IT BAROMETER NEW ZEALAND – A SURVEY OF COMPUTER USE AND ATTITUDES IN THE NEW ZEALAND CONSTRUCTION INDUSTRY

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ABSTRACT

Building productivity in New Zealand lags other countries and industries which invest more heavily in technology. Improved productivity of the construction sector is widely touted as a significant factor in boosting the performance of the country as a whole. Application of IT has for some time been hailed as the key to implementing such productivity gains.

International initiatives such as BuildingSMART and Integrated Design & Delivery Solutions (IDDS) are very strongly oriented around improving construction through IT and associated processes. To use their findings, and to allow informed decision making in IT investment, development and education, the New Zealand construction industry needs more information on the current state of IT use.

This paper reports on a national survey undertaken in 2009/2010, based on the IT Barometer questionnaire. Elements of a 1997 New Zealand survey of construction IT use were also incorporated to allow longitudinal analysis. The target population was the construction and facility management sector of New Zealand and the questionnaire was delivered to 388 companies. Eighty completed responses were received, a response rate of 21%.

Results show that while most companies use computers, for many it is primarily used for administrative functions, rather than a tool in construction processes. As found in the 1997 survey, many specialist construction-focused programs are used, but few are standard across the sample. Project webs have come into more common use since the earlier survey but do not appear to be well regarded by users. Mobile computing is used only to a limited extent. A fundamental barrier to increased use of IT is the cost of investment, with several respondents commenting that this is due to the staff time and disruption involved and not simply the financial cost of the hardware and software required.

Keywords: survey, IT barometer, computer use, New Zealand

1. INTRODUCTION

Internationally, construction research and practice are describing a strong shift towards use of Building Information Modelling (BIM) and Integrated Design and Delivery Systems (IDDS) (Owen et al. 2009). 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. To make these gains, there needs to be a corresponding shift in focus and processes within the construction industry. This is not a change that can 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 fundamental to this new process of design and construction. International organisations such as BuildingSMART and the CIB are coordinating major projects in Europe, USA and Australia to support the development of the industry in these countries. In order for the New Zealand construction industry to participate

in these initiatives and to make use of their findings, more information is needed about current practice. It may be that fundamental shifts in equipment, investment or attitudes need to occur before any development into advanced IT can take place. Alternatively, IT use may be more pervasive than has been 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.

This paper presents selected results from a survey carried out in New Zealand in 2009/2010, to help inform the discussion on future directions and developments within the New Zealand industry.

1.1 New Zealand Studies

IT use in the New Zealand construction industry was last formally surveyed in 1997 (Doherty 1997). This followed a more limited 1992 survey by Thompson (cited in Doherty 1997). A survey by Wang (2007) focused on the role of ICT in the construction supply chain in New Zealand, with some small areas of overlap with the current survey.

1.2 International Studies

IT surveys based on, or similar to, the IT Barometer (Samuelson 1998) have been published in at least 11 countries in the last decade, as listed in Table 1.

Table 1: International surveys/IT barometer studies

Country	Survey Year	Type	Publication
Canada	1999	IT Barometer modified	Rivard (2000)
Malaysia	2000/2001	Stand-alone (internet focus)	Mui et al. (2002)
Finland	2001	IT Barometer	Samuelson (2002)
Denmark	2001	IT Barometer	Samuelson (2002)
Turkey	2001	Stand-alone	Sarshar & Isikdag (2004)
Singapore	2003	IT Barometer	Hua (2005)
Australia	2004	Stand-alone	Kajewski et al. (2004)
New Zealand	2007	Stand-alone (supply chain focus)	Wang (2007)
Sweden	2007	IT Barometer	Samuelson (2008)
Taiwan	2008	Stand-alone	Chien & Barthorpe **(**2010**)**
Nigeria	2009	IT Barometer modified (proposed)	Adejimi (2009)

Unfortunately, because of the rate at which IT changes and the widely varying time frames of previous industry surveys, it is difficult to make detailed comparisons between these survey results. Even where the survey is based on the IT Barometer, each new use of the structure results in amendments to the questions or format to take into account technological changes over time, or to customize the survey to the needs of the specific country. This is also the case for this survey, where the questions have been amended to incorporate some of those asked in the previous New Zealand survey (Doherty 1997). However, it is still possible to observe trends and directions within the industry, and, where possible, observations have been made on relationships between New Zealand results and those for other countries.

2. METHODOLOGY

1.3 IT Barometer

This project used a survey methodology based on the internationally applied “IT Barometer” instrument (Samuelson 1998). Modifications were made to include a selection of questions used in the earlier New Zealand study (Doherty 1997), 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. Prior to this survey, the last reported application of this instrument was in Sweden in 2007 (Samuelson 2008), so minor modifications were required to the questionnaire to include industry and IT changes for use in 2009, such as the addition of laptops and mobile computing devices to the question regarding equipment. Pre-testing of the early survey design suggested that the survey was too long and would result in low response rate, so several sections of the standard IT-barometer survey were omitted, including the detailed questions regarding CAD use, and questions on hypothetical future spending and development intentions.

The three criteria of the IT Barometer, as stated by Samuelson (2008), are to

> "1. Be repeatable and comparable over time.
> 2. Be comparable between countries.
> 3. Cover all categories of companies in the construction industry, which was defined as architects, technical consultants, contractors, facility managers and the materials industry."

As previously mentioned, comparison across time and country are less straightforward in practice. However, this study has attempted to meet these criteria. The first and second criteria are met by aligning primarily with the IT Barometer questions, to permit some comparison with the other countries which have used this structure previously. The second criterion has also been taken into account by incorporating questions from the previous New Zealand survey, to allow comparisons as far as possible across time. The third criterion has been followed by using a sample which includes all of the categories of companies in the construction industry listed.

1.4 Data collection

The survey was conducted using a postal questionnaire. This 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 was used, and less confident computer users may have been deterred from responding. It was considered particularly important to avoid this because the questionnaire focuses on IT use. However, there is a strong likelihood that respondents in surveys such as this tend to be those with a particular interest or awareness of computer use in the industry.

The target population 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 the Building Research Association of New Zealand (BRANZ), the project sponsor. This was a list of industry participants who had previously participated in the BRANZ Industry Needs survey and represented a wide variety of organizations types and sizes. In addition, the New Zealand Institute of Building (NZIOB) sent out a call to its members, inviting them to participate. The BRANZ list required some editing, in particular to remove educational institutes and professional bodies, and duplicate entries. The final list contained 405 names and addresses. The NZIOB call resulted in 30 members expressing interest in participating.

Survey packs containing a cover letter, questionnaire and stamped addressed return envelope were sent to 435 contacts. Of these, 47 were returned unopened, a reflection of the effects of the recession in New Zealand, with many companies no longer trading or having moved premises. A further 11 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%. While this response rate is similar to other studies of this type, it does not provide sufficient data to offer statistically significant results.

Figure 1 shows the distribution of responses according to company type, and Figure 2 by company size.

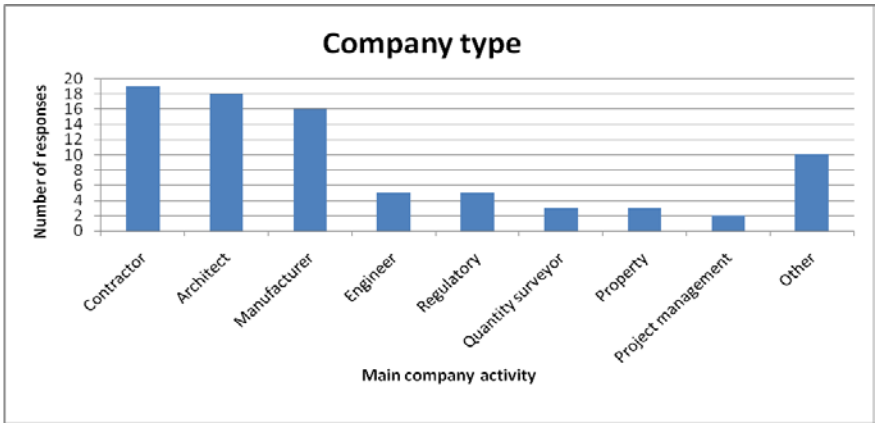

Figure 1: Distribution of survey responses by main company activity

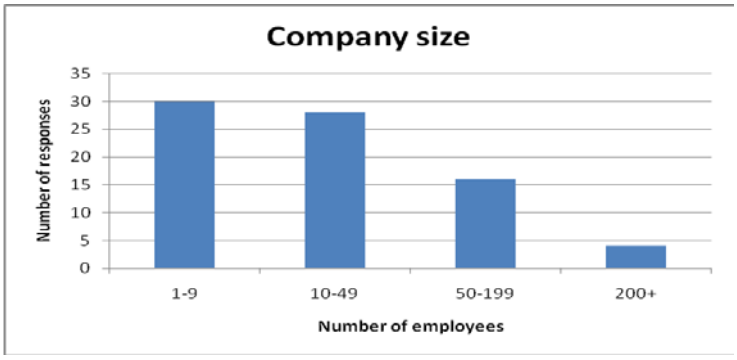

Figure 2: Distribution of survey responses by company size

Despite the lack of statistical significance offered by a sample of this size, the survey provides 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.

3. RESULTS

1.5 Access to computers and communication tools

All of the companies which responded used computers as a part of their daily business. In 68% of companies, 100% of employees had a desktop or laptop for their exclusive use. Individual email addresses were provided for all employees in 60% of companies. Just over half (43/80) provided internet access to 100% of employees from their own desktop or laptop computer. Across the group, 70% of employees had access to the internet from their own computer, which is very similar to earlier findings in Sweden (Samuelson 2008). Including those companies and employees with internet access via a shared computer, 70% of companies allowed internet access for 100% of their employees. However, 21% of respondents provided internet access for fewer than 50% of their employees.

Mobile phones were not as universal as 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. 11% of companies do not provide mobile phones for any of their employees, and a further 26% provide phones to fewer than 50% of employees. Only 16% of companies provide all employees with a mobile phone.

Mobile computing was also poorly represented, with 32 out of 80 not making use of this technology at all, and only half of the respondents providing mobile computing to more than 10% of employees. The potential benefits of mobile computing for construction have been reported for at least seven years (Bowden, Thorpe & Baldwin 2003), and with the current proliferation of devices the slow take-up within the industry is surprising.

The majority of respondents had broadband internet connections (85%), with 43% having a download rate of between 2-8Mbit/s and 33% above 8Mbit/s. However, as one respondent wryly commented, 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 noting that this was not through choice but because broadband was still not available for their location in New Zealand.

1.6 Commonly used applications

Results show that 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. As might be expected, Microsoft has near universal coverage of word processing and spreadsheets, and a majority of databases and email applications (see Figure 3). Versions used range from two users still using 1997 and 2000 programs, with the majority split between 2003 and 2007 versions.

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.

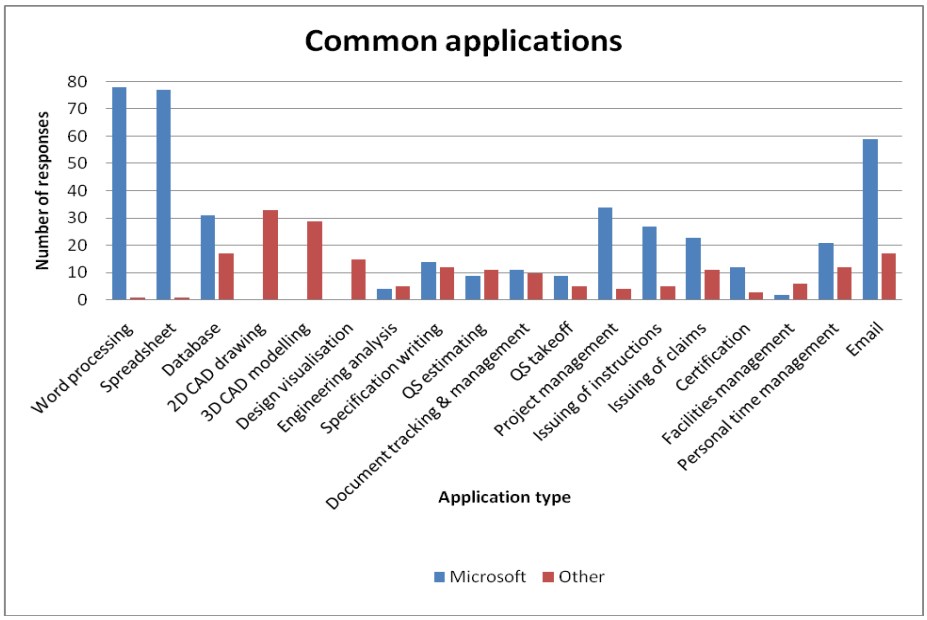

Figure 3: Commonly used applications, showing Microsoft dominance

The range of specialist construction-focused programs found in the 1997 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 4000 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.

1.7 Use of CAD

The questionnaire used the cumulative levels of CAD use as defined in the IT Barometer, ranging from "geometrical data in 2D (drawings)", "geometrical data in 2 and 3D (drawings and geometrical modelling)", "also for data other than geometrical (e.g. time, cost, product properties)", through to 3D CAD with full BIM functionality, defined as "also including object-based in databases, where several parties are able to supply and retrieve data (product-model-based design, also called BIM – Building Information Model)".

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. 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. Figure 4 shows the breakdown of CAD use by the three largest industry sectors which responded to the survey.

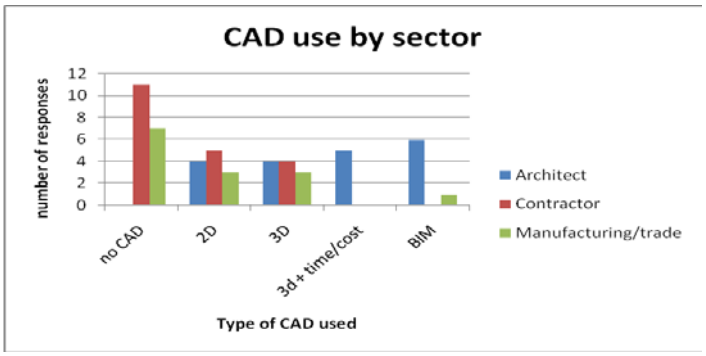

Figure 4: Levels of CAD use by different industry sectors

In terms of the software used for CAD, the most frequently used system across all respondents was the AutoDesk set of products (including AutoCAD, AutoCAD LT and Revit), with ArchiCAD following a distant second. This has been the case in the majority of surveys internationally (eg., Doherty 1997, Howard et al. 1998, Rivard 2000, Samuelson 2008).

Despite the dominance of Autodesk in 2D and 3D CAD, a wide variety of CAD tools were used across the group. Figure 5 shows the range and popularity of software used for different CAD tasks. This variety was also seen in the 1997 survey, with most of the same programs in the list, so it does not appear that the CAD market has narrowed at all. One interesting point to watch is the rise in popularity of the Google program Sketchup for 3D CAD and design visualization. All but one of the respondents listing Sketchup used free versions of the software.

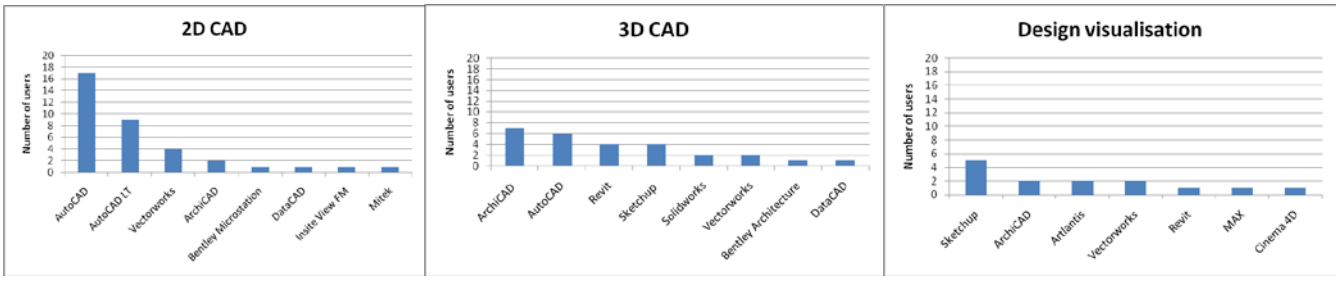

Figure 5: CAD Software used for different purposes

1.8 Use of Project webs

Interest in project webs is also growing. In the 1997 survey, data interchange was not an aspect investigated. In the 2009/2010 survey however, 44% of respondents have used project webs of some sort. Of the 28 systems named, Aconex was the most commonly used, with a quarter of those who had used such systems in the past year having used it. Despite the range of construction-specific tools available for sharing project documents, many respondents identified generic file-sharing tools that they had used in the past year.

Table 2 lists both the construction specific and generic file sharing systems named by respondents. In addition to this list, a further 5 respondents used un-named custom or in-house systems.

Of the respondents who have never used project webs, one third consider they would be useful. However, several comments suggested that there was disillusionment with this type of system from some respondents who had used them. Comments included "Falling out of favour - too expensive/only client driven" and "We don't find them very good because no-one updates them." In the list of systems used, 3 respondents identified "Systems provided by other companies" or "As provided by client", from which it could be inferred that there was no feeling of ownership or even partnership in the use of the systems.

Table 2: Computer programs used for sharing project documents

Construction specific systems	General systems
Aconex (10)	4Shared.com
Buzzsaw	AppPortal
CatProjects	Arkserve
CATPlan	Backpack
CollaborIT	Dropbox
Mainzeal Content Management (MCM) (2)	Google document
	Lotus QuickR
	Mindjet
	Sharepoint (2)
	TeamViewer
	Tenderlink
	WebOffice

1.9 Proportion of operations computerized

Costing and budgeting was the business operation most widely computerized, with 76% of respondents agreeing that 76-100% of this was computerized in their workplace. Drawing production was also quite substantially computerized; 76-100% of drawing production operations were computerized for 67% of respondents for whom this was a necessary operation. The majority of respondents in every category agreed that that their operations were 76-100% computerized, except for facility control and supervision, where 51-75% computerization was most common.

Very few respondents used only manual methods for any of the operations listed, the highest being 8% of respondents (6 out of 80) using manual methods only for materials control/purchase.

In terms of internal and external transmission of material, meeting minutes were the most likely to be sent digitally, and none of the respondent used only hard-copy. Drawings were sent digitally 76-100% of the time by a third of respondents, with only one respondent using exclusively hard-copy. Purchase orders/invoices and tender invitations were least likely to be sent digitally.

1.10 IT investment

Only 2 of the 80 respondents had made no new investments into IT in the last two years. New hardware and new software were the most common investments, with 86% of respondents indicating investment in these two areas. Investments in telecommunications equipment were made by 63% and networks or servers by 61%. Staff training

in IT was the real loser in investments over this period, with only 43% investing in this area. The most important motive for investment into IT was to make the administrative work more efficient, with 93% of respondents agreeing that this applied in their workplace. This tallies well with the dominance of administration-focused tools in the lists of applications used by respondents. The desire to make technical work more efficient was listed by 82% of respondents. Demands from employees came third as a motivation for investment, with 55% of respondents considering this a factor in their workplace.

1.11 IT training

As reflected in the low investment in staff training, ad-hoc training approaches were most common. "Teach yourself on the job using trial and error/computer's on-line help" was by far the most common method, reported by 76% of respondents. Next most common was "Teach yourself on the job using provided training books/videos/on-line tutorials". Respondents' preferred approaches were for "an in-house "expert" to provide one-to-one training" (used in only 43% of companies) and "staff attend external short courses of less than 8 hours" (used by 46%). The most uncommon and least popular training options were for external courses of more than 8 hours.

1.12 Advantages and barriers

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 this 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.

In the survey, 20 possible barriers to increased use of IT were offered. These were drawn from both the IT Barometer format and the previous NZ survey (Doherty 1997). The four disadvantages most commonly experienced by respondents were :

1. Lack or finance/cost of investment
2. What we use now meets our current needs and change is unnecessary
3. Staff do not have adequate knowledge
4. Resistance to change.

Samuelson (2008) found that the barrier of cost had reduced in Scandinavia from previous studies; however, respondents' comments in the current survey indicated that they considered the cost of staff disruption from retraining and implementation to be a significant part of the "cost of investment" barrier, rather than focusing solely on the cost of software and hardware. This was also linked to the complexity of much of the software, and the difficulty practitioners found in applying systems to their needs. Several respondents also commented that their company did not have projects of sufficient size to allow substantial change in systems or processes. These problems seem to all be aspects of the cost of investment, in terms of the time cost of training and disruption caused by development and implementation. The high ranking of "Staff do not have adequate knowledge" also indicates that these two barriers are reinforcing each other.

Satisfaction with current methods was the most significant barrier found in the earlier New Zealand study (Doherty 1997) and rated highly in this instance also. "Resistance to change" is another barrier that rates highly in many surveys of this type (Davis & Songer 2008, Chien & Barthorpe 2010). The linking of these two barriers in the top four barriers identified is an interesting connection. Acceptance of the status quo may in many cases be motivated more by fear of the unknown than by complete satisfaction with current systems. However, additional comments such as "We always use latest versions" and "We buy what we need" suggest that the perception that change is unnecessary is not necessarily a barrier to increased use of IT by some companies, but is in some cases a fair assessment of appropriate IT investment by informed practitioners.

DISCUSSION & CONCLUSIONS

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.

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 high levels of 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.

Training 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 management and staff performance.

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 a an essential ingredient for successful culture change (Weippert & Kajewski, 2004).

On the technology side, it was interesting to note the slow uptake of mobile computing within the New Zealand construction industry. Anecdotal evidence suggests that the industry was an early adopter and is one of the highest users of mobile telephony. However, mobile computing is taking a much slower route. Given the comments regarding poor broadband performance in terms of both speed and coverage, it may be that the problem is one of connectivity rather than lack of performance of the devices themselves (Svidt & Christiansson 2006).

Project webs are another technology area where the promise seems to have outrun the performance. Although many systems were listed by respondents, and there was a high level of interest from other respondents who had not used project webs, there were also a number of negative comments from respondents who had experience with project webs, that indicated disillusionment with the concept.

The findings of this survey show that the application of IT in the New Zealand construction industry is not significantly different to that of other countries, despite the perception of slow development and progress within the industry. Some technological factors have been identified which need to be addressed, to allow the industry to participate fully in the international initiatives currently underway. The most immediate of these is perhaps the upgrade of broadband capacity in New Zealand, which would facilitate the effective use of mobile computing. However, the bigger issue seems to lie in training and staff development, rather than the hardware and software in use. In order to improve the uptake of ICT in the New Zealand construction industry, this survey indicates that the most important factor is to increase the level of investment in staff training. A better-informed workforce would lead to, and support, a higher level of acceptance and application of technology in the industry. Crucially, staff training would also help companies to reduce many of the costs and inefficiencies that form a major barrier to increased application of IT.

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