A National Perspective on the Status of ICT in the Australian Construction Industry

Report 2001-008-C-08

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Research Program C:
Delivery and Management of Built Assets

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

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PREFACE

The Cooperative Research Centre for Construction Innovation (CRCCI) research project 2001-008-C: *'Project Team Integration: Communication, Coordination and Decision Support'*, is supported by a number of Australian industry, government and university based project partners including: Queensland University of Technology (QUT); Commonwealth Scientific Industrial Research Organisation (CSIRO), University of Newcastle; Queensland Department of Public Works (QDPW); and the Queensland Department of Main Roads (QDMR).

Supporting the project's research aims and objectives, this report investigates the current status of ICT within the Australian construction industry through survey analysis and discussion. The topics investigated include ICT uptake, ICT training and ICT implementation Drivers/Barriers.

EXECUTIVE SUMMARY

This report outlines the results of a survey conducted in November 2003 aimed at investigating the Australian construction industry's current performance in ICT related issues. The survey targeted three broad areas:

- Current ICT status including annual ICT investment, access to and use of ICT devices according to annual turnover;
- ICT training including training participation by individuals, training support within respondent organisations with regards to workload and time flexibility for employees, preferred mode of training for individuals, and level of ICT competence expectations of the various construction project participants of their colleagues; and
- ICT trends and opinions on the Benefits/Drivers and Barriers/Limitations to the implementation and use of ICT on construction projects.

The survey was implemented on a National (Australia) basis within the construction industry - including Non-building, Building (Commercial/Industrial), and Residential sub-sectors - with a view to informing the decision makers within the construction industry on ICT policy relating to:

- The types of ICT being used across the construction industry sub sectors and for various project sizes to enable them to identify possible improvements through ICT uptake;
- The preferred mode of training amongst construction industry employees allowing them to implement suitable ICT training regimes for employees; and
- The Benefits/Drivers and Barriers/Limitations to the uptake of ICT on construction projects to enable them to identify suitable ICT implementation strategies within their organisations.

Respondents where asked to answer specific questions to enable detailed comparative analysis of the responses. In terms of a general profile, the analysis revealed that:

- 92% of respondents were from the East Coast of Australia;
- 78% of respondents have some form of Tertiary Qualification;
- 71% of respondents were in some form of managerial role within their organisation;
- All respondents had greater than 1 year and 54% had at least 10 years service in their present position;
- 63% of respondents were from a contracting organisation and 29% were from a consultant/specialist organisation with the remaining 12% being spread between Supplier and Client organisations;
- The majority (74% of those who knew the organisation's annual turnover) of respondents organisations had annual turnover's of less than $5M and 10% of respondents organisations had annual turnover's of $100M+ or greater; and
- At least 80% of respondents were from the Vertical/Building construction sub-sector.

This information enabled respondents to be categorised for analytical purposes. The main categories found to be significant in further analysis included:

- Sub-sectors of the construction industry including Non-building, Building (Commercial/Industrial), and Residential; and
- Annual Turnover.

The investigation of the current ICT status of respondents and respondent's organisations revealed that:

- Annual investment in ICT ranged from $500 to $1M with the most frequent response being $2000 annually, this may be due to the majority of respondents (74%) being from a small turnover category i.e. less than $5M annually, and
- Results showed organisations that had a higher annual turnover ($500k and above) had greater access and use of more innovative technologies such as Handheld and Tablet computers, Video Conferencing and Wi-Fi than the lower turnover ranges. These organisations, in general, also had a higher annual ICT investment budget.

In terms of ICT training, the survey analysis showed that:

- Almost half (49%) of respondents indicated that they had undergone official ICT training and that overall 76% had undergone some form of ICT training;
- The Sub-contractor group were found to have the lowest numbers to have completed any official ICT training;
- An apparent trend between an organisation's annual turnover and the participation rates in ICT training was identified i.e. lower annual turnover organisations had lower ICT training participation. Moreover, Residential sub-sector respondents (95% fall in the lower annual turnover category) were allowed less time by their company during office hours to undertake official ICT training than other sub-sector groups;
- The majority (46%) of respondents preferred to undergo training with professional consultants;
- Overall, respondents expect all project participants to have at least an average level of competence with Consultants/Specialists expected to have the highest level of ICT competence;
- Managers expect a higher level of competence from team members than did other role types; and
- Sub-contractors expect a higher level of ICT competence from themselves and Contractors than other sub-sector organisations.

In terms of ICT trends and opinions, respondents were asked to indicate what influence a range of issues would have on their decision to implement or use ICT on projects. The analysis of the results looked at both the Benefits or Drivers and the Barriers or Limitations to the use or implementation of ICT. Both sections were analysed as follows:

- Overall average response;
- Comparative analysis between construction sub-sectors; and
- Correlation analysis results between the various issues.

The results of the analysis determined the top three Benefits/Drivers to ICT implementation or use on projects were:

1. *'To help gain increased efficiency (improved productivity)'.*
2. *'To help improve overall team/company efficiency (productivity)'.*
3. *'To help increase business opportunities'*.

There were some differences of opinion when comparing the sub-sectors but in general these were the most influential issues.

The Benefits/Drivers of least influence (Total Mean) were found to be:

1. *'To help become industry leaders in ICT adoption'.*
2. *'To help enable electronic tendering (eTender)'.*
3. *'To help downsize or become a leaner company/team'.*

The most significant findings from these results are that construction organisations perceive ICT to provide productivity Benefits at an operational level and strategically through improved business opportunities. There was a statistically significant correlation in the responses for the top two issues.

The results of the analysis on the Barriers/Limitations to ICT implementation or use on projects showed more variability in the responses between the sub-sector organisations, however overall, the top three Barriers were:

1. *'ICT investment restrictions due to budget constraints'.*
2. *'Having to use incompatible ICT hardware/software/systems'.*
3. *'Having limited or no ICT technical support readily available'.*

Overall, the most influential Barrier/Limitation for the respondents - when considering implementing or using ICT on projects - was budget constraints. This agrees with the results of previous sections of the survey where the annual turnover and ICT investment appear to be closely related to an organisation's ICT status and training characteristics. Technical issues such as incompatibility and ICT technical support also ranked highly as being influential Barriers.

The Residential sub-sector indicated that '*The continuous & quick succession of ICT upgrades/advancement'* was a significant Barrier. While the Non-building sub-sector indicated that '*Demanding and inflexible workload*' was a significant Barrier to the implementation or use of ICT on projects.

There was a statistically significant positive relationship between those who indicated that '*Demanding and inflexible workload*' was a significant Barrier to the implementation or use of ICT on projects and whether their company adjusts/reduces their workload to undertake official training. For the respondents who indicated their company adjusts/reduces their workload to undertake official training, this was their number one Barrier, however, it should be noted that this group achieved a higher than average response than the sample for sixteen of the eighteen Barriers.

Also, there was a statistically significant positive relationship between those who indicated they had never undergone any official ICT training - their responses to '*Lack of ICT training & experienced (knowledge, awareness & skills)*' - and '*Having limited or no ICT training opportunities within your company/team*', indicating these issues were highly influential Barriers to implementation or use of ICT on projects.

The Barriers/Limitations issues of least influence (Total Mean) were found to be:

1. *'Your company's perception that ICT is not part of its core business'.*
2. *'Inconsistent employee requirements on projects'.*
3. *'Not having an ICT implementation "Champion" on a project'.*

The following Barrier/Limitation issue pairs were found to be statistically significant for correlation:

- *'Security issues (re project data, access etc.)*' and '*Confidentiality issues (re shared project data)'; and*
- *'Lack of ICT training & experience (knowledge, awareness & skill)' and 'Having limited or no ICT training opportunities within your company/team'.*

The most significant observations from the survey results are that annual turnover has an effect on both the uptake of ICT and training performance in ICT for an organisation. That is

budget constraints impact directly on ICT access, use and the training needs according to the respondents.

Identified effects of budget on uptake and/or current ICT status include:

- In general, higher ICT investment was observed for higher annual turnover organisations;
- In general, higher ICT investment, hence annual turnover organisations, have a higher rate of use or access to emerging or innovative ICTs such as Handheld and Tablet computers, Video Conferencing and Wi-Fi devices; and
- The most significant Barrier/Limitation to the implementation or use of ICT on projects was budget constraints.

Identified effects of budget on ICT training include:

- Lower turnover construction organisation respondents are less likely to have undergone ICT training;
- Lower turnover construction organisations are less supportive of ICT training through flexible workload and time allocation; and
- Higher turnover organisations have a greater preference for the professional consultants mode of training and conversely, lower turnover organisations have a greater preference for self learning.

Technical issues such as interoperability (incompatibility) and not having an ICT professional on site or within ready access were found to be strong influential Barriers to the uptake of ICT on projects for most respondents.

The overriding driver for ICT uptake for respondents, was to improve their operational performance through improved productivity at both the personal level and the organisational /team level. Improved strategic performance was also high the agenda for respondents, with the driver of improving business opportunities ranking highly.

There is a clear need for simple ICT solutions to be developed that can be implemented without substantial infrastructure needs and can be remotely managed. In addition, there is a need for the value of ICT implementation to be demonstrated to industry to encourage uptake.

1 INTRODUCTION

This report documents the analysis of a survey of ICT related issues in the Australian construction industry conducted in November 2003. The survey targeted three broad areas:

- Current ICT status including annual ICT investment, access to and use of ICT devices;
- ICT training including training participation by individuals, training support within respondent organisations with regards to workload and time flexibility for employees, preferred mode of training for individuals, and level of ICT competence expectations of the various construction project participants; and
- ICT trends and opinions on the Benefits/Drivers and Barriers/Limitations to the implementation and use of ICT on construction projects.

1.1 Aim

The aim of this report is to investigate on a National (Australia) basis within the construction industry - including Non-building, Building (Commercial/Industrial), and Residential sub-sectors - various ICT issues, with a view to informing the decision makers within the construction industry on ICT policy relating to:

- The types of ICT being used across construction industry sub sectors and various project sizes, to identify possible improvements through ICT uptake;
- The preferred mode of training amongst construction industry employees, to implement suitable ICT training regimes for employees; and
- The Benefits/Drivers and Barriers/Limitations to the uptake of ICT on construction projects, to identify suitable ICT implementation strategies for construction organisations.

2 METHODOLOGY

The survey reported here was carried out using web based survey methodology. An email was sent to potential respondents with a web link embedded enabling respondents to hotlink to the survey web server. Respondents were asked to complete each of the four sections and submit the responses - which were stored in the web server. After the nominated survey closing date the responses were forwarded for analysis by the project team.

2.1 Survey Development

A pilot survey was carried out using the adopted methodology to test both the medium and a range of questions. The pilot survey was equivalent in length to a 14-page mail survey and was made available to members of the Queensland Department of Public Works and the Queensland Main Roads Department databases to complete. A selection of the descriptive analysis of the pilot survey can be viewed in APPENDIX A – PILOT SURVEY.

The national survey was developed based on the responses to the questions in the pilot survey and discussions within the project team including input from the project partners (Non-Research). The two overriding concerns raised were the survey length and the suitability of questions in obtaining appropriate data for the research questions.

The survey question selection process led to a reduction in the number of questions relating to the respondents' personal and company information and helped identify a reduced set of issue specific questions that would not only meet the survey requirements, but the overall

project objectives as well. In the end, the final survey was reduced in size considerably to a 4-page document, which minimised the effort required by respondents.

General principles for survey questionnaire construction adopted were:

- Use of short and concise questions;
- Avoidance of leading questions;
- Avoidance of double-barrelled questions;
- Avoidance of questions that are beyond the respondents capabilities or knowledge;
- Relevance of questions to the research problem; and
- Avoidance of ambiguity, confusion and vagueness.

These measures would help minimise non-sampling error. Careful choice of questions was made to facilitate triangulation of the responses for the two surveys to enable use of pilot survey data if required to clarify results. Care was taken with the formation of questions in order to create a non-biased survey to ensure the respondent was not influenced in anyway to ensure validity and reliability of the survey. Most questions were closed questions with the response types being generally ordinal or nominal enabling respondents to easily and quickly complete the questionnaire. The question development was completed with industry involvement to insure the relevancy of the survey questions.

2.2 Survey Sample Frame

The population for the survey was defined as members of the Australian Construction Industry in 2003 however, the sample frame was limited to those known to have an IT capacity. It was believed that the sample frame would be representative of the general population. The sample frame consisted of all members of two construction industry contact databases made available for the survey. In all 467 potential respondents were emailed informing them how they were chosen for the survey, who is carrying out the research and the research objectives. Data collection was completed by 14th November, 2003.

2.3 Analysis Methodology

A preliminary analysis plan was prepared with the research objectives in mind and based on the pilot survey analysis. This ensured appropriate data was collected - particularly when considering likely differential factors. Development of the analysis plan also helped in limiting the questions asked thus reducing the burden on the respondents.

The response types were generally ordinal or nominal. However, the category scales used were chosen to allow responses to be treated as interval (continuous) data, thus enabling use the more powerful statistical tests to be carried out, where deemed useful. Both parametric and non-parametric tests were carried out on most question responses to check that the analysis results weren't spurious.

Parametric tests are more statistically powerful than their non-parametric counterparts, however, for them to be reliable, certain underlying assumptions need to be met. The responses were tested to determine how well they met the basic underlying assumptions of normally distributed responses and equal variance. For normality, the data was subjected to the Kolmogorov-Smirnov and Chi-squared test of normality and for variance equality a ratio of sample variance F-test and Bartlets-test of equality of variances were used.

Where the results of the tests of the underlying assumptions were marginal the data was also subjected to non-parametric tests. Although the non-parametric test equivalents to the parametric tests are generally lower on power, they are free of the assumptions regarding the distribution of the data, and so serve to either support or dispute the results.

Descriptive statistics in the form of frequency and univariate analysis were performed to describe the response data. Measures of central tendency and dispersion, histograms, and frequency distributions provided a summary of the data and allow preliminary assessment of the parametric qualities of the data. Further to this, an assessment was made whether statistically significant differences were identifiable, based on the factors that were determined. Measures of association used predominately correlation analysis, Spearman's Rho - which is a measure of the correlation of the ranks of the data rather than the values - and Somers' d - which is a measure of association between two ordinal variables that ranges from -1 to 1. Like correlation analysis, values close to an absolute value of 1 indicate a strong relationship between the two variables, and values close to 0 indicate little or no relationship between the variables with a positive statistic indicating a positive relationship. Measures of differences used predominately Chi-squared tests. These tests are non-parametric tests.

The significance level for the tests was nominally at the 0.05 level. All tests were two-tailed, looking for any difference in the statistic concerned. The statistical analysis was carried out using SPSS statistical analysis package together with Microsoft Excel.

2.4 Data

Prior to analysis, the survey data was put through a process of data cleansing where:

- Every question was checked to ensure the response was of the appropriate type (consistency);
- All relevant questions were completed (completeness); and
- Duplications were identified and, after verification, removed.

Missing values were ignored rather that imputed and only valid answers to a question were analysed. This meant that the sample size differed between questions and it might be difficult to draw inferential conclusions about the population. The data was then coded for analytical purposes.

The response analysis factors are detailed in Table 1 below.

Table 1 Survey analysis factors

Factor	Description	Categories
Size	Size of organisation – based on turnover	
State	The state in which the respondent works	
Role	The current position of the respondent	Administrative, Professional, Technical, Manager, Other
Class	Main classification of the respondents company	Client, Consultant, Contractor, Sub-contractor, Supplier
Industry sector		Non-building, Building, Residential
Years service	Length of time in the current position	< 10 years 10 or more years

3 RESPONDENT PROFILE

This section looks at the respondent profile. Knowledge of respondent profile allows the identification of categories for further analysis. To gain the required respondent profile the following areas were investigated through survey:

- Loacation by State;
- Educational background;
- Current role within organisation;
- Length of service with current organisation;
- Organisation's annual turnover; and
- Sub-sector within the construction industry.

In all 78 respondents registered and completed the survey. This represents a response rate of 16.7%, which is considered quite reasonable for this type (email) of survey.

3.1 Respondent Geographical Distribution

Each respondent was asked to complete contact details for the purpose of response verification if required. This information was also used to identify the respondent's State. Figure 1 shows the respondents were predominately (67%) from Queensland while NSW and Victoria provided in combination approximately a quarter of respondents.

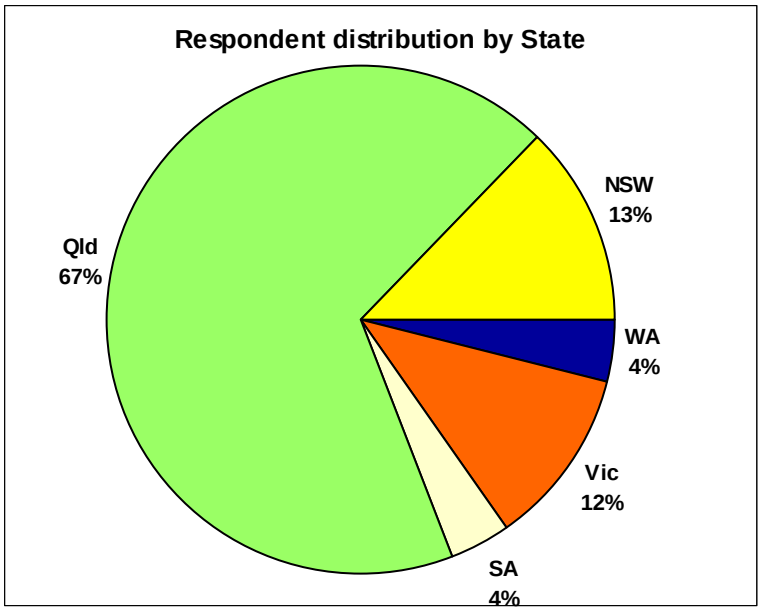

Figure 1 Geographical distribution of the respondents

3.2 Respondent Educational Distribution

Respondents were asked to indicate the highest level of education completed from a defined list of responses. Only one respondent chose not to answer this question. Of those who responded, 78% had some form of tertiary qualification, a Bachelor degree having the highest frequency with 32% of the total responses - with the respondent distribution detailed in Figure 2.

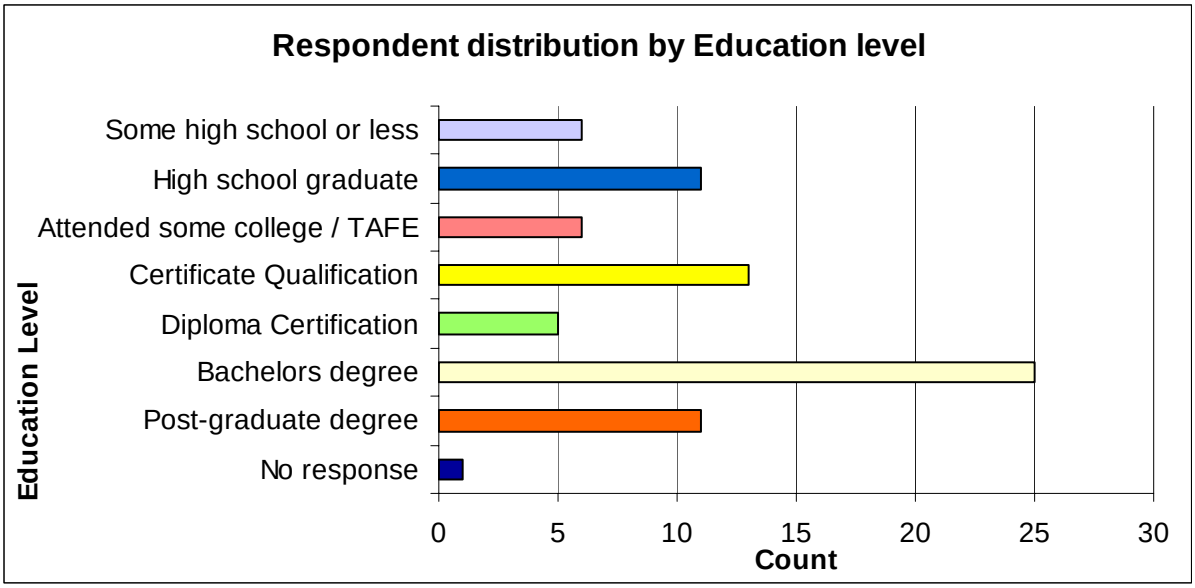

Figure 2 Respondent distribution by highest level of education completed

3.3 Respondent Role Distribution

Respondents were asked to indicate their current position. This question was an open question format and the responses were grouped arbitrarily into role categories. The categories included Technical, Manager, General and Administrator. The positions listed in the respondents were wide ranging and are listed in Figure 3. Respondents predominately (71%) were in a managerial role. Original survey responses and their arbitrary role categories are provided in APPENDIX B – CURRENT POSITION.

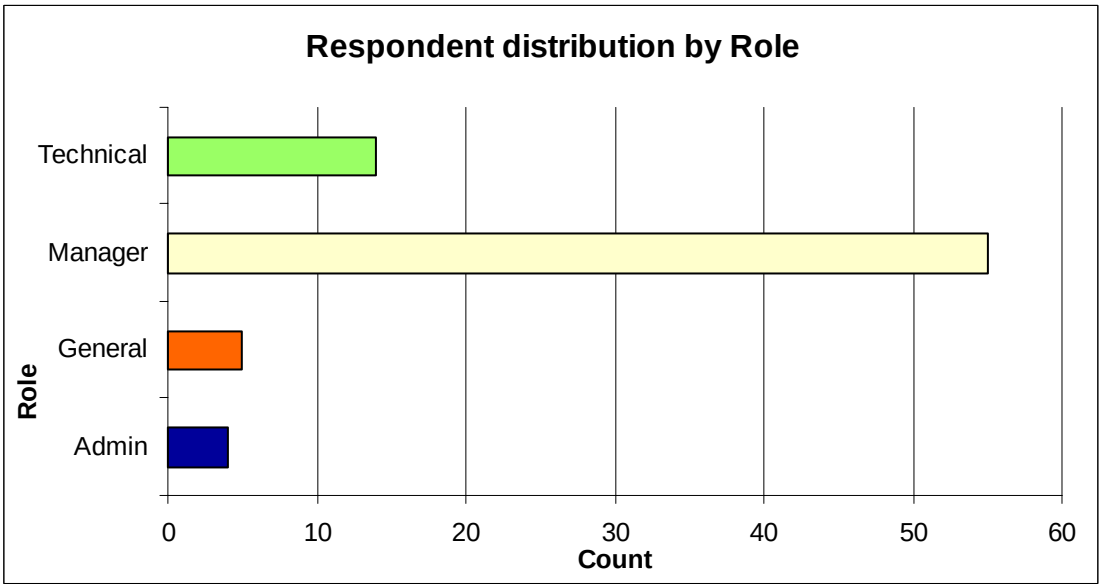

Figure 3 Respondent distribution by role

3.4 Respondent Years-of-Service Distribution

Respondents were asked to indicate how long (years) they have been working in their present position. The distribution can be seen in Figure 4.

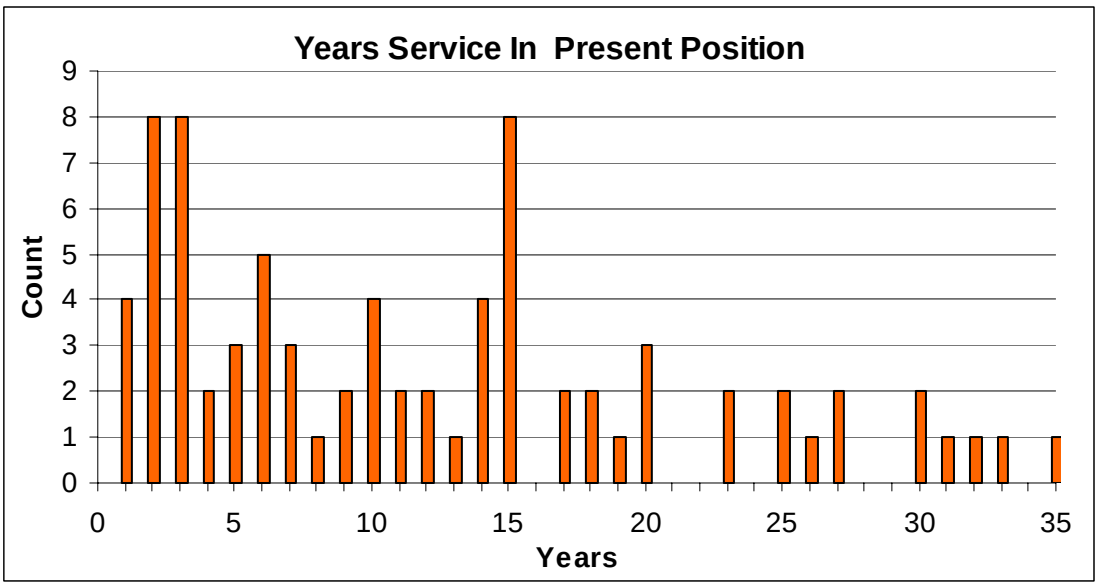

Figure 4 Years service

Respondents were grouped into two groups for analytical purposes, group one contained all who have had less than ten years service, and group two contained the remainder.

3.5 Respondent Organisation Classification Distribution

Respondents were asked to nominate their company's main classification from a selected list. Figure 5 shows the majority (63%) of respondents were in a contracting organisation i.e. either a Sub-contractor (12%) or Contractor (51%), with Consulting organisations making up the second largest single category with 29%.

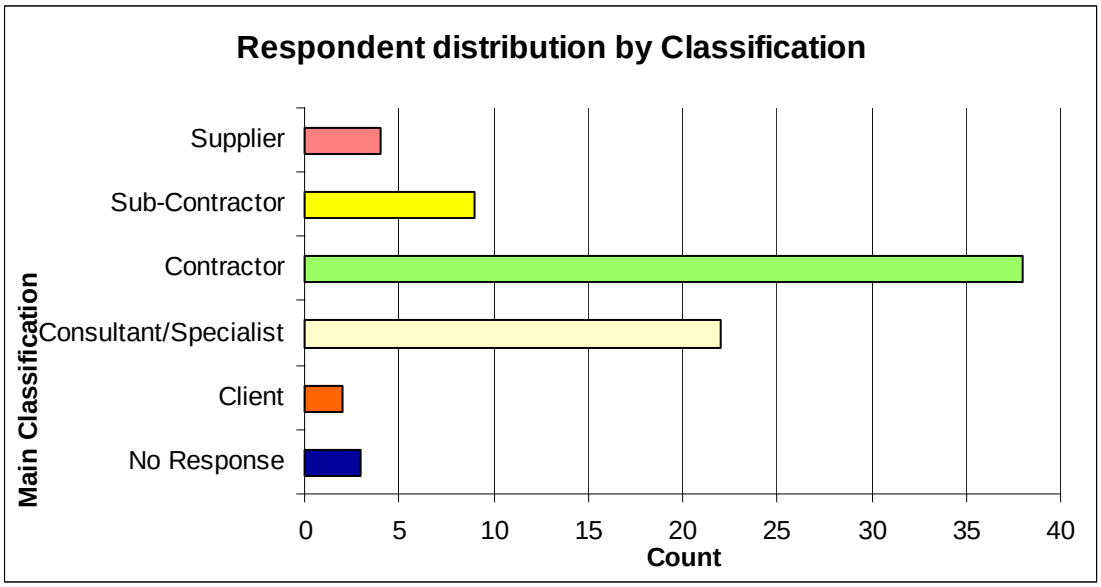

Figure 5 Respondent companies main classification

3.6 Respondent Organisations Annual Turnover Distribution

Respondents were asked to indicate from a specified list their companies average annual turnover. Six respondents did not know and Figure 6 shows, that of those who indicated their annual turnover, 38% nominated less than $500,000 with a further 29% indicating a turnover range between $1M and $5M. This indicates in general that the respondents were

predominately from the smaller turnover organisations, with a total of 74% having annual turnover's less than $5M.

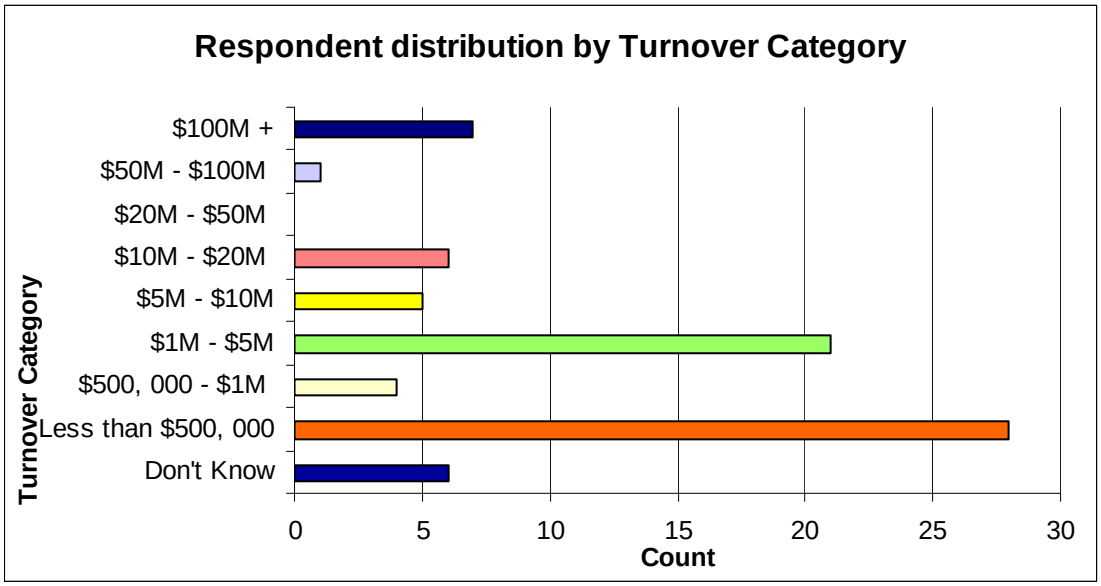

Figure 6 Respondent distribution by turnover category

3.7 Respondent Sub-Sector Distribution

Respondents were asked to indicate in which industry sector their company operates. Respondents were able to nominate any or all of the three alternatives. Figure 7 shows one respondent did not respond however, of those who did respond, 80% indicated Building construction, Residential construction or both Building and Residential construction sectors. This indicates that the majority of respondents are involved in the vertical/Building construction industry, and only 9% indicated involvement in Non-building construction. A further 9% indicated that they were involved in all sub-sectors of the industry.

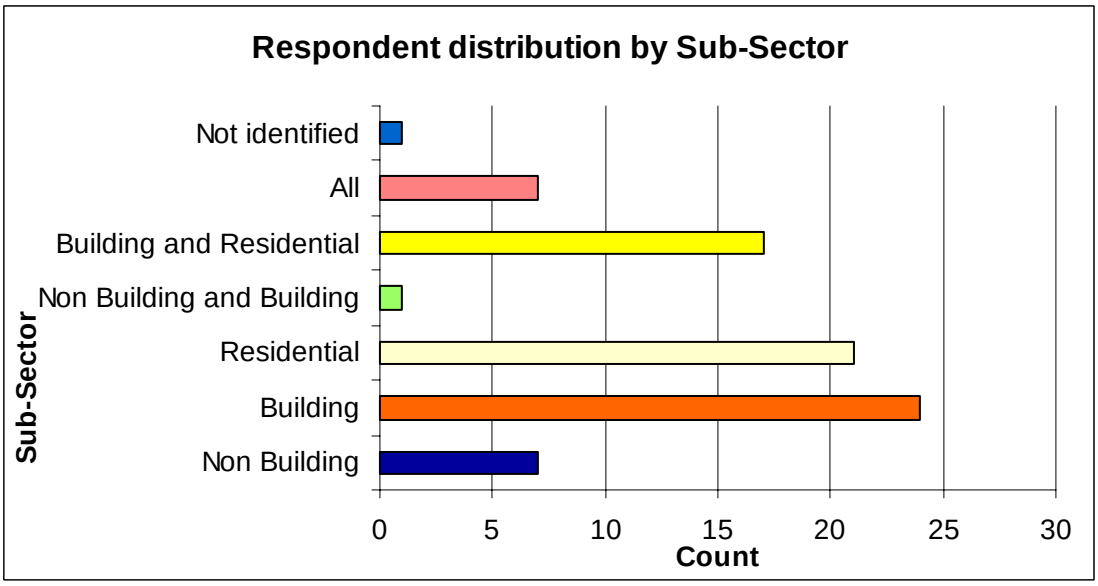

Figure 7 Respondent industry sub-sector

Closer examination of the respondents, as revealed in Table 2, showed 3 of the 7 respondents that indicated they were in the Non-building construction sector had an annual turnover of $100M+.

Table 2 Respondent industry sector by company turnover

	Don't Know	Less than $500, 000	$500, 000 - $1M	$1M - $5M	$5M - $10M	$10M - $20M	$20M - $50M	$50M - $100M	$100M +	All
Non-building			1		1	2			3	7
Building	1	4	1	11	3	1			3	24
Residential	1	11	2	6				1		21
Non-building and Building						1				1
Building and Residential	3	8	1	3		2				17
All	1	3		1	1				1	7
Not identified		1								1
Total	6	28	4	21	5	6		1	7	78

3.8 Respondent Profile Summary

The following list provides a summary of the respondent profile:

- 92% of respondents were from the East Coast of Australia;
- 78% of respondents have some form of Tertiary Qualification;
- 71% of respondents were in some form of managerial role within their organisation;
- All respondents had greater than 1 year and 54% had at least 10 years service in their present position;
- 63% of respondents were from a contracting organisation and 29% were from a consultant/specialist organisation with the remaining 12% being spread between Supplier and Client organisations;
- The majority (74% of those who knew the organisation's annual turnover) of respondents organisations had annual turnover's of less than $5M and 10% of respondents organisations had an turnover's of $100M+ or greater; and
- At least 80% of respondents were from the Vertical/Building construction sub-sectors.

4 SURVEY ANALYSIS RESULTS

In general, three broad areas were investigated for this survey report:

- ICT Status - including investment commitment to ICT, access and use of specific ICT devices and relationships between ICT investment and several factors including annual turnover and access to more emerging or innovative ICT devices;
- ICT Training - including ICT training participation, ICT training mode preference, industry expectations of ICT competence amongst project participants, and further investigation into multivariate relationships - mainly the effect of annual turnover on ICT training issues; and
- ICT Trends and Opinions - including Benefits/Drivers and Barriers/Limitations to ICT implementation or use on projects for Total Mean and sub-sector groups, correlation analysis between Benefit/Driver and Barrier/Limitation issues.

The following sections outline the results to questions targeting the various areas mentioned above and discusses the most pertinent and significant results.

4.1 Current ICT Status

This section investigates the respondents, and respondent's organisations where appropriate, current ICT status including:

- ICT organisational investment: including further analysis of ICT investment according to sub-sector and annual turnover; and
- ICT device access and use: including use and access for various devices, access and use of emerging/innovative technologies by annual turnover.

Finally a summary of all the interesting and significant results are summarised in section 4.1.3.

4.1.1 ICT Organisational Investment

Respondents were asked to specify how much their company currently invests in ICT annually. The amount spent varied considerably from $500 to $1,000,000 with the most frequent amount specified being $2000. The factors expected to be influential on ICT investment included annual turnover and the industry sector. Figure 8 displays the distribution of the respondents organisations annual ICT investment commitment by turnover category. The categories were arbitrarily set at greater than $10M, between $10M and 1$M and less than $1M. A further category (Don't Know) is provided to cover respondents (three of) that did not know their organisations annual turnover.

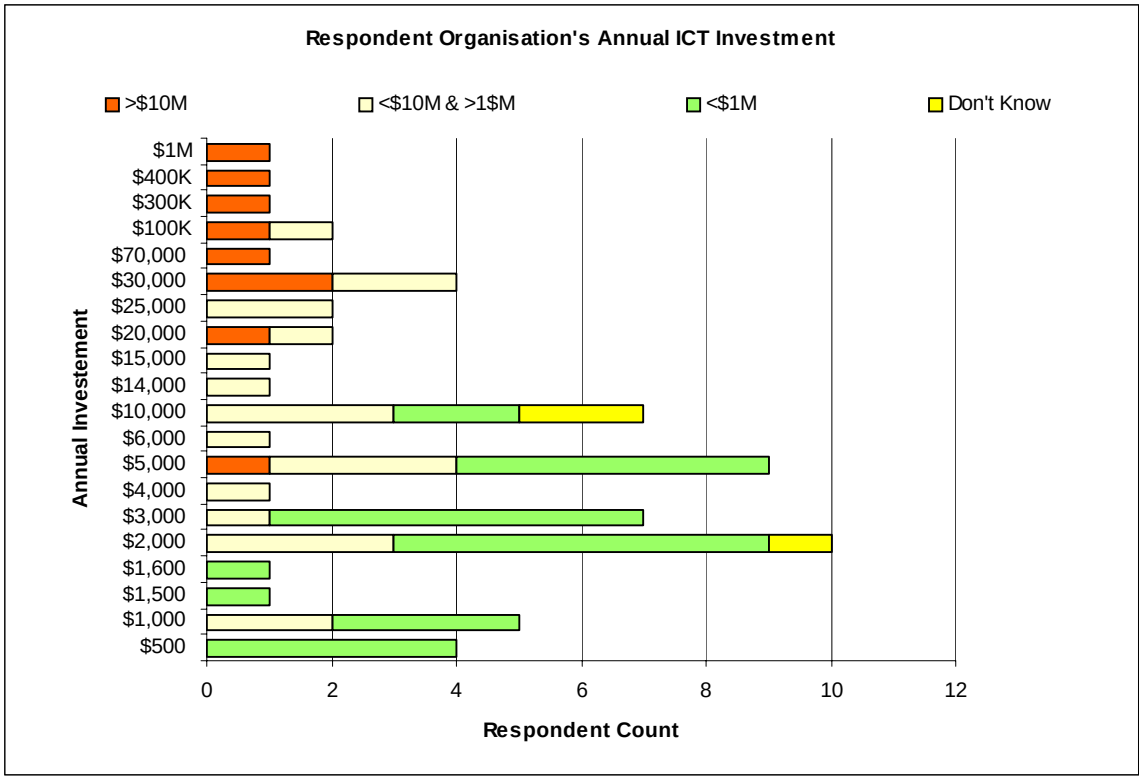

Figure 8 Distribution of ICT investment amount by annual turnover category

To test whether a relationship existed between the annual investment in ICT and annual turnover ranges, a correlation test was carried out. The annual turnover responses were coded from 1 to 9 with 1 being the lowest turnover category and 9 being the highest. The correlation statistic used for this test was the Spearman's Rho. The analysis between annual turnover (coded) and ICT investment indicated a positive relationship exists (Spearman's rho 0.51, Correlation is significant at the 0.01 level). It is worth remembering that a proportionally

higher number of respondents from the Non-building sector were also represented in the higher turnover ranges, which could be confounding the results. Other factors as documented earlier were tested for relationships however, no other relationships were statistically significant.

4.1.2 ICT Device Access & Use

Respondents were asked to identify which ICT devices, from a specified range, they have access to within their company and subsequent to this, which of these devices they used on a range of project sizes. Details of project size the respondent participates in was not readily obtained, thus the data were pooled and analysed for any project size. Responses for both of these questions are illustrated in Figure 9 below. The chart is ordered by usage rate.

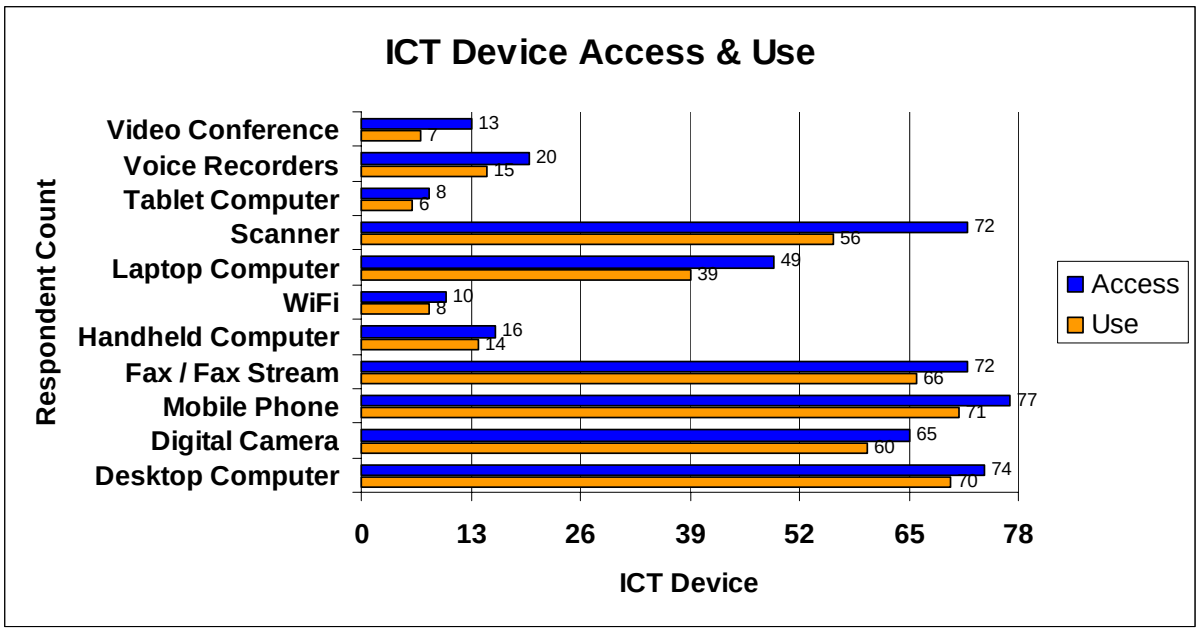

Figure 9 ICT access and usage

The list provides a range of ICT technologies, some ICT technologies such as Desktop computer, Mobile phone, Scanner, Fax and Digital camera are established technologies and according to the responses are accessible by most respondents. Based on the responses, these technologies are widely used on construction projects. When considering emerging technologies such as Wi-Fi, Handheld and Tablet computers, and Video Conference equipment, the analysis revealed that the amount of annual ICT investment of the companies apparently impacts on accessibility. Organisations with higher investment budgets have a higher proportion of these emerging technologies. This is illustrated in Figure 10 below which displays the distribution of access to handheld computers according to the ICT investment category. This chart shows that 83% of the respondents with an annual ICT investment budget greater than $50,000 have access to handheld computers compared with only 4% of those with an ICT budget of less than $10,000. A similar pattern is revealed when analysing technology usage for other emerging technologies.

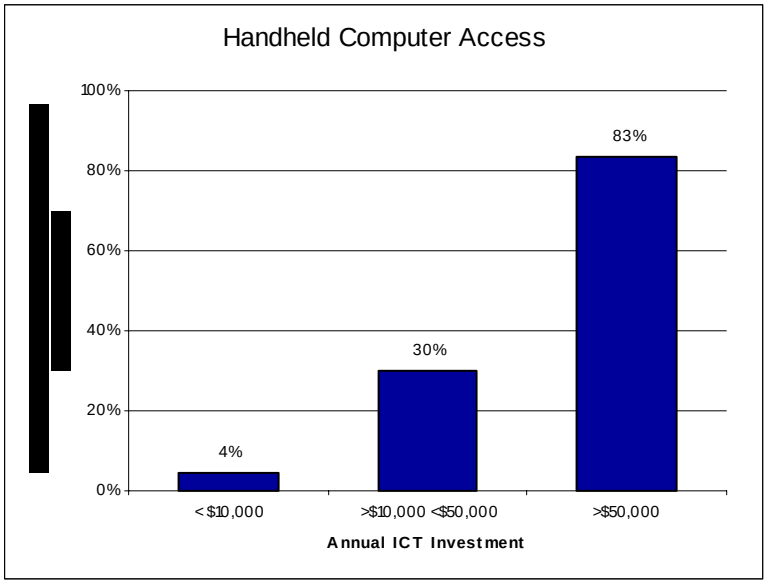

Figure 10 Distribution of Handheld computer access

4.1.3 Summary Current ICT Status Results

Annual investment in ICT amongst respondents ranged from $500 to $1M. The most frequent response being $2000/year. It appears that ICT investment is relative to Annual Turnover where, not unexpectedly, the higher turnover organisations invest more money on ICT. Further analysis revealed that 83% of companies with an annual ICT investment of $50k or greater had invested in Handheld computers with similar results were found for other emerging technologies.

There was a positive correlation between the annual turnover of the respondents company and the annual ICT investment, indicating that those with a higher turnover were more likely to invest more in ICT than those with a lower turnover. However, the relationship was not clearly linear. In general though, it would appear that the budget of organisations has a distinct influence on their current ICT status, where the higher budget organisations are spending more on ICT. This appears to have a flow on effect allowing them to be more innovative in utilising emerging technologies such as Handheld and Tablet computers, Video Conferencing, and Wi-Fi.

4.2 ICT TRAINING

This section investigates the ICT training characteristics of the respondents and respondent's organisations including:

- Official ICT training participation - including overall participation, participation considering annual turnover, and participation variability in the sub-sector groups;
- ICT training company support - including whether the respondents were allowed time or workload flexibility to undergo ICT training, sub-sector analysis was also completed;
- ICT training mode preference - including analysis dependent on annual turnover ranges;
- ICT competence expectations - including respondent's expectations dependent on sub-sector group.

Finally a summary of the interesting and significant results are summarised in section 4.2.5.

4.2.1 Official ICT Training Participation

Respondents were asked to indicate whether they had undergone any official ICT training. Almost half (49%) of the respondents indicated they had undergone official training. When comparing responses by the company classification, Sub-contractors were more likely to have never undergone official training. Larger ($100M+ turnover) organisations had a higher proportion of respondents indicating they had undergone official training, as did respondents who indicated their core sector was Non-building construction (both 5 out of 7). While worthy of note, these were not statistically significant findings.

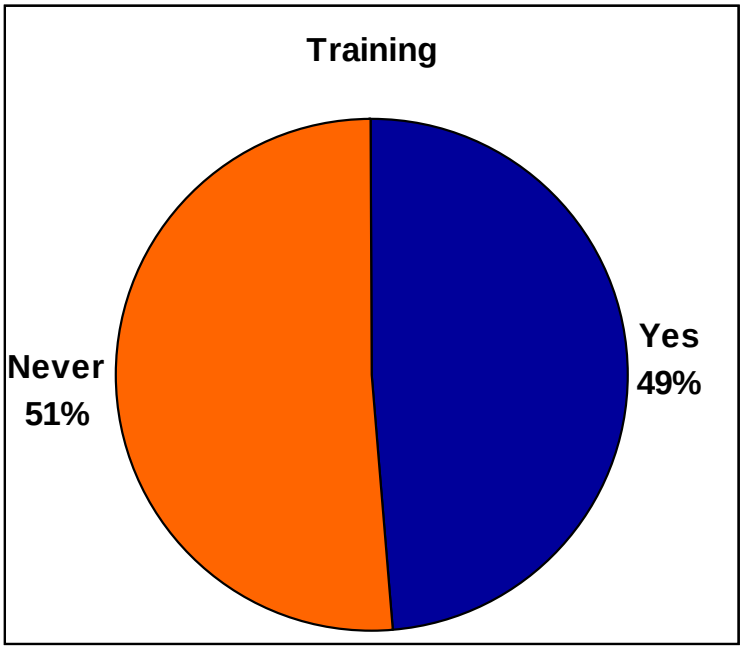

Figure 11 Proportion of respondents who had undergone official ICT training

4.2.2 ICT Training Company Support

Respondents were asked to indicate whether their company allowed them sufficient time during office hours to undergo ICT training. Over half (44 of the 78) of the respondents indicated their company did allow them sufficient time during office hours to undergo ICT training. Although respondents from the Residential construction sector were less likely to be provided adequate time for training (13 out of 21), this was not a statistically significant finding. Respondents were also asked whether their company adjusted/reduced their workload to undergo ICT training - with only 10 respondents indicating their company did adjust/reduce their workload. Interestingly, 6 of those were from companies with a turnover range between $1M - $5M.

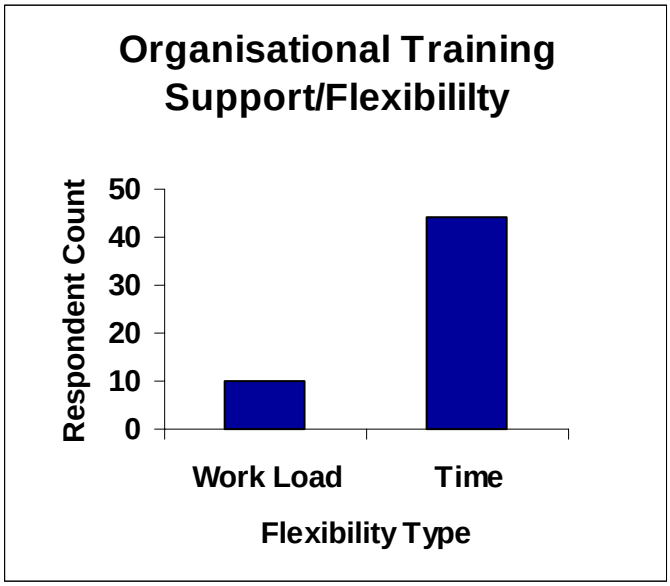

Figure 12 Organisational training support

Overall, only two had undergone official ICT training and had been allowed sufficient time and had their workload adjusted to undergo training. Conversely, 18 respondents indicated they had not undergone any official ICT training or received any adjusted workload or time to undergo ICT training. The Residential building sector was heavily represented in this group.

Based on the responses 59 respondents indicated they either, have had either official training or have had their workload reduced, or been allowed sufficient time during work hours to undergo training, implying at least 76% have undergone some kind of training.

4.2.3 ICT Training Mode Preference

The respondents were asked to nominate their preferred mode of training from a selected list. As is evident in Figure 13, the preferred training mode was with professional consultants, with 46% of respondents nominating this method.

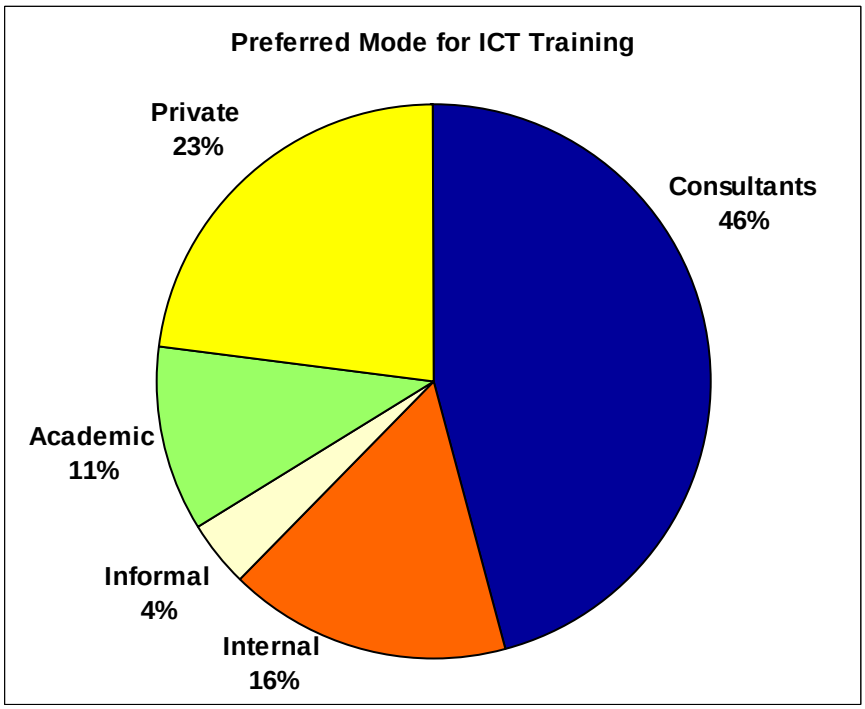

Figure 13 Preferred mode of training

The two respondents who had undergone official ICT training and had been allowed sufficient time and had their workload adjusted to undergo training, both indicated a preference for training with professional consultants. This preference was supported by the 18 respondents who indicated they had not undergone any official ICT training or received any adjusted workload or time to undergo ICT training.

Figure 14 shows the response trend for preferred mode of training dependent on the respondent's turnover classification. The chart shows an increasing preference for professional consultants as the annual turnover category increased. 86% of respondents from the higher turnover categories indicated a preference for training mode with professional consultants compared with the lower turnover categories, where 52% indicated a preference for private training.

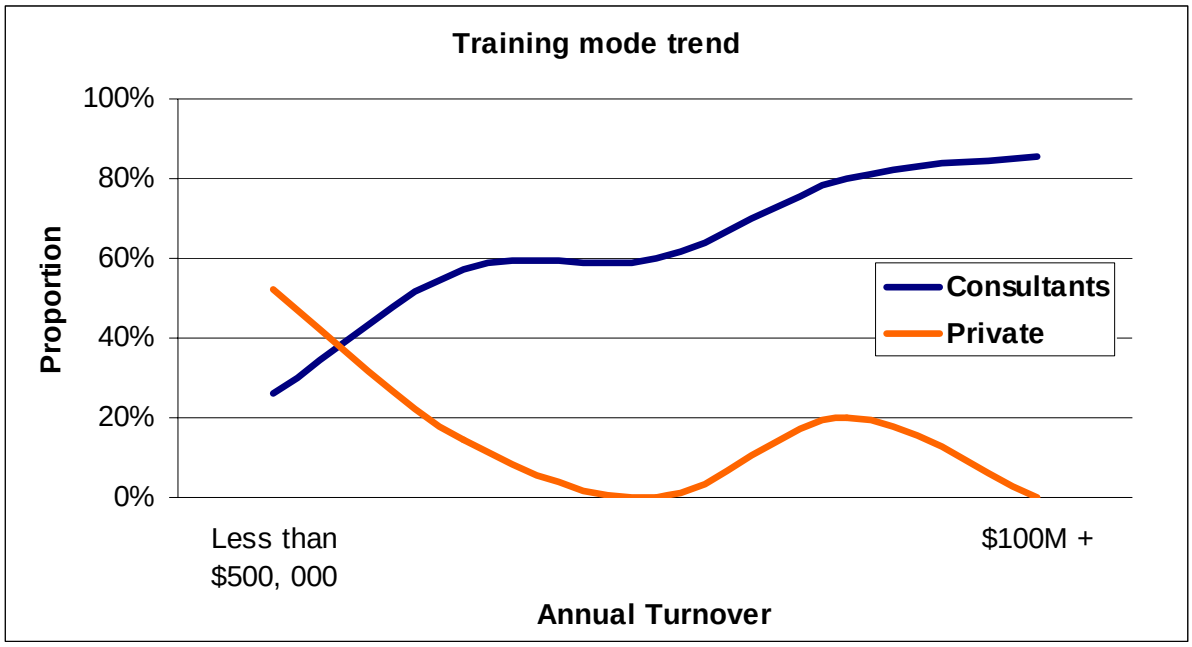

Figure 14 Training mode preference trend

4.2.4 ICT Competence Expectations

Respondents were asked to indicate what overall level of ICT competence (capabilities, skills, etc) they believed specific team members should have on a project. Overall respondents expect the consultant to have a greater level of ICT competency than all other team members. This result was statistically significant. Contractors and Suppliers were rated next with Clients and Sub-contractors rated lowest however, still expected to have at least average competence.

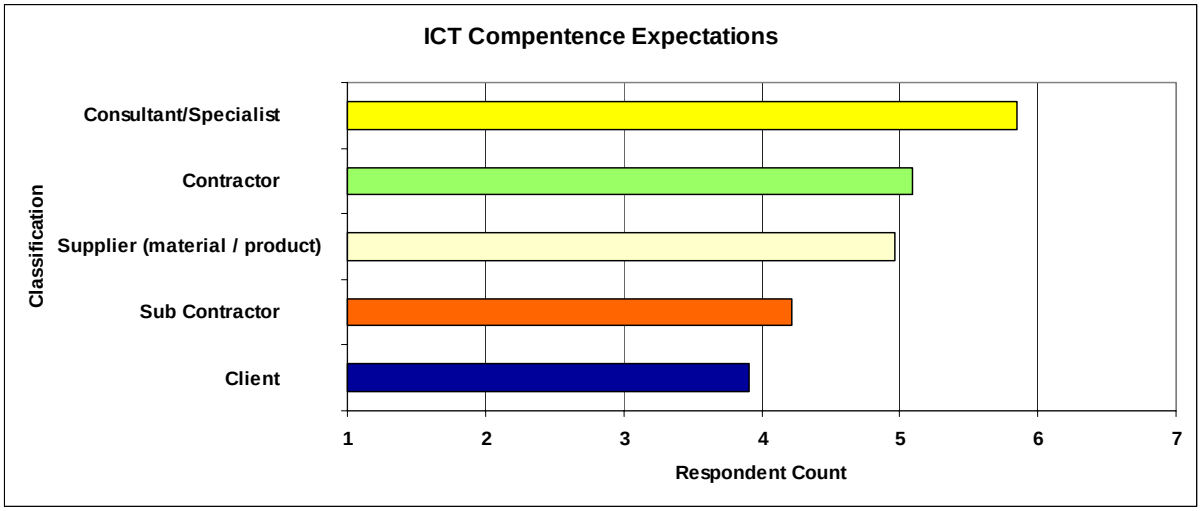

Figure 15 Average responses for overall level of ICT competence

When comparing the responses dependent on the role of the respondent it was apparent that those in managerial roles tended to expect a higher competency from all team members than did other groups. This was not a statistically significant finding. When comparing responses based on the respondent class, Sub-contractors tended to expect a greater level of competency from Sub-contractors in general than did other groups. They also expected a higher level of competency from Contractors than other groups.

4.2.5 Summary ICT Training Results

Almost half (49%) of respondents indicated that they had undergone official ICT training. However, it was found that 76% had indicated either directly and/or indirectly through subsequent questions, that they had undergone some form of ICT training. The Sub-Contractor group was found to have the lowest numbers to have undergone any official ICT training.

Further investigation revealed a proportional trend between an organisation's annual turnover and the participation rates in ICT training. Another relationship which highlights the effect of annual turnover on ICT training, was the Residential sub-sector having the lowest positive responses to the question on whether sufficient time is allowed to undergo ICT training during work hours. Almost all (95%) of the Residential sub-sector respondent organisation's had turnovers of less than $5M.

The majority (46%) of respondents preferred to undergo ICT training with professional consultants. A proportional trend was found between an organisation's annual turnover and preference for professional consultant mode of ICT training. Also, there appeared to be an inversely proportional relationship between preference for private self taught training and annual turnover. However, both of these observations were not statistically significant.

Overall, respondents expect Consultants/Specialists to have the highest level of ICT competence and all project participants to have at least an average level of competence. Further investigation found that Managers expect a higher level of competence from team members than did other role types. Another result of interest was that Sub-contractors expect a higher level of ICT competence from themselves and Contractors than did other classes of organisation.

4.3 ICT TRENDS & OPINIONS

This section firstly investigates the results of the analysis on the Benefits or Drivers to the implementation or use of ICT on construction projects. Secondly, the results of the analysis into the Barriers or Limitations to the implementation or use of ICT on construction projects is presented. Both sections are structured as follows:

- An overall response is graphically presented and interesting or significant results are discussed;
- Correlation analysis results between the various issues are graphically presented and interesting or significant results are discussed; and
- Further investigation into the results according to construction sub-sector is graphically presented and interesting or significant results are discussed.

Finally a summary discussion is provided including all the interesting or significant results found for both sections.

4.3.1 Benefits/Drivers for ICT on Projects

Respondents were asked to indicate what influence a specified range of Benefits/Drivers has on their decision to implement or use ICT on projects.

The issues presented included:

Benefit 1. To help improve overall team/company efficiency (productivity).
Benefit 2. To help enable electronic banking etc (eCommerce).
Benefit 3. To help enable electronic tendering (eTender).
Benefit 4. To help enable electronic archiving of documentation (eArchive).
Benefit 5. To help set up a dependable ICT infrastructure within your company.
Benefit 6. To help become Industry leaders in ICT adoption.
Benefit 7. To help downsize or become a leaner company/team.
Benefit 8. To help increase business opportunities.
Benefit 9. To help gain increased efficiency (improved productivity).
Benefit 10. To help support industry Research and Development.
Benefit 11. To help receive tangible rewards (pay/job advancement).
Benefit 12. To help receive intangible rewards (respect, self fulfillment).

The response options ranged from no influence at all to highly influential with a total of seven rating options.

The mean response rating for most issues was above average suggesting that most issues were influential in their decision to implement or use ICT on projects. The only issue with a below average mean response was '*To help become Industry leaders in ICT adoption*'. The mean response for the issues is displayed in Figure 16 below.

The chart shows the issue with the highest mean rating was '*To help gain increased efficiency (improved productivity*)' followed by '*To help improve overall team/company efficiency (productivity)*' and '*To help increase business opportunities*'.

Based on the sample error the results showed a statistically significant difference in the mean response between issues, with the top three issues being significantly different to the bottom six issues. This result suggests that the top three issues are likely to be the most influential for the population in general.

The issues found to be of least influence, in order of influence include:

- *'To help become industry leaders in ICT adoption';*
- *'To help enable electronic tendering (eTender)';* and
- *'To help downsize or become a leaner company/team'.*

Essentially, respondents perceive ICT to provide productivity Benefits to their project operations, both at the individual and team/company level. They also perceive some strategic Benefits in the way of improved business opportunities that the ICT may provide.

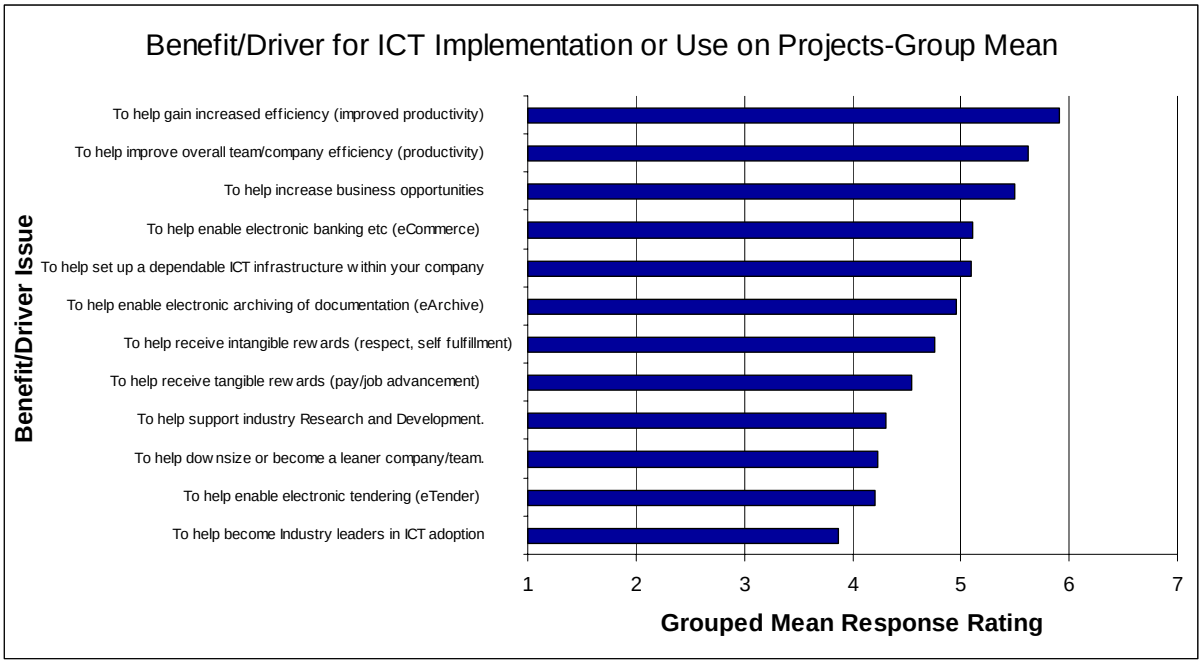

Figure 16 Mean response for Benefits/Drivers influencing ICT implementation

Correlation analysis confirmed the consistency by the respondents with regards to the Benefits/Drivers listed. Figure 17 contains the correlation coefficients and the significance levels along with the number of respondents for each issue. The issues are numbered according to the order of appearance in the survey form and as listed above. The issues '*To help gain increased efficiency (improved productivity*)' and '*To help increase business opportunities*' achieved a strong positive correlation as did the issues '*To help improve overall team/company efficiency (productivity)*' and '*To help gain increased efficiency (improved productivity*)', in both cases the correlation coefficient was greater than 0.7 and significant at the 0.01 level.

Correlations

			BENEFIT1	BENEFIT2	BENEFIT3	BENEFIT4	BENEFIT5	BENEFIT6	BENEFIT7	BENEFIT8	BENEFIT9	Benefit10	Benefit11	Benefit12
Spearman's rho	BENEFIT1	Correlation Coefficient	1.000	.180	.318**	.577**	.611**	.343**	.464**	.648**	.724**	.452**	.381**	.379**
		Sig. (2-tailed)	.	.120	.005	.000	.000	.003	.000	.000	.000	.000	.001	.001
		N	76	76	76	75	75	75	72	75	76	75	76	76
	BENEFIT2	Correlation Coefficient	.180	1.000	.342**	.399**	.214	.156	.139	.308**	.359**	.245*	.143	.206
		Sig. (2-tailed)	.120	.	.002	.000	.065	.182	.240	.007	.001	.034	.216	.072
		N	76	77	77	76	75	75	73	76	77	75	76	77
	BENEFIT3	Correlation Coefficient	.318**	.342**	1.000	.442**	.360**	.260*	.220	.252*	.359**	.416**	.346**	.371**
		Sig. (2-tailed)	.005	.002	.	.000	.001	.024	.062	.028	.001	.000	.002	.001
		N	76	77	77	76	75	75	73	76	77	75	76	77
	BENEFIT4	Correlation Coefficient	.577**	.399**	.442**	1.000	.677**	.373**	.363**	.521**	.558**	.463**	.322**	.411**
		Sig. (2-tailed)	.000	.000	.000	.	.000	.001	.002	.000	.000	.000	.005	.000
		N	75	76	76	76	74	74	72	75	76	74	75	76
	BENEFIT5	Correlation Coefficient	.611**	.214	.360**	.677**	1.000	.537**	.563**	.681**	.626**	.506**	.385**	.460**
		Sig. (2-tailed)	.000	.065	.001	.000	.	.000	.000	.000	.000	.000	.001	.000
		N	75	75	75	74	75	75	72	74	75	74	75	75
	BENEFIT6	Correlation Coefficient	.343**	.156	.260*	.373**	.537**	1.000	.471**	.393**	.394**	.643**	.424**	.417**
		Sig. (2-tailed)	.003	.182	.024	.001	.000	.	.000	.001	.000	.000	.000	.000
		N	75	75	75	74	75	75	72	74	75	74	75	75
	BENEFIT7	Correlation Coefficient	.464**	.139	.220	.363**	.563**	.471**	1.000	.539**	.505**	.384**	.474**	.429**
		Sig. (2-tailed)	.000	.240	.062	.002	.000	.000	.	.000	.000	.001	.000	.000
		N	72	73	73	72	72	72	73	73	73	71	72	73
	BENEFIT8	Correlation Coefficient	.648**	.308**	.252*	.521**	.681**	.393**	.539**	1.000	.775**	.552**	.547**	.525**
		Sig. (2-tailed)	.000	.007	.028	.000	.000	.001	.000	.	.000	.000	.000	.000
		N	75	76	76	75	74	74	73	76	76	74	75	76
	BENEFIT9	Correlation Coefficient	.724**	.359**	.359**	.558**	.626**	.394**	.505**	.775**	1.000	.508**	.523**	.470**
		Sig. (2-tailed)	.000	.001	.001	.000	.000	.000	.000	.000	.	.000	.000	.000
		N	76	77	77	76	75	75	73	76	77	75	76	77
	Benefit10	Correlation Coefficient	.452**	.245*	.416**	.463**	.506**	.643**	.384**	.552**	.508**	1.000	.502**	.451**
		Sig. (2-tailed)	.000	.034	.000	.000	.000	.000	.001	.000	.000	.	.000	.000
		N	75	75	75	74	74	74	71	74	75	75	75	75
	Benefit11	Correlation Coefficient	.381**	.143	.346**	.322**	.385**	.424**	.474**	.547**	.523**	.502**	1.000	.622**
		Sig. (2-tailed)	.001	.216	.002	.005	.001	.000	.000	.000	.000	.000	.	.000
		N	76	76	76	75	75	75	72	75	76	75	76	76
	Benefit12	Correlation Coefficient	.379**	.206	.371**	.411**	.460**	.417**	.429**	.525**	.470**	.451**	.622**	1.000
		Sig. (2-tailed)	.001	.072	.001	.000	.000	.000	.000	.000	.000	.000	.000	.
		N	76	77	77	76	75	75	73	76	77	75	76	77

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

Figure 17 Correlation analysis results for Benefits/Drivers

When comparing the responses dependent on the analysis factors, there was considerable variability between the core sectors, in particular the responses for the Non-building sub-sector. Due to the small number of respondents in this category the differences, in general, were not statistically significant. Figure 18 below displays the results of the core sub-sector analysis. The Non-building sub-sector respondents perceived '*To help improve overall team/company efficiency (productivity)*' and '*To help gain increased efficiency (improved productivity)*' as the most influential Benefits/Drivers respectively to ICT implementation or use on projects. Other issues, which have a strong influence for the Non-building sub-sector respondents, in order of influence are:

- *'To help set up a dependable ICT infrastructure within your company';*
- '*To help enable electronic archiving of documentation (eArchive)';* and
- *'To help increase business opportunities'.*

It is worthy of note that those in the Non-building sub-sector indicated that "*To help set up dependable ICT infrastructure'* was more influential than "*To help increase business opportunities*" where the overall mean response showed a different result. This sub-sector also rated (4th highest) eArchive capability more influential than did the group mean, which gained a ranking of 6th highest overall. Also worthy of note was that all issues raised had higher than average influence response for the Non-building sub-sector.

Building construction (Commercial/Industrial) respondents perceived '*To help gain increased efficiency (improved productivity)'* and '*To help improve overall team/company efficiency (productivity)'* as being the most influential Benefits/Drivers respectively to implementing or using ICT on projects. Other issues, which have a strong influence for Building construction sub-sector, in order of influence are:

- *'To help increase business opportunities';*
- *'To enable electronic banking etc (eCommerce)';* and
- '*To help set up a dependable ICT infrastructure within your company'.*

These results are in line with the grouped mean response for all sub-sectors where the top 5 issues match in order of influence.

The Residential sub-sector respondents perceived '*To help gain increased efficiency (improved productivity)'* and *'To help increase business opportunities'* as their most influential Benefits/Drivers respectively to ICT use and implementation on projects. Other issues, which have a strong influence for the Residential sub-sector, in order of influence are:

- *'To enable electronic banking etc (eCommerce)';*
- *'To help enable electronic archiving of documentation (eArchive);* and
- *'To help receive intangible rewards (respect, self fulfilment)'.*

It is interesting to note that the Residential sub-sector rated the increase in business opportunity Benefit/driver as more influential than the other sub-sectors. Another interesting result for Residential sub-sector is the relatively high influence rating, compared to the group mean, for the issue '*To help receive tangible rewards (pay/job advancement)*'. It is also interesting to note that the issue '*To help enable electronic tendering (eTender)*' had less influence for those in the Residential construction sub-sector than the other two.

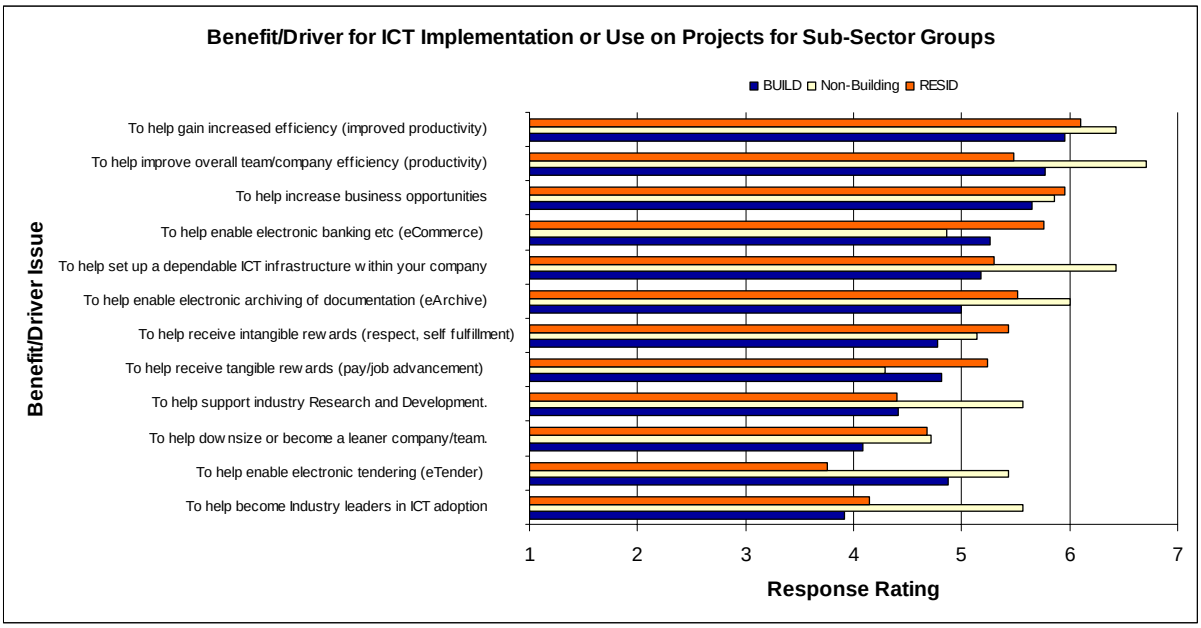

Figure 18 Mean response for Benefits/Drivers by core sector

Figure 19 below displays the rating response distribution for the influence the specific Benefits/Drivers had on their decision to implement or use ICT on projects.

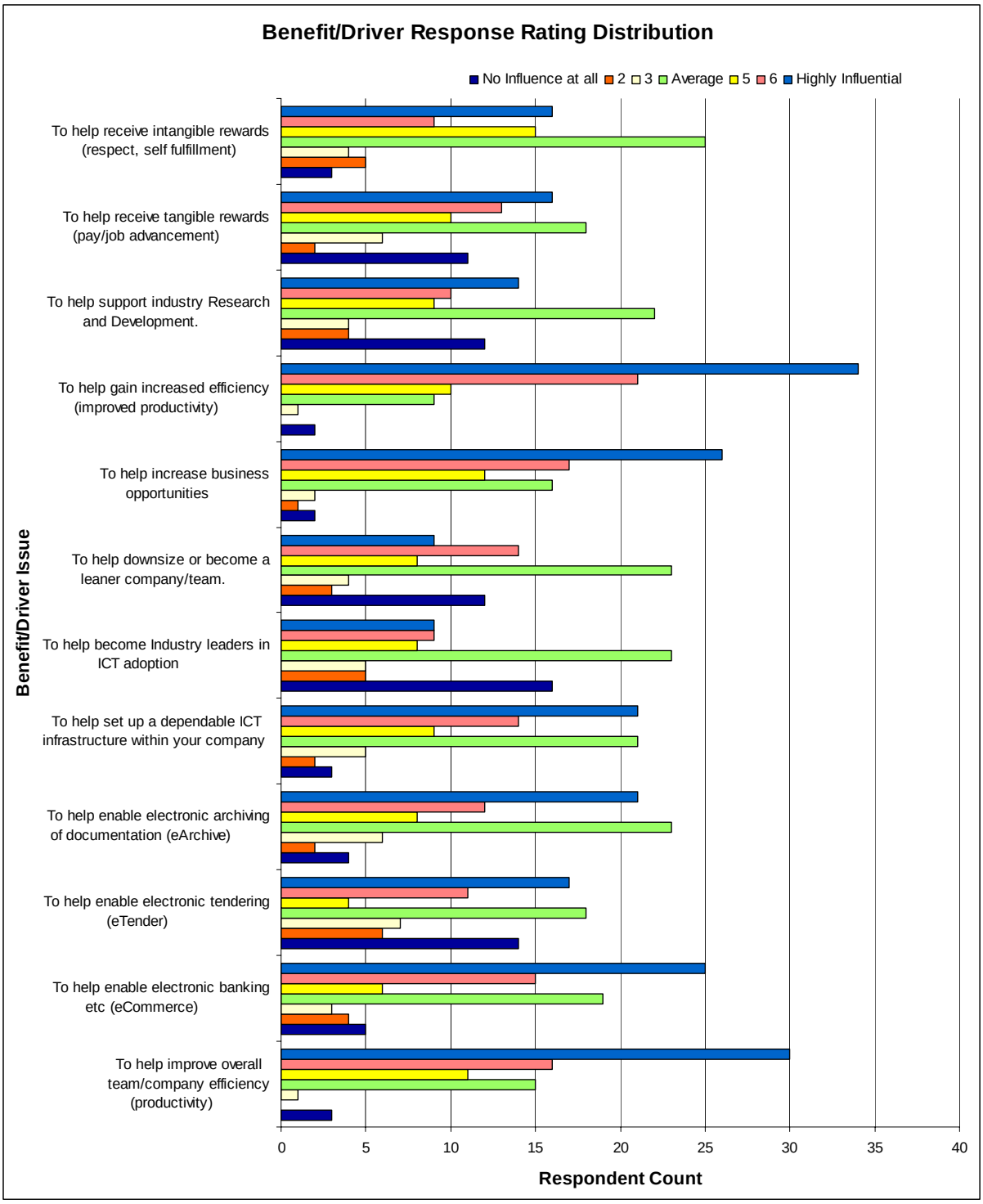

Figure 19 Response distribution for Benefits/Drivers influencing ICT implementation

4.3.2 Barriers/Limitations for ICT on Projects

Respondents were also asked to indicate what influence a specified range of Barriers/Limitations has on their decision to implement or use ICT on projects.
The issues presented included:

Barrier 1. Not having an ICT implementation "Champion" on a project.
Barrier 2. Existing use of traditional/paper-based documentation.
Barrier 3. The dispersed nature of the industry/projects & participants.
Barrier 4. Having limited or no ICT Infrastructure in place.

Barrier 5. Having limited or no ICT technical support readily available.
Barrier 6. ICT investment restrictions due to budget constraints.
Barrier 7. Not being aware of the cost benefits of investing in ICT.
Barrier 8. The continuous & quick succession of ICT upgrades/advancement.
Barrier 9. Having to use incompatible ICT hardware/software/systems.
Barrier 10. Security issues (re project data, access etc).
Barrier 11. Confidentiality issues (re shared project data).
Barrier 12. Legislative issues (re contracts, electronic signatures).
Barrier 13. Having no ICT Strategy Plan (re ICT use).
Barrier 14. Your company's perception that ICT is not part of its core business.
Barrier 15. Inconsistent employee requirements on projects.
Barrier 16. Lack of ICT training & experienced (knowledge, awareness & skills).
Barrier 17. Demanding & inflexible workload.
Barrier 18. Having limited or no ICT training opportunities within your company/team.

The response options ranged from no influence at all to highly influential with a total of seven rating options. The mean response for these issues is displayed in Figure 20. The chart shows that all issues are grouped between slightly-below to slightly-above average influence and that '*ICT investment restrictions due to budget constraints*' was most influential. This result confirms results in previous sections, where in general annual turnover, hence project/organisational budget, has had a great influence on both ICT status and ICT training outcomes.

Technical issues such as '*Having to use incompatible ICT hardware/software/systems'*, '*Having limited or no ICT hardware/software support readily available'* and 'The continuous & *quick succession of ICT upgrade/advancement'* were the next most influential Barrier/Limitations issues when considering to implement or use ICT on projects.

The issues found to be of least influence, in order of influence include:

- *'Your company's perception that ICT is not part of its core business';*
- *'Inconsistent employee requirements on projects'; and*
- *'Not having an ICT implementation "Champion" on a project'.*

The issue of incompatibility is currently being addressed in ICT research and development worldwide, with technologies such as the Java programming language and Java Virtual Machines (JVM) allowing interoperability between various platforms.

Another technology which is allowing interoperability amongst collaborative project members is the Internet, which through networking technologies such as Virtual Private Networks (VPN) and Application Service Providers (ASP), is allowing clients to provide services with minimal technological requirements, only requiring a Web Browser to access the project web site and sophisticated software applications. This leads to another influential (6th highest mean response) issue amongst respondents, the issue '*Security issues (re project data, access etc.)*' In an electronic collaborative environment such as construction project websites, data security becomes a major consideration in the implementation and use of ICT for project participants.

Another issue of high influence for respondents was '*Not being aware of the cost benefits of investing in ICT*'. More applied research, such as case studies, may enable the benefits of ICT to be demonstrated, thus removing this Barrier.

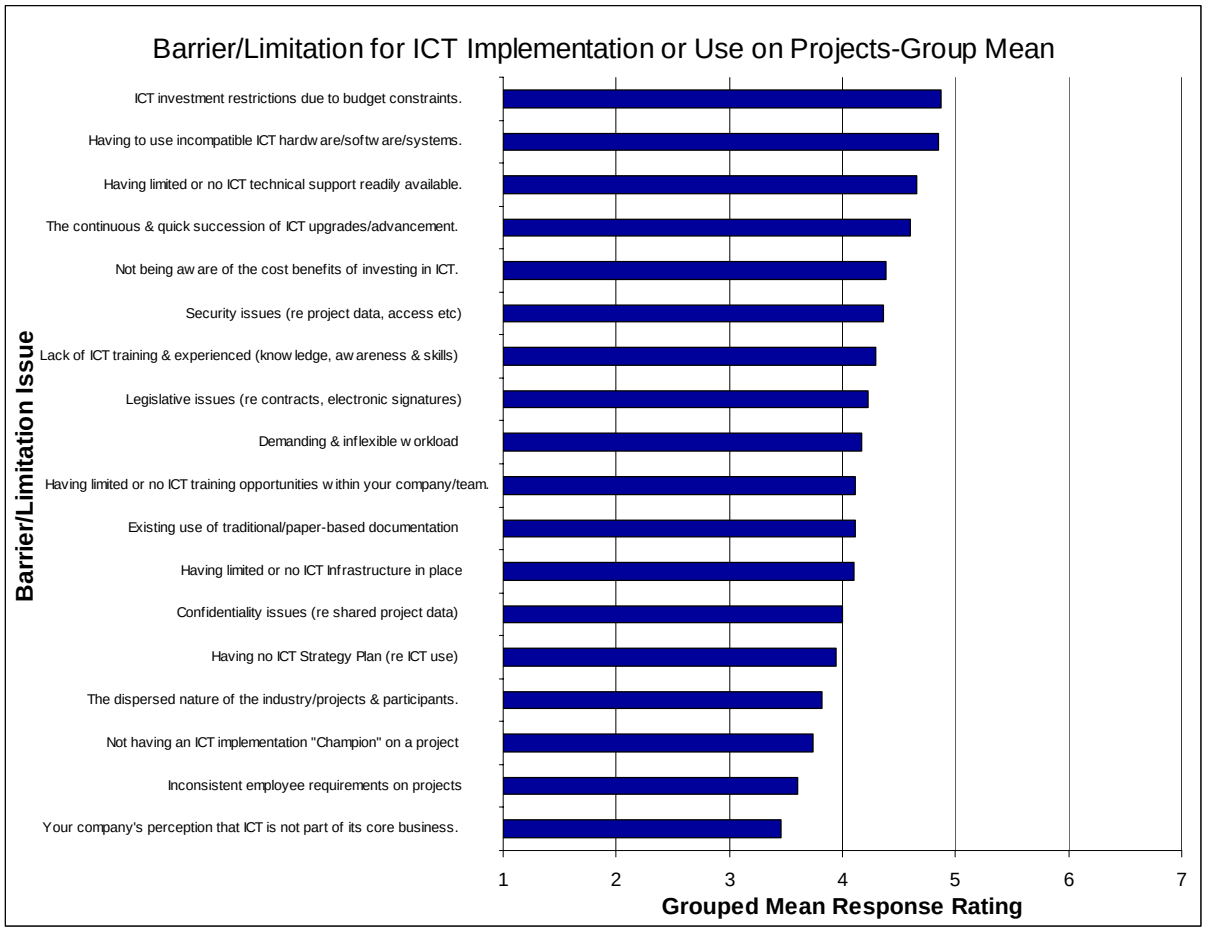

Figure 20 Mean response for Barriers/Limitations influencing ICT implementation

Correlation analysis also confirmed the consistency with regards to the Barriers/Limitations listed. Figure 21 contains the correlation coefficients and the significance levels along with the number of respondents for each issue. The issues are numbered according to the order of appearance in the survey form and as listed above. '*Security issues (re project data, access etc)*' and '*Confidentiality issues (re shared project data)*' were strongly correlated as were '*Lack of ICT training & experienced (knowledge, awareness & skill)'* and '*Having limited or no ICT training opportunities within your company/team*'. These issues achieved a correlation coefficient greater than 0.7 and were significant at 0.01 level.

Correlations

			BARRIER1	BARRIER2	BARRIER3	BARRIER4	BARRIER5	BARRIER6	BARRIER7	BARRIER8	BARRIER9	Barrier10	Barrier11	Barrier12	Barrier13	Barrier14	Barrier15	Barrier16	Barrier17	Barrier18
Spearman's rho	BARRIER1	Correlation Coefficient	1.000	.466**	.494**	.332**	.326**	.321**	.434**	.101	.124	.222	.284*	.191	.235*	.283*	.478**	.308**	.543**	.195
		Sig. (2-tailed)	.	.000	.000	.004	.004	.005	.000	.390	.287	.055	.013	.099	.043	.014	.000	.007	.000	.099
		N	76	74	76	75	75	75	74	74	75	75	76	76	75	75	75	76	75	73
	BARRIER2	Correlation Coefficient	.466**	1.000	.617**	.355**	.188	.236*	.294*	.171	.144	.112	.104	.048	.044	.266*	.314**	.149	.321**	.133
		Sig. (2-tailed)	.000	.	.000	.002	.108	.045	.012	.148	.223	.345	.376	.683	.710	.023	.007	.205	.006	.268
		N	74	74	74	73	74	73	72	73	73	73	74	74	73	73	73	74	73	71
	BARRIER3	Correlation Coefficient	.494**	.617**	1.000	.459**	.268*	.280*	.482**	.235*	.173	.110	.282*	.147	.249*	.271*	.267*	.167	.368**	.190
		Sig. (2-tailed)	.000	.000	.	.000	.020	.015	.000	.044	.137	.347	.013	.205	.031	.019	.021	.150	.001	.106
		N	76	74	76	75	75	75	74	74	75	75	76	76	75	75	75	76	75	73
	BARRIER4	Correlation Coefficient	.332**	.355**	.459**	1.000	.680**	.531**	.433**	.447**	.512**	.357**	.462**	.364**	.516**	.537**	.423**	.571**	.524**	.575**
		Sig. (2-tailed)	.004	.002	.000	.	.000	.000	.000	.000	.000	.002	.000	.001	.000	.000	.000	.000	.000	.000
		N	75	73	75	76	75	75	74	73	74	74	75	75	75	75	74	76	75	73
	BARRIER5	Correlation Coefficient	.326**	.188	.268*	.680**	1.000	.648**	.399**	.454**	.512**	.365**	.432**	.453**	.454**	.512**	.462**	.548**	.443**	.501**
		Sig. (2-tailed)	.004	.108	.020	.000	.	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000
		N	75	74	75	75	76	75	74	74	74	74	75	75	75	75	74	76	75	73
	BARRIER6	Correlation Coefficient	.321**	.236*	.280*	.531**	.648**	1.000	.386**	.474**	.455**	.242*	.224	.431**	.381**	.287*	.320**	.318**	.385**	.381**
		Sig. (2-tailed)	.005	.045	.015	.000	.000	.	.001	.000	.000	.038	.054	.000	.001	.012	.005	.005	.001	.001
		N	75	73	75	75	75	76	74	74	74	74	75	75	75	75	74	76	75	73
	BARRIER7	Correlation Coefficient	.434**	.294*	.482**	.433**	.399**	.386**	1.000	.424**	.455**	.380**	.450**	.191	.403**	.567**	.370**	.354**	.563**	.417**
		Sig. (2-tailed)	.000	.012	.000	.000	.000	.001	.	.000	.000	.001	.000	.103	.000	.000	.001	.002	.000	.000
		N	74	72	74	74	74	74	75	72	73	73	74	74	74	74	73	75	75	73
	BARRIER8	Correlation Coefficient	.101	.171	.235*	.447**	.454**	.474**	.424**	1.000	.492**	.293*	.288*	.146	.173	.379**	.213	.401**	.380**	.499**
		Sig. (2-tailed)	.390	.148	.044	.000	.000	.000	.000	.	.000	.012	.013	.214	.144	.001	.071	.000	.001	.000
		N	74	73	74	73	74	74	72	74	73	73	74	74	73	73	73	74	73	71
	BARRIER9	Correlation Coefficient	.124	.144	.173	.512**	.512**	.455**	.455**	.492**	1.000	.385**	.431**	.357**	.314**	.263*	.207	.355**	.311**	.447**
		Sig. (2-tailed)	.287	.223	.137	.000	.000	.000	.000	.000	.	.001	.000	.002	.007	.024	.076	.002	.007	.000
		N	75	73	75	74	74	74	73	73	75	74	75	75	74	74	74	75	74	72
	Barrier10	Correlation Coefficient	.222	.112	.110	.357**	.365**	.242*	.380**	.293*	.385**	1.000	.712**	.607**	.260*	.298*	.236*	.466**	.228	.451**
		Sig. (2-tailed)	.055	.345	.347	.002	.001	.038	.001	.012	.001	.	.000	.000	.025	.010	.043	.000	.051	.000
		N	75	73	75	74	74	74	73	73	74	75	75	75	74	74	74	75	74	72
	Barrier11	Correlation Coefficient	.284*	.104	.282*	.462**	.432**	.224	.450**	.288*	.431**	.712**	1.000	.511**	.220	.305**	.273*	.528**	.283*	.593**
		Sig. (2-tailed)	.013	.376	.013	.000	.000	.054	.000	.013	.000	.000	.	.000	.057	.008	.018	.000	.014	.000
		N	76	74	76	75	75	75	74	74	75	75	76	76	75	75	75	76	75	73
	Barrier12	Correlation Coefficient	.191	.048	.147	.364**	.453**	.431**	.191	.146	.357**	.607**	.511**	1.000	.368**	.251*	.289*	.348**	.083	.238*
		Sig. (2-tailed)	.099	.683	.205	.001	.000	.000	.103	.214	.002	.000	.000	.	.001	.030	.012	.002	.481	.042
		N	76	74	76	75	75	75	74	74	75	75	76	76	75	75	75	76	75	73
	Barrier13	Correlation Coefficient	.235*	.044	.249*	.516**	.454**	.381**	.403**	.173	.314**	.260*	.220	.368**	1.000	.608**	.523**	.464**	.415**	.320**
		Sig. (2-tailed)	.043	.710	.031	.000	.000	.001	.000	.144	.007	.025	.057	.001	.	.000	.000	.000	.000	.006
		N	75	73	75	75	75	75	74	73	74	74	75	75	76	75	74	76	75	73
	Barrier14	Correlation Coefficient	.283*	.266*	.271*	.537**	.512**	.287*	.567**	.379**	.263*	.298*	.305**	.251*	.608**	1.000	.618**	.516**	.541**	.412**
		Sig. (2-tailed)	.014	.023	.019	.000	.000	.012	.000	.001	.024	.010	.008	.030	.000	.	.000	.000	.000	.000
		N	75	73	75	75	75	75	74	73	74	74	75	75	75	76	74	76	75	73
	Barrier15	Correlation Coefficient	.478**	.314**	.267*	.423**	.462**	.320**	.370**	.213	.207	.236*	.273*	.289*	.523**	.618**	1.000	.523**	.554**	.347**
		Sig. (2-tailed)	.000	.007	.021	.000	.000	.005	.001	.071	.076	.043	.018	.012	.000	.000	.	.000	.000	.003
		N	75	73	75	74	74	74	73	73	74	74	75	75	74	74	75	75	74	72
	Barrier16	Correlation Coefficient	.308**	.149	.167	.571**	.548**	.318**	.354**	.401**	.355**	.466**	.528**	.348**	.464**	.516**	.523**	1.000	.475**	.757**
		Sig. (2-tailed)	.007	.205	.150	.000	.000	.005	.002	.000	.002	.000	.000	.002	.000	.000	.000	.	.000	.000
		N	76	74	76	76	76	76	75	74	75	75	76	76	76	76	75	77	76	74
	Barrier17	Correlation Coefficient	.543**	.321**	.368**	.524**	.443**	.385**	.563**	.380**	.311**	.228	.283*	.083	.415**	.541**	.554**	.475**	1.000	.489**
		Sig. (2-tailed)	.000	.006	.001	.000	.000	.001	.000	.001	.007	.051	.014	.481	.000	.000	.000	.000	.	.000
		N	75	73	75	75	75	75	75	73	74	74	75	75	75	75	74	76	76	74
	Barrier18	Correlation Coefficient	.195	.133	.190	.575**	.501**	.381**	.417**	.499**	.447**	.451**	.593**	.238*	.320**	.412**	.347**	.757**	.489**	1.000
		Sig. (2-tailed)	.099	.268	.106	.000	.000	.001	.000	.000	.000	.000	.000	.042	.006	.000	.003	.000	.000	.
		N	73	71	73	73	73	73	73	71	72	72	73	73	73	73	72	74	74	74

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

Figure 21 Correlation analysis results for Barriers/Limitations

Sub-sector groups were analysed to find results of any significance with regard to the Barriers/Limitations influencing ICT implementation or use on projects.

Non-building construction respondents perceived *'Having limited or no ICT technical support readily available'* and '*Demanding and inflexible workload'* to be equally the greatest Barriers/Limitations influencing their decision to implement or use ICT on projects. Other issues, which have a strong influence for this sub-sector, in order of influence were:

- *'Having limited or no ICT training opportunities within your company/team';*
- *'Having to use incompatible ICT hardware/software/systems';* and
- *'Having limited or no ICT infrastructure in place'.*

It is interesting to note that '*ICT investment restrictions due to budget constraints'* was not as highly influential for this sub-sector than for the other two. This may be as a result of the relationship between ICT investment and annual turnover, where results indicate that a large percentage (86%) of the Non-building sub-sector respondent organisations were in the high (greater than $5M) annual turnover ranges. It would appear they typically have more money to invest, hence their lower perceived restriction on budgets for ICT, and their tendency to be more innovative. All of the issues presented were perceived by the Non-building sub-sector to be at least an average influential Barrier/Limitation to ICT implementation or use on projects.

The relatively high influence of '*Having limited or no ICT training opportunities within your company/team*' is an interesting result due to the fact that all respondents in this sub-sector indicated that they are allowed sufficient time during office hours to undergo official ICT training. However, only 1 respondent indicated that they are able to adjust or reduce their workload to undergo ICT training, indicating that workload may be a significant determining factor when it comes to ICT training for the Non-building sub-sector.

Building construction (Commercial/Industrial) respondents perceived '*ICT investment restrictions due to budget constraints*' and '*Having to use incompatible ICT hardware/software/systems'* as being the most influential Barriers/Limitations respectively to implementing or using ICT on projects. Other issues, which have a strong influence for this sub-sector, in order of influence were:

- *'Having limited or no ICT technical support readily available';*
- *'Existing use of traditional/paper based documentation';* and
- *'The continuous & quick succession of ICT upgrades/advancement'.*

The Residential sub-sector respondents perceived '*The continuous & quick succession of ICT upgrades/advancement'* and *'ICT investment restrictions due to budget constraints '* as their most influential Barriers/Limitations respectively to ICT use and implementation on projects. Other issues, which have a strong influence for this sub-sector, in order of influence were:

- *'Not being aware of the benefits of investing in ICT'.*
- *'Having to use incompatible ICT hardware/software/systems';* and
- *'Demanding and inflexible workload'.*

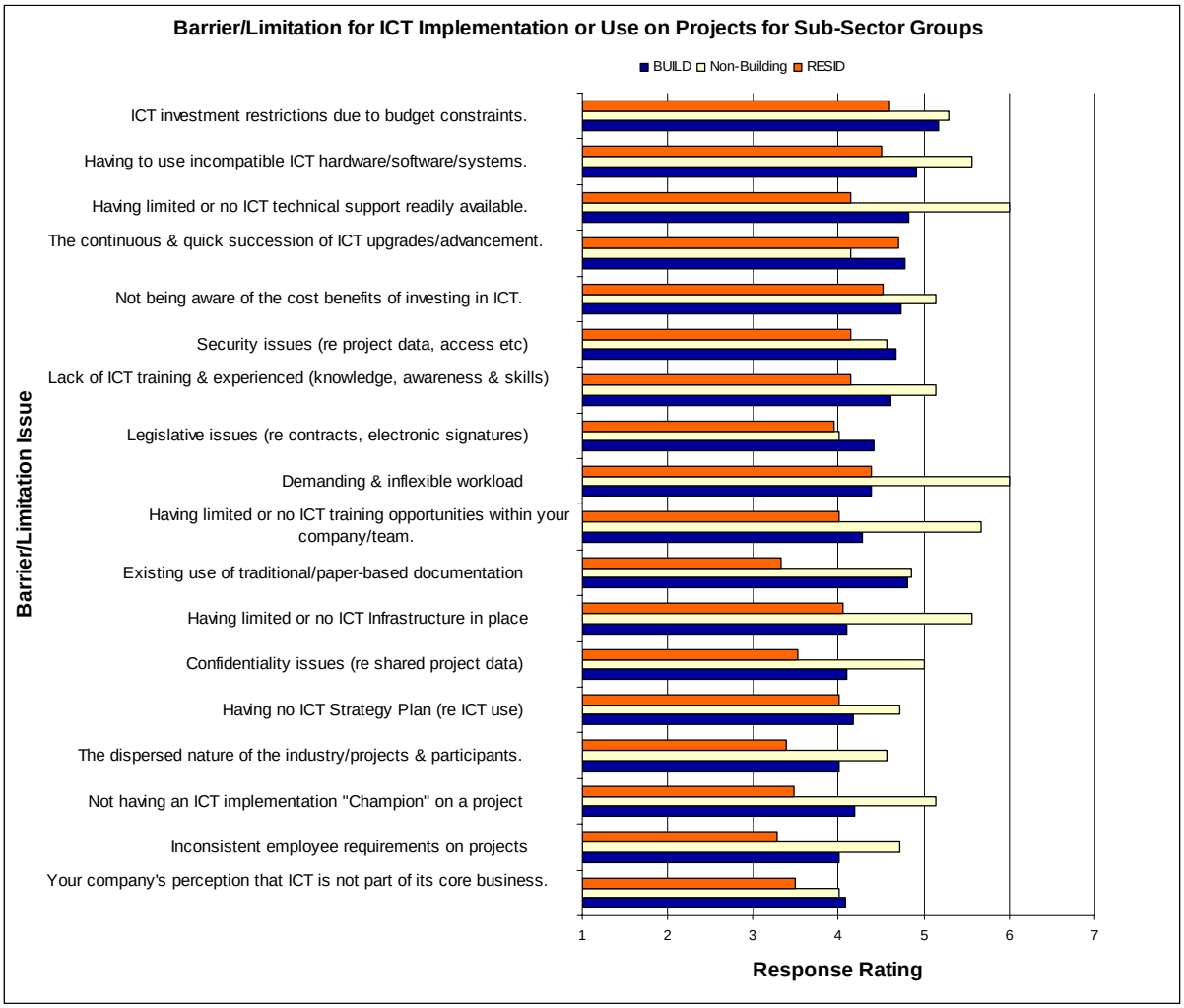

Figure 22 Mean response for Barriers/Limitations by core sector

Figure 23 displays the distribution of responses indicating what influence the range of Barriers/Limitations had on their decision to implement or use ICT on projects. As is clear many respondents indicated the issues had an average influence on their decision to implement or use ICT on projects.

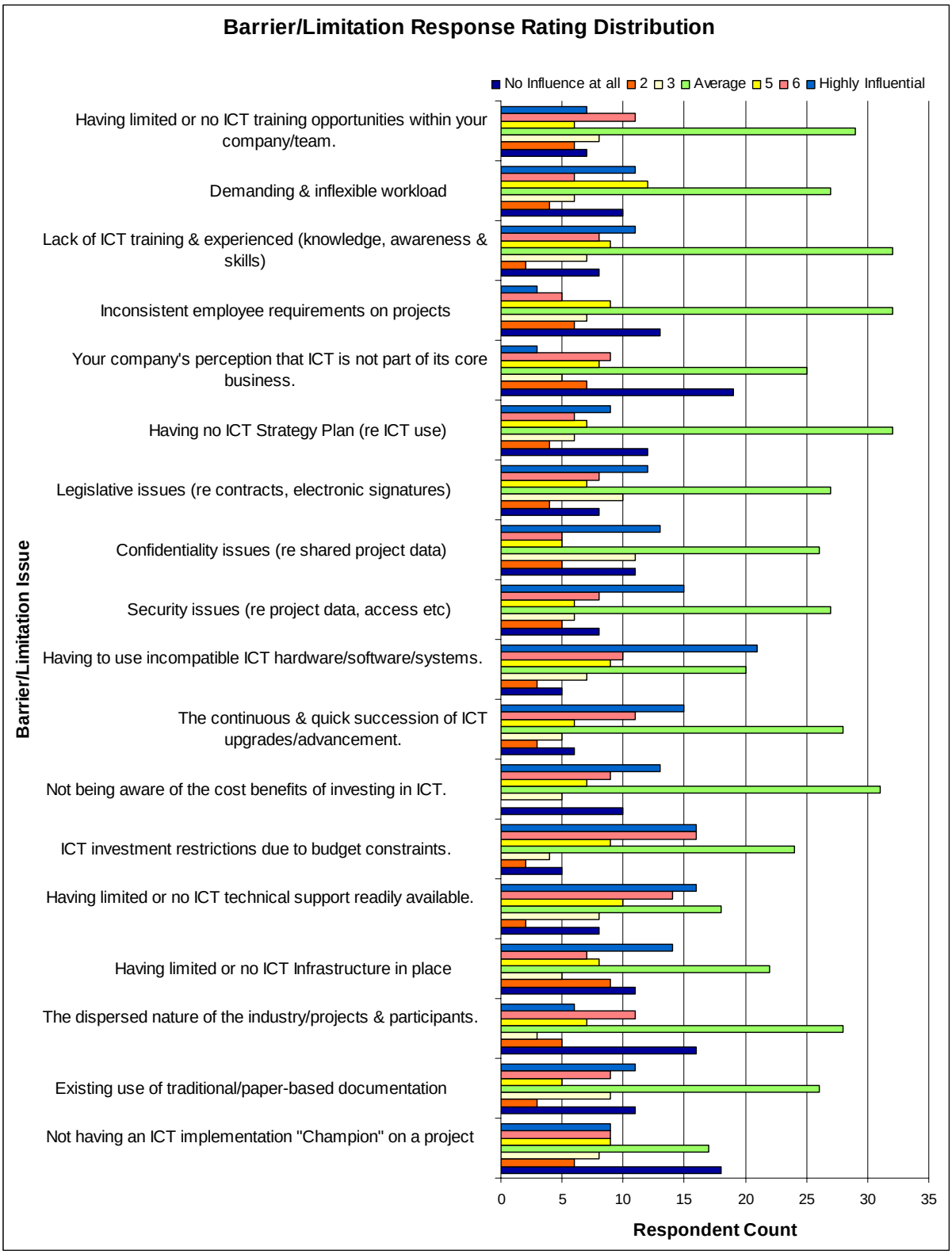

Figure 23 Distribution for Barriers/Limitations influencing ICT implementation

4.3.3 Summary ICT Trends & Opinions Results

Table 3 summarises the results of the most influential Benefit/Driver issues for respondents.

Table 3 Benefit/Driver issue ranking according to respondent group

Group	Benefit/Driver Influence Ranking				
	1	2	3	4	5
Total Mean	*To help gain increased efficiency (improved productivity)*	*To help improve over all team/company efficiency (productivity)*	*To help increase business opportunities*	*To help enable electronic banking etc (eCommerce)*	*To help set up a dependable ICT infrastructure within your company*
Non-building	*To help improve overall team/company efficiency (productivity)*	**To help gain increased efficiency (improved productivity); and* **To help set up a dependable ICT infrastructure within your company*		*To help enable electronic archiving of documentation (eArchive)*	*To help increase business opportunities.*
Building	*To help gain increased efficiency (improved productivity)*	*To help improve overall team/company efficiency (productivity)*	*To help increase business opportunities*	*To help enable electronic banking etc (eCommerce)*	*To help set up a dependable ICT infrastructure within your company*
Residential	*To help gain increased efficiency (improved productivity)*	*To help increase business opportunities*	*To enable electronic banking etc (eCommerce)*	*To help enable electronic archiving of documentation (eArchive)*	*To help receive intangible rewards (respect, self fulfilment)*

* Both had same influence and tied for second.

And the Benefit/Driver issues of least influence (Total Mean) were found to be:

1. *'To help become industry leaders in ICT adoption'.*
2. *'To help enable electronic tendering (eTender)'.*
3. *'To help downsize or become a leaner company/team'.*

The most significant findings from these results were that construction organisations perceive ICT to provide productivity benefits at an operational level and strategically through improved business opportunities.

The following Benefit/Driver issue pairs were found to be statistically significant for correlation:

- *'To help gain increased efficiency (improved productivity*)' and '*To help increase business opportunities*'*; and*
- *'To help improve overall team/company efficiency (productivity)' and 'To help gain increased efficiency (improved productivity)'.*

Table 4 summarises the results of the most influential Barrier/Limitation issues for respondents.

Table 4 Barrier/Limitation issue ranking according to respondent group

Sub-sector	Barrier/Limitation Influence Ranking				
	1	2	3	4	5
Total Mean	*ICT investment restrictions due to budget constraints*	*Having to use incompatible ICT hardware/software /systems*	*Having limited or no ICT technical support readily available*	*The continuous & quick succession of ICT upgrades/advancement*	*Not being aware of the cost benefits of investing in ICT*
Non-building	**Having limited or no ICT technical support readily available; and* **Demanding and inflexible workload*		*Having limited or no ICT training opportunities within your company/team*	*Having to use incompatible ICT hardware/software /systems*	*Having limited or no ICT infrastructure in place*
Building	*ICT investment restrictions due to budget constraints*	*Having to use incompatible ICT hardware/software /systems*	*Having limited or no ICT technical support readily available*	*Existing use of traditional/paper based documentation*	*The continuous & quick succession of ICT upgrades/advancement*
Residential	*The continuous & quick succession of ICT upgrades/advancement*	*ICT investment restrictions due to budget constraints*	*Not being aware of the cost benefits of investing in ICT*	*Having to use incompatible ICT hardware/software /systems*	*Demanding and inflexible workload*

* Both had same influence and tied for first.

In addition, the Barrier/Limitation issues of least influence (Total Mean) were found to be:

1. *'Your company's perception that ICT is not part of its core business';*
2. *'Inconsistent employee requirements on projects'; and*
3. *'Not having an ICT implementation "Champion" on a project'.*

As a complete group, the most significant finding was that budget constraints are the most influential Barrier/Limitation when considering implementing or using ICT on projects. This coincides with the results of previous sections of the survey where the annual turnover and ICT investment appear to be closely related to an organisation's ICT status and training characteristics. Technical issues such as incompatibility and ICT technical support also ranked highly as being influential Barriers. This is to be expected, due to many projects being remote (from the main office) with likely limited access to an IT professional.

In general, the sub-sector groups showed more variability in terms of the Total Mean responses to Barrier/Limitation compared to the Benefit/Driver results indicating the perceived Barriers may vary dependent on many factors however, the benefits may be more generic. For example, the Non-building and Residential groups rated workload as being an influential Barrier to ICT implementation or use on projects, where overall this issue did not rank in the top five issues.

Other interesting results included those who indicated their company adjusts/reduces their workload to undertake official training also believed strongly that demanding and inflexible workload was a Barrier to implementation or use of ICT on projects (Somers' D = 0.520 sig: 0.014). This statistic indicates that there is a statistically significant positive relationship between the two variables. For the respondents who indicated their company adjusts/reduces their workload to undertake official training this was their number one Barrier however, this group achieved a higher than average response than the sample for sixteen of the eighteen Barriers.

Also, those who indicated they had never undergone any official ICT training indicated that 'Lack of ICT training & experienced (knowledge, awareness & skills)' (Somers' D = -0.259 sig: 0.035) and 'Having limited or no ICT training opportunities within your company/team'

(Somers' D = -0.236 sig: 0.061) were highly influential Barriers to implementation or use of ICT on projects. These statistics indicate that there is a statistically significant positive relationship between the variables.

The following Barrier/Limitation issue pairs were found to be statistically significant for correlation:

- *'Security issues (re project data, access etc).*' and '*Confidentiality issues (re shared project data); and*
- *'Lack of ICT training & experienced (knowledge, awareness & skills)' and 'Having limited or no ICT training opportunities within your company/team'.*

5 CONCLUSION

The most significant observations from the survey results were that annual turnover has an effect on the uptake of ICT and training performance in ICT for an organisation.

Identified effects of budget on uptake and/or current ICT status include:

- In general, higher ICT investment was observed for higher annual turnover organisations;
- In general, higher ICT investment, hence annual turnover organisations, had a higher rate of use and access to emerging or innovative ICTs such as Handheld and Tablet computers, Video Conferencing and Wi-Fi devices; and
- The most significant Barrier/Limitation to the implementation or use of ICT on projects was budget constraints.

Identified effects of budget on ICT training include:

- Lower turnover construction organisation respondents were less likely to have undergone ICT training;
- Lower turnover construction organisations were less supportive of ICT training through flexible workload and time allocation; and
- Higher turnover organisations had a greater preference for the professional consultants mode of training and conversely, lower turnover organisations had a greater preference for self learning.

Technical issues such as interoperability (incompatibility) and not having an ICT professional on site or within ready access were found to be strong influential Barriers to the uptake of ICT on projects for most respondents. When investigating results according to sub-sector, several of the groups were found to rank highly issues that were not in the top five as a sample group. For example, the Non-building and Residential groups ranked their demanding and inflexible workloads as being in their top 5 Barriers to uptake of ICT for projects.

The overriding driver for ICT uptake for respondents was to improve their operational performance through improved productivity at both the personal level and the organisational /team level. Improved business opportunity was also highly influential for respondents. Similar results to these were found on investigation of results according industry sub-sectors. However, interestingly the Residential sub-sector rated the driver of improved business opportunities higher than the other two sub-sector groups.

6 APPENDIX A – PILOT SURVEY

A preliminary analysis of the pilot survey data was undertaken to attempt to understand the respondents position/s. The analysis carried out was a minimal analysis covering only central tendencies, spread and distribution in general with cross sectional analysis performed on those questions where a difference in responses between specific groups were expected or where a large spread was observed. Given the number of respondents (64) a normal distribution was assumed for the responses for some of the questions and, while not strictly correct, this approach was believed suitable for the purpose of providing feedback in preparation for the national survey.

No attempt was made to validate the consistency of responses by any respondents or identify clusters/factors during this analysis however, in general, a large number of the responses to questions were consistent across the sample and , for some questions at least, generalisation to the population would be reasonable, however the factors used in the cross-sectional analysis were too detailed for significant results but on occasions pointed toward a likelihood of a significant result with a larger pool of respondents and a smaller number of categories in the factor/s.

6.1 INTRODUCTION

The following analysis compares the results of the pilot questionnaire to those of the national survey. The purpose is to compare the responses of the Industry partner contacts with the national responses. Only questions repeated in both surveys have been assessed.

6.2 RESPONDENT PROFILE

This section looks at the respondent profile including:

- Educational background;
- Current role within organisation;
- Length of service with current organisation;
- Organisation's annual turnover; and
- Sub-sector within the construction industry.

In all 64 respondents completed the survey, however as it was not possible to determine the number of organisations the survey was made available to, no response rate could be determined.

6.2.1 Respondent Educational Distribution

Respondents were asked to indicate the highest level of education completed from a defined list of responses. Of those who responded, 96% had some form of tertiary qualification, a Bachelor degree having the highest frequency with 47% of the total responses. The respondent distribution is detailed in Figure 24.

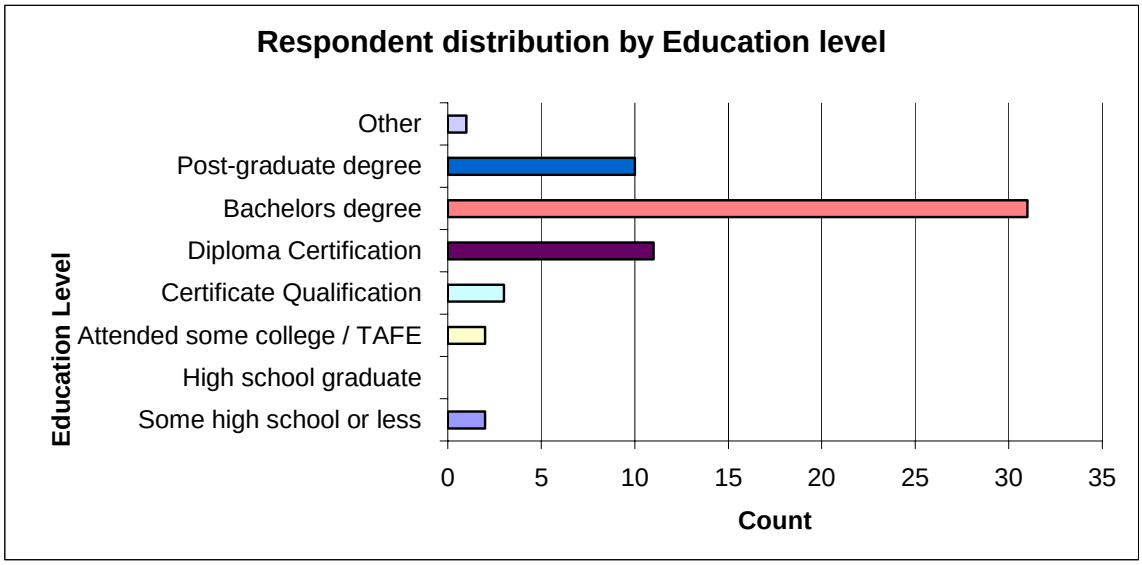

Figure 24 Respondent distribution by highest level of education completed

6.2.2 Respondent Role Distribution

Respondents were asked to indicate their current position. This question offered a large range of response categories and the responses were grouped arbitrarily into role categories. The categories included Technical, Manager, General and Administrator. The positions listed in the respondents were wide ranging and are listed in Figure 25. Respondents predominately (77%) were in a managerial role.

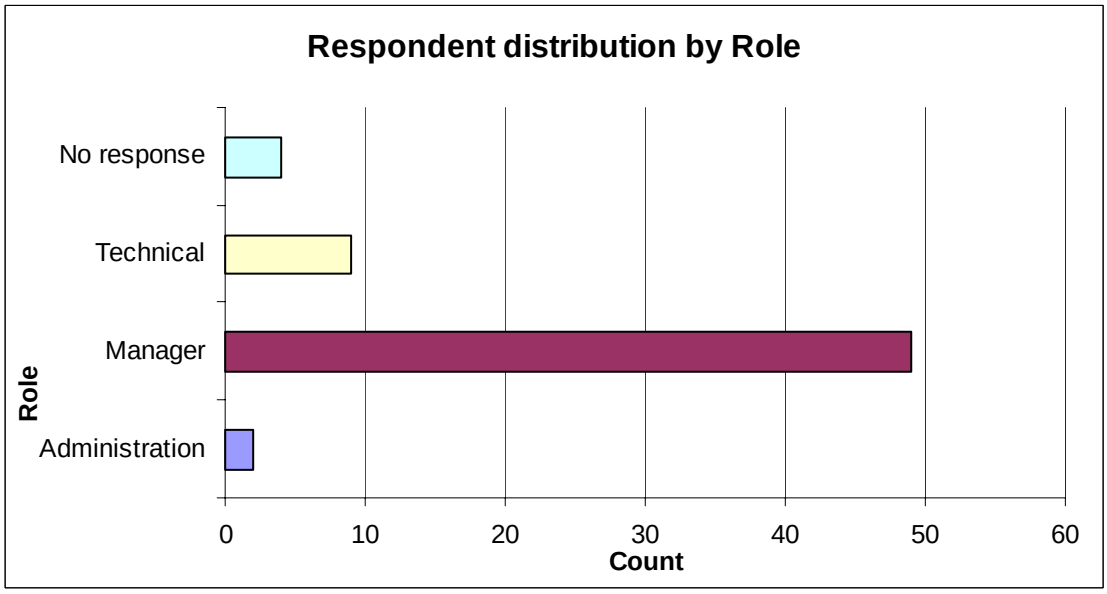

Figure 25 Respondent distribution by role

6.2.3 Respondent Years-of-Service Distribution

Respondents were asked to indicate how long (years) they have been working in their present position. The distribution can be seen in Figure 26. Most respondents had ten years service or less.

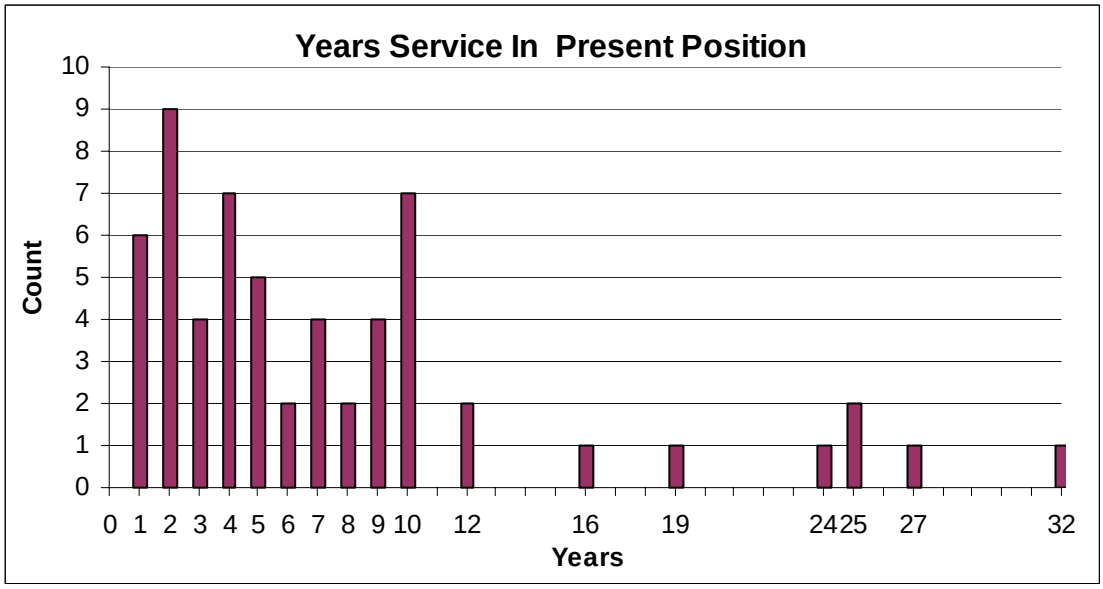

Figure 26 Years service

6.2.4 Respondent Organisation Classification Distribution

Respondents were asked to nominate their company's main classification. Figure 5 shows the majority (65%) of respondents were Contractors, with Consulting organisations making up most of the balance with 33%.

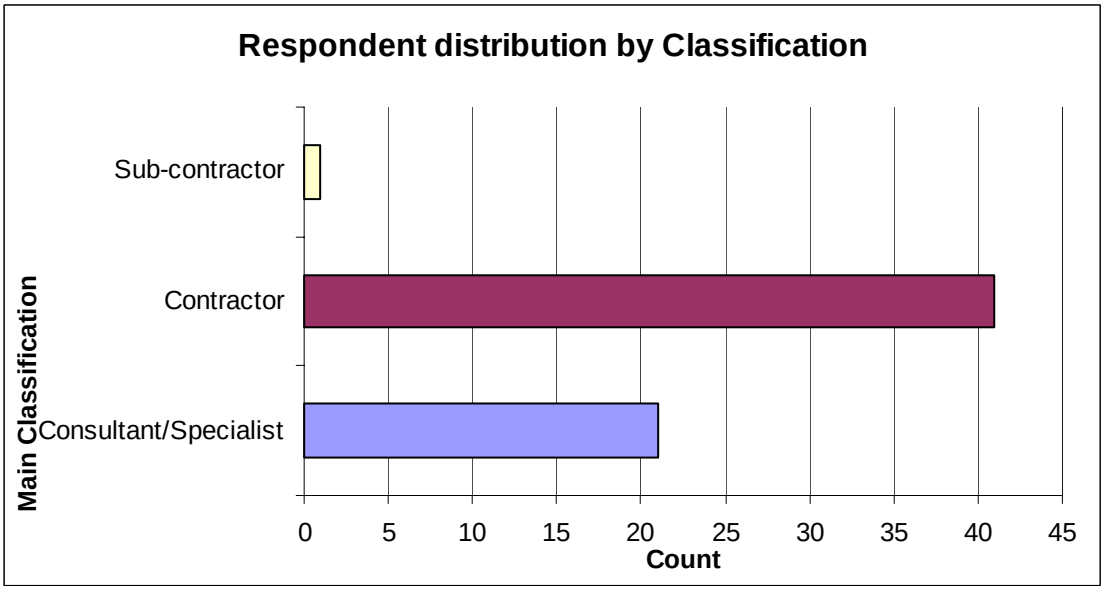

Figure 27 Respondent companies main classification

6.2.5 Respondent Organisations Annual Turnover Distribution

In terms of the respondents company's average annual turnover, the respondents were asked to indicate their company's average annual turnover for their state, nationally and internationally. This data is displayed in Table 5 below. Combining these responses provides the data for Figure 28. Figure 28 shows that of those who indicated their annual turnover, 27% nominated less than $500,000 and 21% indicating a turnover range greater than $50M providing a large range of organisations.

Table 5 Respondents turnover range

Turnover by	$0/Nil	Less than $500, 000	$500, 000 - $1M	$1M - $5M	$5M - $10M	$10M - $20M	$20M - $50M	$50M - $100M	$100M +	Don't Know
International	8	1	1	1	0	0	1	1	4	9
National	4	5	1	4	5	0	3	2	10	8
Your State	0	10	5	10	4	3	4	3	5	8

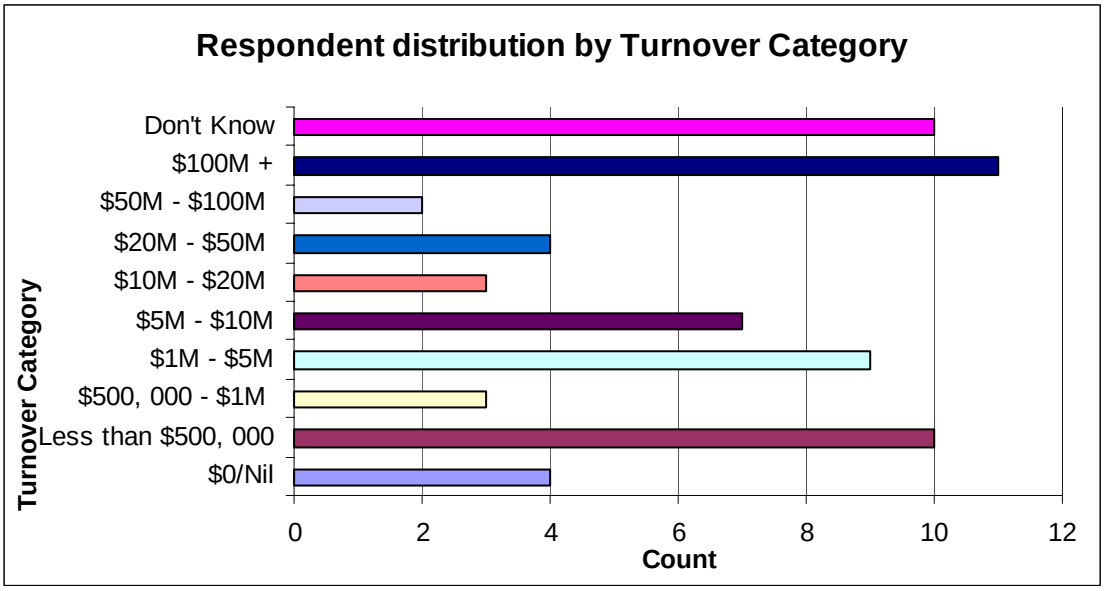

Figure 28 Respondent distribution by turnover category

6.2.6 Respondent Sub-Sector Distribution

Respondents were asked to indicate in which industry sector their company operates. Respondents were able to nominate a range of alternatives. Figure 29 shows four respondents did not respond however, of those who did respond, 97% indicated Building construction, Residential construction or both Building and Residential construction sectors. This indicates that the majority of respondents are involved in the Vertical/Building construction industry, where only 6% are involved in Non-building construction. Only 3% indicated that they were involved in all sub-sectors of the industry.

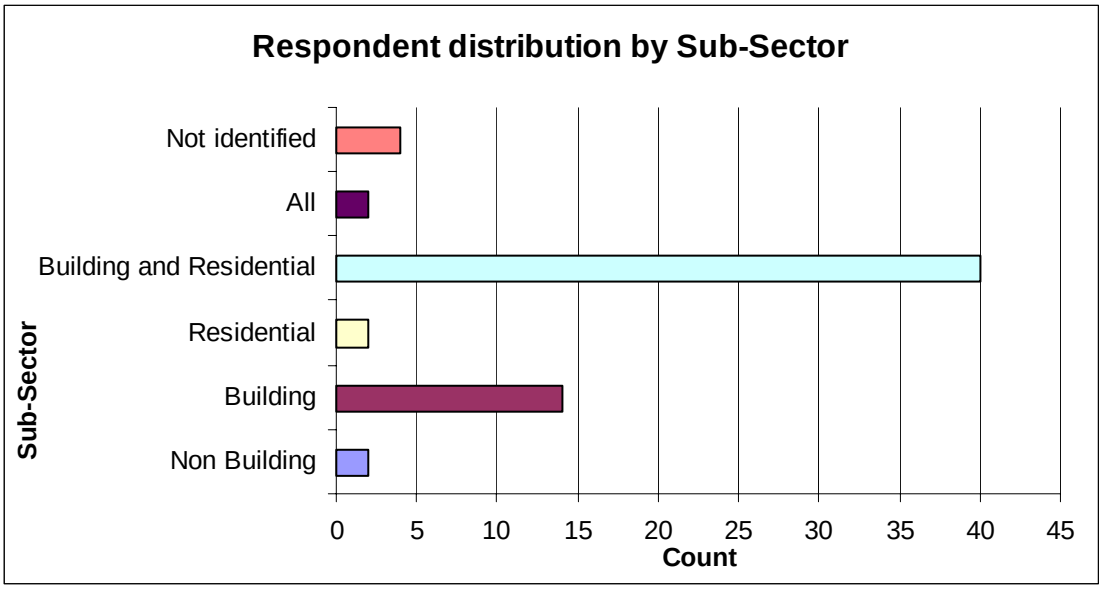

Figure 29 Respondent industry sub-sector

6.3 RESULTS

In general, three broad areas were investigated for this survey report:

- ICT Status: including investment commitment to ICT, use of specific ICT devices;
- ICT Training: including ICT training participation, ICT training mode preference, industry expectations of ICT competence amongst project participants; and
- ICT Trends and Opinions: including Benefits/Drivers and Barriers/Limitations to ICT implementation or use on projects.

The following sections outline the results to questions targeting the various areas mentioned above graphically and discusses the most pertinent and significant results.

6.3.1 Current ICT Status

This section investigates the respondents and respondent's organisations where appropriate, current ICT status including:

- ICT organisational investment; and
- ICT device use.

ICT Organisational Investment

Respondents were asked to specify how much their company currently invests in ICT annually. The amount spent varied considerably from $2,000 to $100,000,000 with the most frequent amounts specified being $20,000 and $100,000.

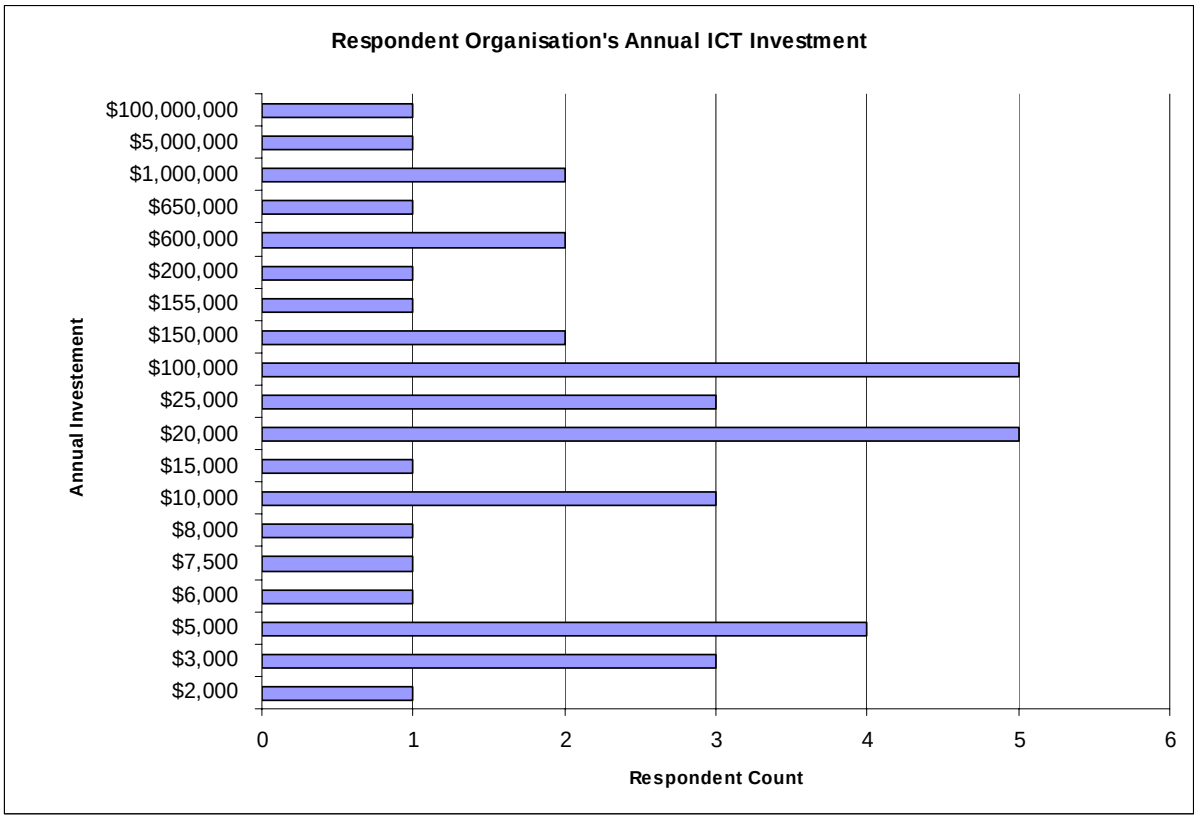

Figure 30 Distribution by ICT investment amount

ICT Device Access & Use

Respondents were asked to identify which ICT devices, from a specified range, they used on any size project. Responses are illustrated in Figure 31 below. The chart is ordered by usage rate.

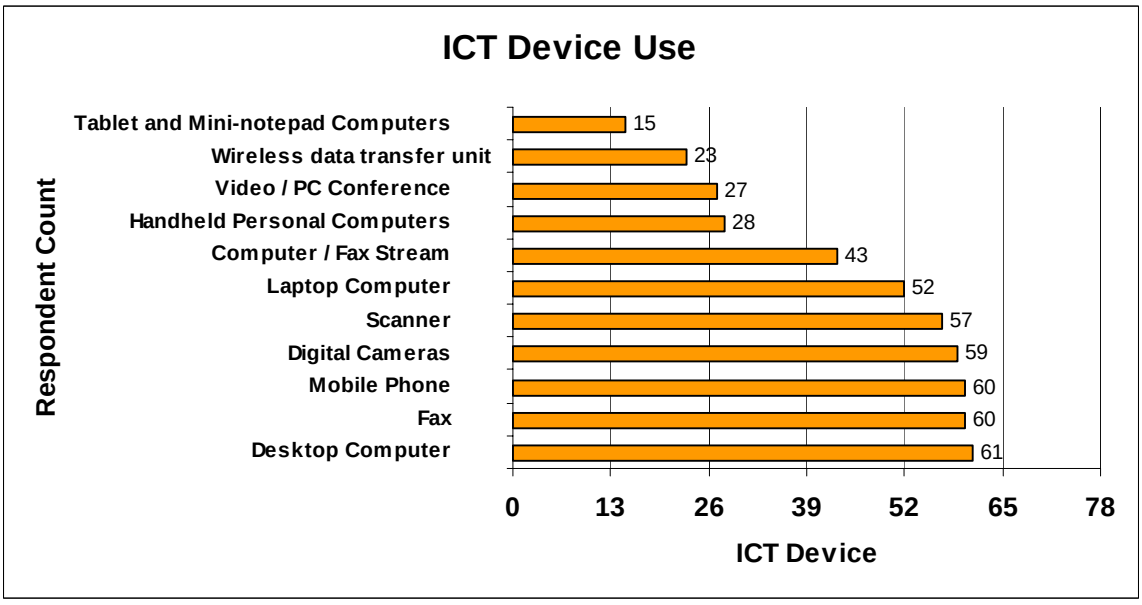

Figure 31 ICT usage

6.3.2 ICT Training

This section investigates the respondents, and respondent's organisations where appropriate, ICT training characteristics including:

- Official ICT training participation;
- ICT training company support;
- ICT training mode preference; and
- ICT competence expectations.

Official ICT Training Participation

Respondents were asked to indicate whether they had undergone any ICT training. Figure 32 below, shows that 47 of the 64 respondents (73%) indicated they had undergone ICT training. There were no significant factors influencing the results.

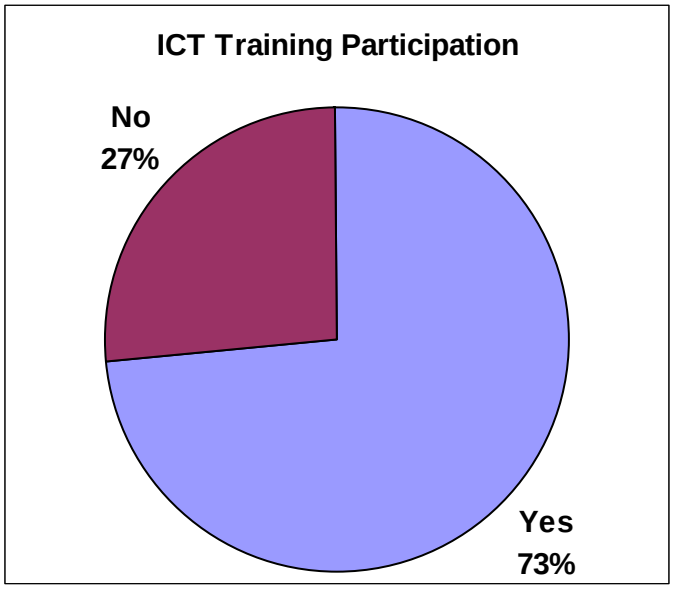

Figure 32 Proportion of respondents who had undergone official ICT training

ICT Training Company Support

With respect to whether the respondent's company allows them time for ICT training, Figure 33 shows that 25 of 49 respondents indicated their company did allow them sufficient time during office hours to undergo ICT training. This was two more than that indicated by those who had undergone ICT training. Considering the workload, 22 respondents indicated their company adjusted/reduced their workload to allow them to undergo ICT training.

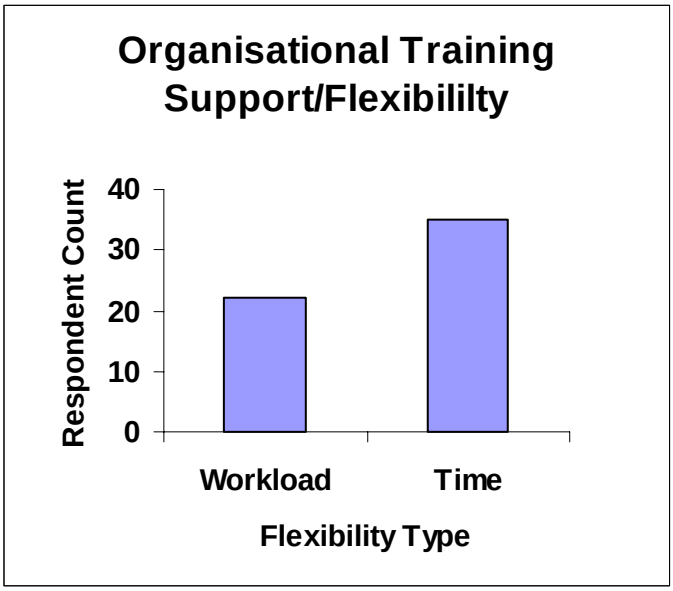

Figure 33 Count of respondents

ICT Training Mode Preference

The respondents were asked to nominate their preferred mode of training from a selected list. As is evident in Figure 34, the preferred training mode varied dependent on the topic. However, it would appear that there is a tendency for respondents to be trained at their workplace or in private.

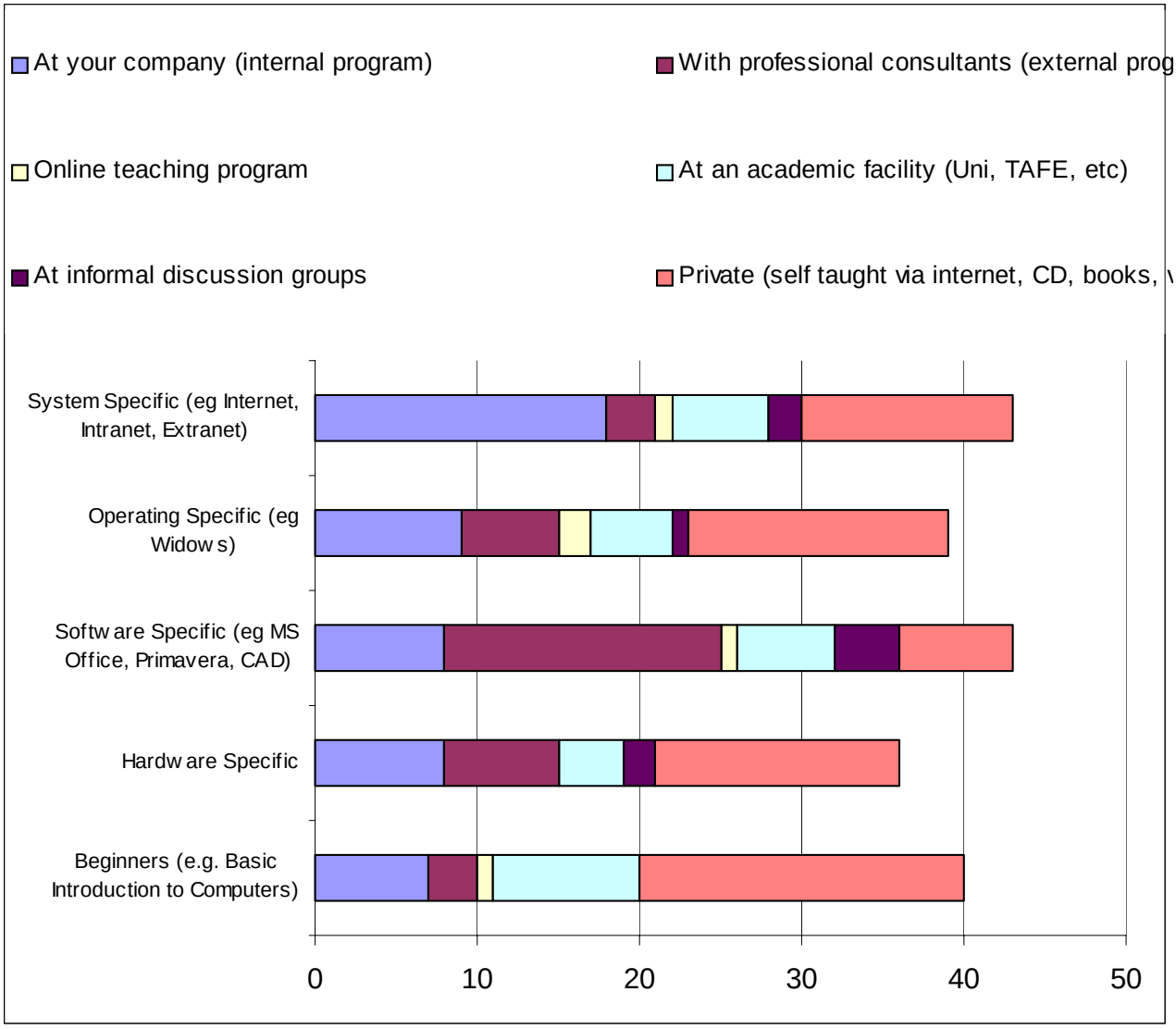

Figure 34 Preferred mode of training

ICT Competence Expectations

Respondents were asked to indicate what overall level of ICT competence (capabilities, skills, etc) they believed a range of team members should have on a project. Figure 35 shows that overall, respondents expect the consultant to have a greater level of ICT competency than all other team members. Contractors and Suppliers were rated next with Clients and Sub-contractors rated lowest however, still expected to have at least average competence.

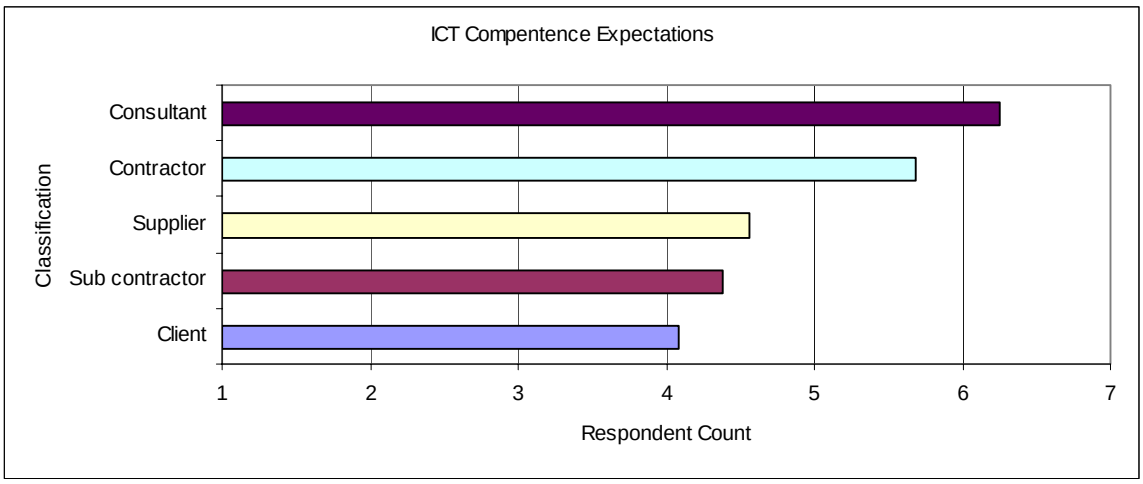

Figure 35 Average response for overall level of ICT competence

6.3.3 ICT Trends & Opinions

This section firstly investigates the results of the analysis on the Benefits or Drivers to the implementation or use of ICT on construction projects. Secondly, the results of the analysis into the Barriers or Limitations to the implementation or use of ICT on construction projects is presented.

Benefits/Drivers for ICT on Projects

Respondents were asked to indicate what influence a specified range of Benefits/Drivers has on their decision to implement or use ICT on projects. A range of issues were presented with the responses for those repeated in the National survey displayed here.

The issues presented included:

1. To help improve overall team/company efficiency (productivity).
2. To help enable electronic banking etc (eCommerce).
3. To help enable electronic tendering (eTender).
4. To help enable electronic archiving of documentation (eArchive).
5. To help set up a dependable ICT infrastructure within your company.
6. To help become Industry leaders in ICT adoption.
7. To help downsize or become a leaner company/team.
8. To help increase business opportunities.
9. To help support industry Research and Development.
10. To help receive tangible rewards (pay/job advancement).
11. To help receive intangible rewards (respect, self fulfillment).

The response options ranged from no influence at all to highly influential with a total of seven rating options.

The mean response rating for all issues was above average suggesting that all issues were influential in their decision to implement or use ICT on projects. The mean response for each of the issues, is displayed in Figure 36 below.

The chart shows the issue with the highest mean rating was '*To help increase business opportunities*' and '*To help improve overall team/company efficiency (productivity)*'.

The issues found to be of least influence, in order of influence include:

- *'To help downsize or become a leaner company/team';*
- *'To help become industry leaders in ICT adoption';* and
- *'To help support industry Research and Development'.*

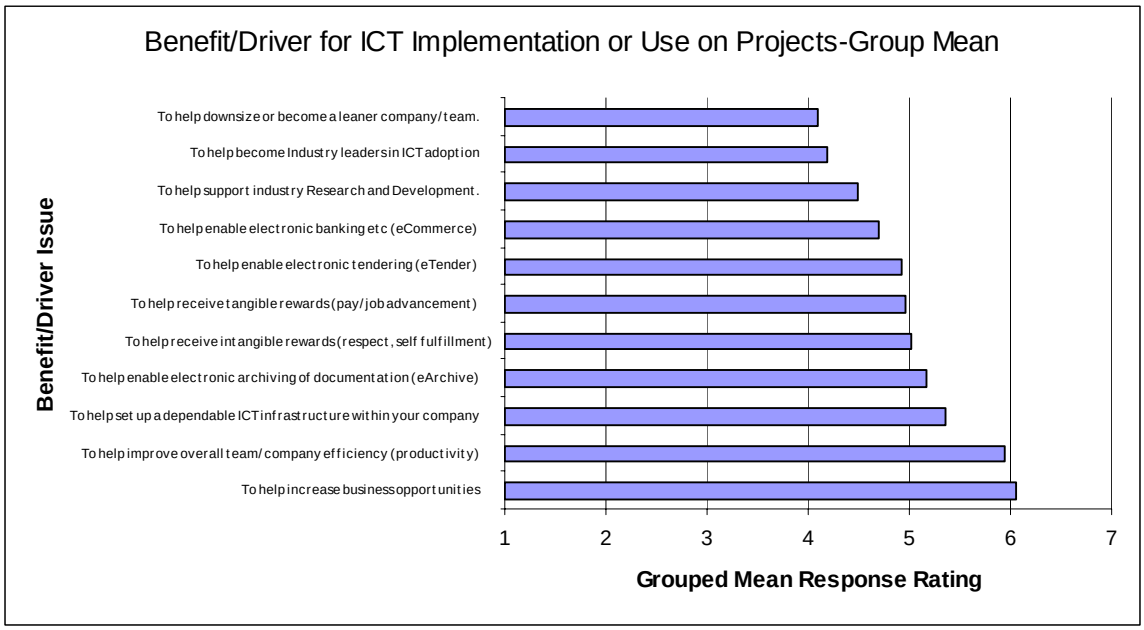

Figure 36 Mean response for Benefits/Drivers influencing ICT implementation

Barriers/Limitations for ICT on Projects

Respondents were asked to indicate what influence a specified range of Barriers/Limitations has on their decision to implement or use ICT on projects. A range of issues were presented with the responses for those repeated in the National survey displayed here.

The issues presented included:

1. Lack of ICT training & experienced (knowledge, awareness & skills).
2. Demanding & inflexible workload.
3. Having limited or no ICT training opportunities within your company/team.
4. Not having an ICT implementation "Champion" on a project.
5. Existing use of traditional/paper-based documentation.
6. The dispersed nature of the industry/projects & participants.
7. Having no ICT Strategy Plan (re ICT use).
8. Your company's perception that ICT is not part of its core business.
9. Inconsistent employee requirements on projects.
10. Having limited or no ICT Infrastructure in place.
11. Having to use incompatible ICT hardware/software/systems.
12. Having limited or no ICT technical support readily available.
13. The continuous & quick succession of ICT upgrades/advancement.
14. Security issues (re project data, access etc).
15. Confidentiality issues (re shared project data).
16. Legislative issues (re contracts, electronic signatures).

The response options ranged from no influence at all to highly influential with a total of seven rating options. The mean response for these issues is displayed in Figure 37. Technical issues such as '*Having to use incompatible ICT hardware/software/systems'*, '*Security issues*

(re project data, access etc)', '*Having limited or no ICT hardware/software support readily available'* and 'The continuous & *quick succession of ICT upgrade/advancement'* were the most influential Barrier/Limitations issues when considering to implement or use ICT on projects.

The issues found to be of least influence, in order of influence include:

- *'Having limited or no ICT training opportunities within your company/team';*
- *'Inconsistent employee requirements on projects'; and*
- *'Not having an ICT implementation "Champion" on a project'.*

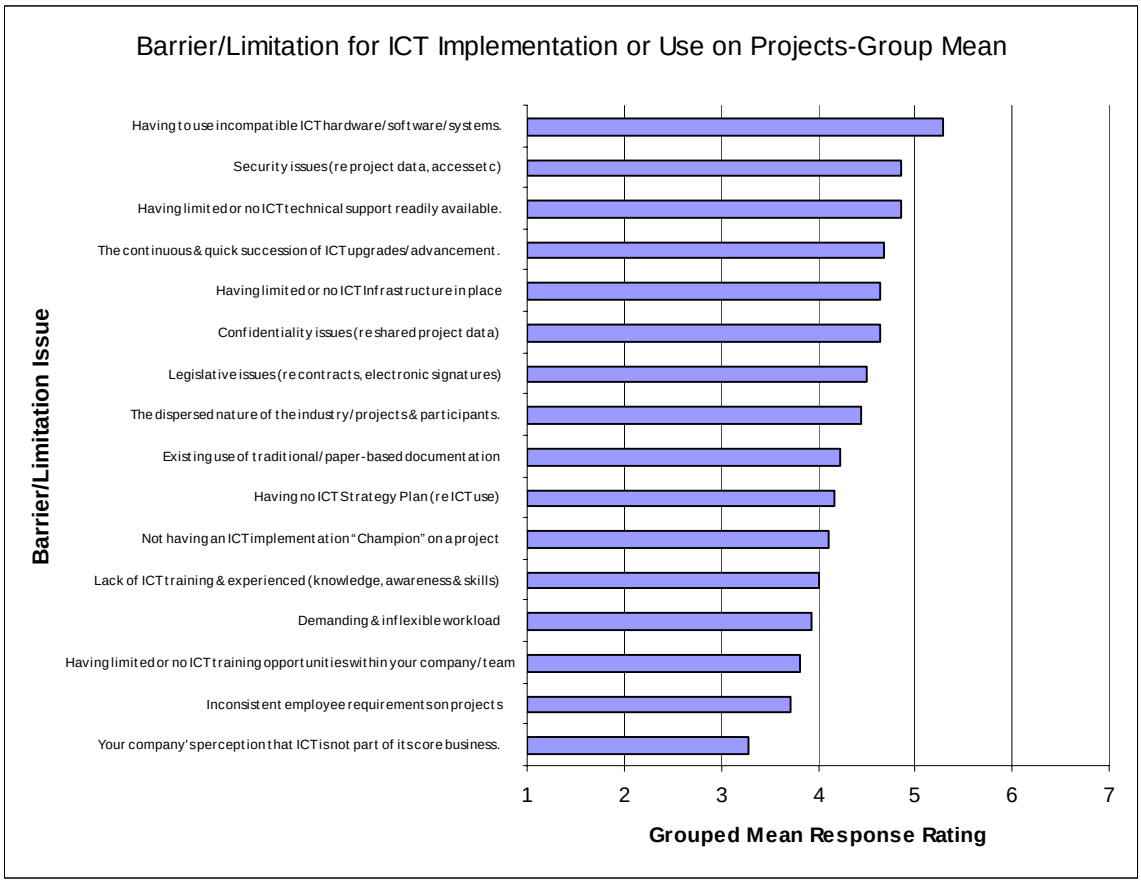

Figure 37 Mean response for Barriers/Limitations influencing ICT implementation

7 APPENDIX B – CURRENT POSITION

Original Response	Arbitrary Category
builder- company director	Manager
Foreman/Builder	Manager
Building Designer	Technical
Sub-contractor owner	Manager
Manager/Director	Manager
Builder	Manager
director	Manager
Carpenter	General
Director/Builder	Manager
Business Owner	Manager
Partner	Manager
Manager	Manager
Construction Manager	Manager
Manager	Manager
director	Manager
Owner	Manager
Manager	Manager
Senior Project Manager	Manager
Manage / Building Consultant	Manager
Director	Manager
Builder	Manager
Principal	Manager
Director	Manager
Partner	General
Managaing Director	Manager
Director	Manager
Managing Director	Manager
Managing Director	Manager
Director	Manager
Admin Assistant	Admin
Partner	General
Principal	Manager
Director of company	Manager
Financial Controller	Admin
Managing Director	Manager
Proprietor	Manager
Managing Director	Manager
MANAGING DIRECTOR	Manager
Director	Manager
Company Secretary	Admin
Director	Manager
Manager	Manager
Business Development Manager	Manager
Sole	Manager
Owner Director	Manager
Business Partner	General
Director	Manager
CEO	Manager
Sales Manager	Manager
Senior Estimator	Technical

Manager Operations	Manager
Principal Scientist (Environmental and Occupational Health)	Technical
M.D	General
Director Projects	Manager
Architect	Technical
Managing Director	Manager
Contract Manager, Sydney Maintenence Contracts	Manager
Director	Manager
Technical Manager, SewerFix Programme	Manager
Sole practitioner architect	Technical
Asset Manager	Manager
company secretary	Admin
Managing Director	Manager
Managing Director	Manager
Compliance Co-ordinator	Technical
Senior Asset & Policy Officer	Manager
GENERAL MANAGER	Manager
Development Manager	Manager
Managing Director	Manager
Manager	Manager
Director	Manager
architect	Technical
Communications and Electrical Engineer	Technical
Director	Manager
Director & Estimating manager	Manager
Manager, Information and Technology	Manager
MANAGING DIRECTOR	Manager
Director / Architect	Manager

8 APPENDIX C – SURVEY QUESTIONNAIRE

ICT in Construction Survey - Team Member Perspective

"Thank you for participating in this 10 minute 'ICT in Construction' Survey."

SURVEY INSTRUCTIONS:
Please complete each of the following four sections.
Once complete, kindly click on the SUBMIT button at the end of the survey.

DEFINITION OF TERMS:
***Information and Communication Technology (ICT)*; is defined here as "*....services and technologies that enable information / data to be accessed, stored, processed, transformed, manipulated, disseminated and communicated over a variety of transmission media*" (ABS1999)**

CLOSING DATE: 14th November 2003

SECTION 1: YOU & YOUR COMPANY

1) Please fill in the following CONTACT DETAILS.

The information you provide in this question will remain CONFIDENTIAL - required only for:
(a) Statistical purposes, and
(b) So that we may be able to contact you, should clarification of any of your responses be required.

Your Name	
Company Name	
Post Code	
Work Phone	
E-mail	
Web Address	

2) What is the HIGHEST level of EDUCATION that you have completed?

(Click here to choose)

3) What is the title of your CURRENT POSITION?

4) HOW LONG have you been working in your present position?

# of years

5) What is your company's MAIN classification?

(Click here to choose)

6) What is your company's average ANNUAL TURNOVER?

(Click here to choose)

7) Which of the following INDUSTRY SECTOR(s) does your company work in?

- ☐ Non-building construction (civil, etc)
- ☐ Building construction (commercial, industrial)
- ☐ Residential

SECTION 2: CURRENT ICT STATUS

1) HOW MUCH does your company currently INVEST in ICT annually?

$

2) Which of the following ICT devices do YOU have ACCESS to within your company?

	I have access to following ICT devices
Desktop Computer	☐
Digital Cameras	☐
Fax / Fax Stream	☐
Handheld Personal Computers	☐
Laptop Computer	☐
Mobile Phone	☐
Scanner	☐
Tablet and Mini-notepad Computers	☐
Video / PC Conference	☐
Voice Recorders	☐
Wireless data transfer unit (WiFi, etc)	☐

3) Which of the following ICT devices do YOU USE on the following size ($) PROJECTS?

	Less than $500,000	$500,000 - $1M	$1M - $5M	$5M - $10M	$10M - $20M	$20M - $50M	$50M - $100M	$100M +
Desktop Computer	☐	☐	☐	☐	☐	☐	☐	☐
Digital Cameras	☐	☐	☐	☐	☐	☐	☐	☐
Fax / Fax Stream	☐	☐	☐	☐	☐	☐	☐	☐
Handheld Personal Computers	☐	☐	☐	☐	☐	☐	☐	☐
Laptop Computer	☐	☐	☐	☐	☐	☐	☐	☐
Mobile Phone	☐	☐	☐	☐	☐	☐	☐	☐
Scanner	☐	☐	☐	☐	☐	☐	☐	☐
Tablet and Mini-notepad Computers	☐	☐	☐	☐	☐	☐	☐	☐
Video / PC Conference	☐	☐	☐	☐	☐	☐	☐	☐
Voice Recorders	☐	☐	☐	☐	☐	☐	☐	☐
Wireless data transfer unit (WiFi, etc)	☐	☐	☐	☐	☐	☐	☐	☐

SECTION 3: ICT TRAINING

1) Have you undergone any OFFICIAL ICT training?

☐ Yes

☐ Never

2) To undergo ICT training, does YOUR COMPANY...

☐ Allow you sufficient TIME during office hours?

☐ Adjust / reduce your WORK LOAD?

3) Of the following, which is your PREFERRED mode of training?

	At your company (internal program)	With professional consultants (external program)	At an academic facility (Uni, TAFE, etc)	At informal discussion groups	Private (self taught via internet, CD, books, video, etc)
Preferred Training Mode	☐	☐	☐	☐	☐

4) What overall level of ICT COMPETENCE (capabilities, skills, etc) do YOU believe the following team members should have on a project?

	None at all	2	3	Average	5	6	Highly Competent
Client	☐	☐	☐	☐	☐	☐	☐
Contractor	☐	☐	☐	☐	☐	☐	☐
Consultant/Specialist	☐	☐	☐	☐	☐	☐	☐
Sub Contractor	☐	☐	☐	☐	☐	☐	☐
Supplier (material / product)	☐	☐	☐	☐	☐	☐	☐

SECTION 4: ICT TRENDS & OPINIONS

1) What INFLUENCE would the following BENEFITS / DRIVERS have on YOUR decision to IMPLEMENT or USE ICT on projects?

	No Influence at all	2	3	Average	5	6	Highly Influential
To help improve overall team/company efficiency (productivity)	☐	☐	☐	☐	☐	☐	☐
To help enable electronic banking etc (eCommerce)	☐	☐	☐	☐	☐	☐	☐
To help enable electronic tendering (eTender)	☐	☐	☐	☐	☐	☐	☐
To help enable electronic archiving of documentation (eArchive)	☐	☐	☐	☐	☐	☐	☐
To help set up a dependable ICT infrastructure within your company	☐	☐	☐	☐	☐	☐	☐
To help become Industry leaders in ICT adoption	☐	☐	☐	☐	☐	☐	☐
To help downsize or become a leaner company/team.	☐	☐	☐	☐	☐	☐	☐
To help increase business opportunities	☐	☐	☐	☐	☐	☐	☐
To help gain increased efficiency (improved productivity)	☐	☐	☐	☐	☐	☐	☐
To help support industry Research and Development.	☐	☐	☐	☐	☐	☐	☐
To help receive tangible rewards (pay/job advancement)	☐	☐	☐	☐	☐	☐	☐
To help receive intangible rewards (respect, self fulfillment)	☐	☐	☐	☐	☐	☐	☐

2) What INFLUENCE would the following BARRIERS / LIMITATIONS have on YOUR decision to IMPLEMENT or USE ICT on projects?

	No Influence at all	2	3	Average	5	6	Highly Influential
Not having an ICT implementation "Champion" on a project	☐	☐	☐	☐	☐	☐	☐
Existing use of traditional/paper-based documentation	☐	☐	☐	☐	☐	☐	☐
The dispersed nature of the industry/projects & participants.	☐	☐	☐	☐	☐	☐	☐
Having limited or no ICT Infrastructure in place	☐	☐	☐	☐	☐	☐	☐
Having limited or no ICT technical support readily available.	☐	☐	☐	☐	☐	☐	☐
ICT investment restrictions due to budget constraints.	☐	☐	☐	☐	☐	☐	☐
Not being aware of the cost benefits of investing in ICT.	☐	☐	☐	☐	☐	☐	☐
The continuous & quick succession of ICT upgrades/advancement.	☐	☐	☐	☐	☐	☐	☐
Having to use incompatible ICT hardware/software/systems.	☐	☐	☐	☐	☐	☐	☐
Security issues (re project data, access etc)	☐	☐	☐	☐	☐	☐	☐
Confidentiality issues (re shared project data)	☐	☐	☐	☐	☐	☐	☐
Legislative issues (re contracts, electronic signatures)	☐	☐	☐	☐	☐	☐	☐
Having no ICT Strategy Plan (re ICT use)	☐	☐	☐	☐	☐	☐	☐
Your company's perception that ICT is not part of its core business.	☐	☐	☐	☐	☐	☐	☐
Inconsistent employee requirements on projects	☐	☐	☐	☐	☐	☐	☐
Lack of ICT training & experienced (knowledge, awareness & skills)	☐	☐	☐	☐	☐	☐	☐
Demanding & inflexible workload	☐	☐	☐	☐	☐	☐	☐
Having limited or no ICT training opportunities within your company/team.	☐	☐	☐	☐	☐	☐	☐

END OF SURVEY

Please click on the "Submit Survey" button below

THANK YOU

Submit Survey | Reset

9 APPENDIX D – AUTHOR BIOGRAPHIES

Mr. STEPHEN McFALLAN

Present Position
Construction Scientist, CSIRO Manufacturing and Infrastructure Technology.

Qualifications
BAppSc (Mathematics), Queensland University of Technology, 1998
Graduate Diploma in Applied Science (Mathematics), Queensland University of Technology, 2001

Research and Industrial Experience
Mr. Stephen McFallan is a construction researcher with CSIRO. His interest lies in the area of the sustainable built environment and performance measurement. He has undertaken statistical analysis of the survey into causes of design and document deficiencies within the Australian Construction Industry, conducted by CSIRO. More recently he has been involved in a project with Australian Construction Industry Forum and Australian Procurement Construction Council seeking an agreed strategy for documentation improvement initiatives for industry adoption.
Stephen's most significant work to date has been on the Property Standard Index (PSI) project in collaboration with Department of Housing, Queensland, the objective of which was to develop and implement a Property Condition Index to facilitate decisions on selling, maintaining and reviewing building stock. This work has experience worldwide interest.

Mr. TODD REMMERS

Present Position
Research Assistant, CSIRO Manufacturing and Infrastructure Technology.

Qualifications
Carpentry and Joinery Apprenticeship, Gold Coast Institute of TAFE, 1984.
Advanced Certificate in House Building Registration, Gold Coast Institute of TAFE, 1987.
BEng (Civil, Honours First Class), Griffith University, 2000.

Research and Industrial Experience
Mr. Todd Remmers has been involved in the building and construction industry since 1980. In 1981 he started a Carpentry and Joinery apprenticeship, which was completed in 1984. Following the completion of his apprenticeship, he worked mainly in the Home Building Industry in South East Queensland as Sub-contract carpenter as well as commercial resort projects around Australia during a two year working holiday in 1988-89. Since completing his Engineering degree, he has worked in Local Government as a Development Engineer.

In 2002, Mr. Remmers joined the CSIRO's Building, Construction and Engineering (now Manufacturing and Infrastructure Technology) Division as a Research Assistant, to investigate issues relating to construction process efficiency, facilities/asset management and sustainable built environments. Relevant topics of research specifically relating to this report Mr. Remmers has been previously involved with include an investigation in to design and documentation quality in the construction industry.