction begins, and the resulting improvements in communication and information exchange between participants in the construction process (Owen et al. 2009).

These gains require a corresponding shift not only in construction processes and techniques, but also in attitudes and ways of thinking within the construction industry. Such a change can not be made by one group or industry sector without involving the others; it is a transition that requires participation from everyone involved in the building process, from building client, designers, builders and product manufacturers.

Use of IT is essential to this new process of design and construction. International organisations such as BuildingSMART and the CIB are coordinating major projects in Europe, USA, Asia and Australia to support the development of the industry in these countries. In order to participate in these initiatives and to use their findings to assist the New Zealand construction industry, information is needed about current practice.

It may be that fundamental shifts in software, investment or attitudes need to occur before any move into advanced-IT can take place. Alternatively, IT use in New Zealand may be more pervasive than is recognised, and the focus needs to be on connecting users and making systems more interoperable. In order to allow informed decision making in IT investment, development and education, the industry needs information on the current state of IT use.

With this information, pathways can be identified to improve current performance, and to gain access to, and involvement in, international initiatives in BIM/IDDS development.

3. Methodology

With support from the Building Research Association of New Zealand (BRANZ) and Certified Builders Association of New Zealand (CBANZ), this study developed into a dual-project undertaking. The first project, as described in the original UREC funding application, was a survey of the whole building industry in New Zealand, across a wide variety of participating companies.

The second project, which developed later as CBANZ became involved, made use of the same survey but focused on the use of IT in predominantly small construction companies, which play a major role in the industry. UK figures show that 89% of construction companies have fewer than 10 employees (Office for National Statistics, 2007). Similarly in the US, 79% of companies have fewer than 10 employees (US Census Bureau, 2005). It is difficult to identify similar breakdowns for New Zealand, but it is likely that a high proportion of the industry is made up of small companies. This is significant, as the literature tends to focus on large companies which are leading the drive for IT uptake and development. Hence the opportunity to expand the scope of the project was seen as very beneficial to the knowledge of industry performance in New Zealand. Both projects followed essentially the same methodology.

3.1 Survey instrument

The survey methodology for this project was based on the internationally applied *IT-Barometer* instrument (Howard, Kiviniemi & Samuelson 1998). Surveys based on the *IT-Barometer* have been carried out on the construction industries in a range of countries in the past decade, including Sweden, Norway, Denmark, Finland, Canada and Singapore.

Similar surveys using individually designed instruments have been conducted in the same timeframe in Australia, Malaysia, Turkey and Taiwan. The surveys in these countries were carried out for a variety of reasons, including benchmarking, measuring performance of investment and education initiatives, and informing government policy making.

Prior to this study, the last reported application of this instrument was in Sweden in 2007 (Samuelson 2008). Because of changes in both the IT available and the characteristics of the construction industry in that time, minor modifications were required to the questionnaire.

In New Zealand, a previous national survey of construction IT use was carried out on behalf of BRANZ in 1997 (Doherty 1997), which provided a snapshot of the industry at that time and was used to direct the development of industry training initiatives. This followed a more limited survey in 1992 by Thompson (cited in Doherty 1997). Since then, there have been no published reports on the use of IT in the New Zealand construction industry, although student projects focusing on aspects of the industry have been conducted (eg., Wang 2007).

The standard IT-Barometer format was modified in this study to include a selection of questions used in the earlier New Zealand survey, specifically detailed questions on

applications used in the respondent's workplace, approaches to training, and some additional options in the questions on advantages and barriers regarding use of IT.

3.2 Survey sample

3.2.1. Project 1 – Industry-wide survey
As identified in the rationale, current industry developments require the involvement of the full range of industry participants. Accordingly, the target population for this survey was the construction and facility management sector, in this case including the whole of New Zealand. A wide range of professions fall into this population, including architects (architectural designers and draughtspersons); technical consultants (engineers, quantity surveyors, project managers); contractors and sub-contractors; property owners and managers; and the materials industry (manufacturers and suppliers).

Potential participants were contacted through two avenues. A database of contacts was provided by BRANZ, as part of their project sponsorship. This list consisted of 664 industry participants who had previously participated in the BRANZ Industry Needs survey, and represented a wide variety of organization types and sizes. The BRANZ list required considerable editing; in particular to remove educational institutes and professional bodies, names with no contact details attached, and duplicate entries. The final list contained 405 names and addresses. In addition, the New Zealand Institute of Building (NZIOB) sent out a call to its members, inviting them to participate. The NZIOB call resulted in 30 members expressing interest in participating. In total 435 addresses were identified for this part of the survey.

3.2.2 Project 2 – Survey of CBANZ members
Following contact made as part of the initial survey, discussions with CBANZ led to the extension of the project to include all of the CBANZ membership. While the distribution of their membership remains confidential to the organisation, it consists predominantly of small businesses. The vast majority of CBNZ members are builders, with some Quantity Surveyors and Architectural Designers in the number. The full membership of 1,530 companies was surveyed.

3.3 Survey distribution
The survey was conducted using a postal questionnaire. Survey packs containing a cover letter, questionnaire and stamped addressed return envelope were sent to all contacts, for both samples.

Use of a postal questionnaire was intended to minimise the "technology bias" as much as possible, so that all respondents would be familiar with the format and approach of the questionnaire. This may not have been the case if an internet or email-based questionnaire had been used, and less confident computer users may have been deterred from responding. It was considered particularly important to avoid this because of the focus on IT use.

The Project 1 survey was addressed and sent directly to all addresses on the list. It was mailed out in the first week of December 2009, with a return date of 1 February 2010. Project 2 was sent out on 1 February 2010, with a return date of 1 March 2010. The longer response period for Project 1 allowed for the Christmas/New Year holidays within this time. Because CBANZ wanted to maintain the confidentiality of their mailing list, the prepared survey packs for Project 2 were sent to the CBANZ office, where the envelopes were addressed and sent.

3.3 Survey response

Of the 435 survey packs sent out in Project 1, 47 were returned unopened. Some of this failure to reach the identified contacts is likely to be a reflection of the effects of the recession in New Zealand, with many companies no longer trading or having moved premises. A further 11 questionnaires were returned with an "opt out" from the contact, commonly because they were no longer working in the industry. Thus the questionnaire was successfully delivered to 387 companies. From these, 80 completed responses were received, a response rate of 21%.

For Project 2, CBANZ were sent 1,530 survey packs for distribution. Of these, none were returned unopened, and 155 were returned completed. This represents a response rate of 10%.

These response rates are similar to those of previous surveys. Doherty (1997) does not state the response rate for the earlier New Zealand survey, but surveys in the last decade range from a response rate of 11% in Singapore (Goh 2003), to 22% in Canada (Rivard 2000). The most recent published use of the IT Barometer was in Sweden in 2007, where the response rate was 13% (Samuelson 2008).

These response rates mean that the reliability of the conclusions can not be statistically tested. Nevertheless they provide a useful insight into the performance of New Zealand construction companies and their use of IT, and the development of IT use in the industry since the last survey in 1997. Broad comparisons can also be made with similar international surveys.

4. Outcomes / findings

The characteristics of the two groups surveyed are clearly different. The average size of companies surveyed in Project 1 was 39 employees, and for Project 2 was 3.7 employees. The level of computer adoption was very different between the two groups, as were the attitudes expressed.

4.1 Current availability, usage, and perceived impact of information technology

4.1.1 Project 1 – Industry-wide survey

Access to computers, types of applications in use and attitudes towards investment and development in construction IT in New Zealand seem to be broadly in line with findings from other countries. All of the companies which responded used computers as a part of their daily business, and the majority (68%) provided desktop or laptop computers for all staff. Similarly, use of internet and email were pervasive. Across all respondents, 70% of employees had access to the internet from their own computer, and 80% had an individual email address. These results are very similar to recent findings in Sweden (Samuelson 2008).

Anecdotal evidence suggests that the construction industry was an early adopter and is one of the highest users of mobile telephony in New Zealand. However, mobile phones were less universal than anticipated. Samuelson (2008) found for Sweden that mobile phones were provided for 80% of employees. In New Zealand in 2009/10, an average of 50% of employees have mobile phones provided. No mobile phones are provided by 11% of companies, and a further 26% provide phones to fewer than half their employees. Only 16% of companies provide all employees with a mobile phone.

Mobile computing was very poorly represented, with 40% of companies not making use of this technology at all, and half of the respondents providing mobile computing

to fewer than 10% of employees. Research into the use and benefits of mobile computing in the construction industry has been widely reported for at least seven years (Bowden, Thorpe & Baldwin 2003), and with the current proliferation of devices and associated applications for the industry, the slow take-up is surprising.

The majority of respondents (85%) reported that they used broadband internet connections, with 43% having a download rate of between 2-8Mbit/s and 33% above 8Mbit/s. However, as one respondent wryly noted, this was the “theoretical rate”, and broadband in practice did not always deliver this. Only 2 out of 80 respondents still operated using dial-up Internet, with one of these also noting that this was not through choice but because they were unable to access broadband at their location in New Zealand.

While most companies use computers, for many it is primarily a business tool for administrative functions, rather than a tool in the construction process. Computers are most commonly used for word processing, spreadsheets, email and, to a lesser extent, databases. Microsoft has near universal coverage of word processing and spreadsheets, and a majority of databases and email applications. As well as for business applications, where Microsoft dominance is expected, many companies have also opted for Microsoft programs for construction-specific tasks. Microsoft was represented in all applications except CAD drawing, modeling and visualization. Excel spreadsheets are frequently used as the basis for in-house systems to manage a variety of processes.

Despite the predominance of Microsoft “generic” software, the range of specialist construction-focused programs found in the 1997 New Zealand study is still evident. Doherty (1997) reported up to 16 different programs in use for each application category, and similar numbers were found in this survey. Most of these programs are used by only one or two of the respondents, so there still appears to be a great deal of variation. The number of respondents from the earlier survey was not reported so is difficult to compare the overall number of programs in use. However, given that over 4,000 items of construction-specific software were identified in a European study in 2000 (Amor et al., 2000), this proliferation of applications in use seems likely to continue. The ad-hoc creation and use of many task-specific tools, including individual adaptations using programs such as Excel, has been cited as a significant barrier to greater interoperability within the construction industry. This variety acts to limit the amount of conformity between tools, and means that although industry standards exist, many companies use non-standard applications that are not able to exchange data.

CAD in some form was used by 53% of respondents. This is similar to the findings in the 1992 and 1997 surveys of computer use in New Zealand, and also agrees broadly with the levels found overall for other studies surveying a similar breadth of industry participants. As noted by Samuelson (2008), use of CAD by designers was well integrated by the mid-1990s and there has been little increase since. What has changed is the type of CAD tools in use. All of the architects used CAD in some form, and this sector was also the most advanced in terms of 3D CAD+time/cost and BIM use. A majority of construction contractors did not use CAD at all, and the CAD use of those who did use it was limited to geometrical data (2D and 3D CAD), with no use of more advanced CAD/BIM systems. While the New Zealand industry has been considered slow to adopt the more advanced forms of CAD/BIM, these results do not differ significantly from those seen in other countries (Gu et al. 2008). This survey shows that the leading proponents of BIM in New Zealand are architects, and some of the largest construction companies. This pattern is also reflected internationally (McGraw Hill 2008)

This survey indicates that interest in project webs is growing in the New Zealand industry. In the 1997 survey, data interchange was not an aspect investigated. Currently 44% of respondents have used project webs of some sort. Of the respondents who have never used project webs, one third consider they would be useful. However, several comments suggested that there was some disillusionment with this type of system from a number of respondents who had used them, and for the majority they were only used on some occasional projects. Only 6% of companies used project webs on more than half of their projects. Use of data interchange systems is a central tenet of IDDS and thus the limited application of this technology by the New Zealand industry is a significant barrier to increased participation in international initiatives.

Attitudes towards the advantages and perceived impact of increased IT use in New Zealand were similar to findings in other surveys. The most highly rated advantage of IT use in New Zealand construction was “Better communication”, identified by 84% of respondents. This factor ranked in the top 4 in Denmark, Sweden and Finland (Howard et al. 2002) but other studies have not listed it as a high-ranking advantage in the view of their respondents. The second ranked advantage in the current survey was “Simpler/faster access to common information”, which has featured as one of the top-ranked advantages in a number of other studies (Howard et al. 2002, Goh 2005, Samuelson 2008). Staffing considerations ranked low as potential advantages, with only 18% seeing IT as offering an advantage in “making the company more attractive when recruiting personnel” and 20% in “possibilities of staff reduction. “Better financial control”, which ranked in the top two for Denmark and Sweden (Howard et al. 2002) ranked eighth overall for the New Zealand companies surveyed. The majority of companies considered their company processes to have improved as a result of IT, with higher process speed identified by 60%, and fewer errors in documentation featuring for over a third of respondents. On the other hand, almost half of respondents considered that use of IT had increased the administrative needs for their company.

Lack of staff knowledge, the cost of training and the time and disruption caused by staff undertaking development work were also perceived to be significant barriers to increased use of IT. This is an attitudinal problem within the industry, linked to overall resistance to change. Improving awareness, particularly through training, is an essential ingredient for successful culture change (Weippert & Kajewski, 2004).Staff training in IT is clearly an issue that requires further attention. Fewer than half of the respondents had invested in staff IT training in the past two years, despite near universal investment in new hardware and software. Brewer & Gajendran (2009) found that companies did not see expenditure in staff training as an investment in the company due to the potential staff turnover, and this may be a factor at play here, especially given the recent economic climate in New Zealand. Where training was taken up by companies, methods used tended to be ad-hoc with users generally left to fend for themselves using trial and error, on-line help, and to a lesser extent, manuals and on-line tutorial systems, to develop their skills. Kajewski et al (2004) identified that very few companies adjust employees’ workload to take account of training time, but that when workload was adjusted in this way, external training was the overriding preference. Staff preferring the in-house and self-training options often do so to maintain greater control over their own time management. Issues of staff training are therefore closely tied to other issues of human resources management.

4.1.2 Project 2 – Survey of CBANZ members

The survey was designed with the underlying assumption that although users would not necessarily be expert or experienced, computers would be used in every

business contacted. This was proven incorrect in the survey of CBANZ members where 7% of respondents had no computerisation in their business, and a similar number who indicated that they used a home computer for administrative tasks but had no business computer. In the majority of companies using computers, only one computer was available, generally for use by the owner/director. Internet and email were used by all of the companies with a computer, and also for those using home computers for work purposes.

Mobile phones were more common across this group with an average of 60% of employees provided with mobile phones. In 34% of companies all employees were provided with a mobile phone. This greater proportion of mobile phone use must be considered in the light of the company size, however. Mobile computing was used by only 23% of companies in this group.

As found in the Project 1 survey group, computer use is focused on administrative tasks for most companies. Most commonly listed software applications are word processing and spreadsheets (exclusively Microsoft Word and Excel), and email (Microsoft Outlook and Outlook Express, as well as various web-based email systems). CAD was used by only 11% of respondents, with one company using full BIM and the remainder working with 3D geometrical data. Project webs had been used by 8%, of which only 3 companies listed systems used within the last 2 years. This review of availability and usage demonstrates clearly that there is a large section of the New Zealand construction industry which is not currently able to participate in the movement towards IDDS.

Investment in Information Technology by these companies was low, with 28% having made no investment in IT (including telecommunications) in the past two years. Only 7 companies had investment in IT training for staff in the past two years, with several suggesting that this came from sponsoring staff on courses of broader scope such as diplomas or degrees in Construction Management.

The most commonly cited barrier to increased use of computers was “Lack of finance/cost of investment” (45%), followed closely by the perception that “what we have now meets our current needs, and changes are unnecessary” (39%). Comments suggested that these two factors combined to produce a “If it ain’t broke, don’t fix it” mentality, where the potential costs of changing and getting it wrong outweighed the perceived benefits received. “[Another barrier is the] time it takes to learn new systems and will they be better than what we already use?” “Too complex to use hence not reliable and cumbersome. Most tasks appear faster when done manually”. Other barriers listed by more than 20% of respondents were “Decision makers have no time for IT efforts due to heavy workload”, “Systems keep changing too fast”, “Staff do not have adequate knowledge”, all of which reinforce the same idea, that these companies do not have the knowledge or expertise to help themselves move towards greater use of IT, and they find it difficult to take the time required to develop the knowledge.

No barriers were identified in 16% of responses, but many of these had added comments. These suggest that there is an element of hostility about the increasing influence of computers on business in general, and a strong denial that computers have a place in the construction industry; for example “Computers can not complete physical labour - we are a construction company,” “I can still work when the power is off”, “Haven't heard of a computer that can stand up frames, pour concrete or nail a nail in.”, “Computers don't build, they would only waste time.”

4.2 Conclusions

- Viewed as a whole, the New Zealand construction industry appears similar in availability, usage, and perceived impact of information technology to industries in other countries. This indicates that we stand to gain the same advantages from the shift to BIM/IDDS as other countries involved in these initiatives.
- Lack of participation in project webs and data interchange systems is a key limitation to development of advanced IT use in New Zealand.
- The proliferation of computer applications in use for construction-specific tasks is a barrier to interoperability between New Zealand companies (albeit a barrier that is found in construction companies internationally). However, this is perhaps better addressed by software developers producing the advance IT systems, rather than by reducing the availability of applications for construction companies. Industry organisations could contribute by providing more information about appropriate software to support particular construction processes, which would reduce the level of in-house or ad-hoc development that is currently seen.
- There needs to be a greater focus on staff training in IT both to improve industry readiness for adoption of advanced IT, and to create a culture change in attitudes towards IT as a part of the industry.
- Small construction companies would benefit from clear guidance, including exemplars or case studies, that demonstrates how IT can be used to improve administrative processes. This is a starting point for increasing knowledge and acceptance of IT in this sector. Currently small companies risk becoming marginalised in their access to both resources and projects, unless they adopt a more open approach towards IT.

5. Publications and dissemination

CIB W78 IT in Construction conference

Abstract accepted - 27 April
Full paper submitted for review - 11 June 2010
Conference – Cairo 16-18 November 2010

Draft for Advance magazine

Brief article (500 words) drafted for next issue of Advance magazine; currently with Jade Reidy for editing.

Draft for Build Magazine

Brief article for the BRANZ trade magazine, reporting on the general findings of the survey; currently waiting on details of style and format from BRANZ in order to complete the final draft.

Drafts for journals

Construction Management and Engineering – paper focusing on computer use in small construction companies
Journal of Information Technology in Construction – paper reporting on use of IT Barometer survey in New Zealand context

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