BRITE Report 2004

Report 2001-012-A-08 BRITE Innovation Survey

Project Leader Karen Manley

Team Members Richard Hough
Stephen McFallan
Mike Swainston
Robert Wilcox
Don Allan
Aletha Blayse
Graham Miller
Mary Hardie
Michelle Coillet

Project Affiliate Graeme Taylor

Research Program A
Business and Industry Development

Project 2001-012-A:
Innovation Potential, Directions and Implementation in the Building and Construction Product System

Project Marketing Name:
The BRITE Project – Building, Research, Innovation, Technology, Environment

30 September 2004

Distribution List

CRC for Construction Innovation

Disclaimer

The Client makes use of this Report or any information provided by CRC for Construction Innovation in relation to the Consultancy Services at its own risk. CRC CI will not be responsible for the results of any actions taken by the Client or third parties on the basis of the information in this Report or other information provided by CRC CI nor for any errors or omissions that may be contained in this Report. CRC CI expressly disclaims any liability or responsibility to any person in respect of any thing done or omitted to be done by any person in reliance on this Report or any information provided.

Please direct all enquiries to:

Chief Executive Officer
Cooperative Research Centre for Construction Innovation
9th Floor, L Block, QUT
2 George St
Brisbane Qld 4000
AUSTRALIA
T: 61 7 3864 1393
F: 61 7 3864 9151
E: enquiries@construction-innovation.info

TABLE OF CONTENTS

FIGURES AND TABLES

List of Figures

List of Tables

ABBREVIATIONS

Table 1 Abbreviations

AAPA	Australian Asphalt Pavement Association
ABS	Australian Bureau of Statistics
ACEA	Association of Consulting Engineers, Australia
AGGA	Australian Glass and Glazing Association
AIQS	Australian Institute of Quantity Surveyors
AMCA	Air Conditioning and Mechanical Contractors Association
ASI	Australian Steel Institute
BRITE	Building Research Innovation Technology and Environment
CCAA	Cement and Concrete Association of Australia
ECA	Electrical and Communications Association, Queensland
EU	European Union
IBIS	IBIS Business Information Pty Ltd
NECA	National Electrical and Communications Association
NRCC	National Research Council of Canada
NSW	New South Wales
OGP	Office of Government Procurement, NSW Department of Commerce
PCA	Property Council of Australia
PWC	PricewaterhouseCoopers
QDMR	Queensland Department of Main Roads
QDPW	Queensland Department of Public Works
R&D	Research and Development
RTA	Roads and Traffic Authority of NSW
VicRoads	Victorian Roads Authority

1 PREFACE

This internal CRC for Construction Innovation report summarises the activities of the BRITE Project in 2004, which primarily involved undertaking a national innovation survey.

The overall objective of the BRITE Project is to improve the incidence and quality of innovation in the Australian construction industry.[1] Many stakeholders in the industry are sceptical about the potential for innovation and its likely benefits. Many also lack the linkages and capabilities required for successful innovation. The BRITE Project is redressing this situation through demonstration and benchmarking activities. The intention is to conduct innovation case studies every second year over the life of the CRC, and an innovation survey in the intervening years.

The BRITE national innovation survey of the construction industry reviews the operation of innovation processes in the industry, comparing the features of high and low innovators, and enabling industry managers to benchmark their organisation's innovation performance and implement appropriate responses. Government officials will also find the results useful in developing appropriate public policy support.

The study has been guided by the BRITE research team, with representatives from Australian industry, academia and government. It represents an important contribution by industry analysts on the topic of innovation – a topic that continues to preoccupy governments internationally and nationally, after nearly a decade of intense interest. Indeed, this sustained interest is testimony to the power of innovation to drive economic growth.

[1] The term 'Construction Industry' implies the 'Property and Construction Industry' and includes building, road, bridge and other construction work.

2 EXECUTIVE SUMMARY

This document reports on an innovation survey of the Australian construction industry undertaken by the BRITE Project of the CRC for Construction Innovation in 2004. The survey sample was drawn from 3,500 businesses in the road/bridge and commercial building sectors in NSW, Vic and Qld, covering main contractors, trade contractors, consultants, suppliers and clients. One-third of this population was sampled and a response rate of 30% was achieved. The survey investigates innovation determinants in the industry, comprising various aspects of business strategy and business environment.

2.1 Overall Results

2.1.1 Innovation Activity

The 'new-to-industry' rate of technological innovation was 18%, which can be compared with an economy-wide rate of 17% for a recent NZ study. Overall, 25 respondents (6%) reported 'new-to-the-world' technological innovation, 17 of whom were consultants.

R&D is a key indicator of technological innovation, and one-quarter of the industry *invests* in R&D. The industry has a very low successful claim rate (15%) against the Commonwealth Government's R&D tax concession, with the majority of businesses being uncertain about their eligibility.

Despite the focus of many analysts almost exclusively on R&D and technological innovation, organisational (managerial) innovation was shown to be of equal value to businesses, and linked to success in technological innovation.

2.1.2 Innovation Determinants

2.1.2.1 Business Strategies

Business strategies are a key determinant of innovation outcomes. The results show a significant positive relationship between the number of business strategies employed by businesses and the number of advanced practices adopted (organisational innovation). The results also show a significant relationship between the use of formal evaluation programs to monitor innovation value and success in both technological and organisational innovation, however only 15% of the industry relies on such programs. Another area of concern is the relatively low ranking of R&D strategies amongst the business strategies. Constrained industry profitability is likely to play a part in this. The importance of transferring project learnings into continuous business processes is also ranked relatively low.

2.1.2.2 Innovation Drivers and Obstacles

The desire for efficiency/productivity improvements drives just over half of all innovation undertaken by the industry; this and 'customer needs' are the two key motivators nominated by respondents.

The high costs of developing innovations is the dominant *obstacle* to innovation, along with insufficient time.

Different industry groups can also act as innovation drivers or obstacles. The survey found that large/repeat clients, architects and manufacturers were the key groups driving innovation in the industry, and that government regulators, insurers and funders were the key groups inhibiting innovation.

2.1.2.3 Sources of Innovation Ideas

Another view of innovation drivers is gained by considering sources of ideas. Indeed, a significant positive relationship was found between the number of sources of ideas nominated by respondents and the number of advanced practices adopted (organisational innovation).

2.1.2.4 Knowledge of the CRC for Construction Innovation and International Competition

Given the mandate of the CRC for Construction Innovation to promote the industry's performance through innovation, the survey sought to determine the reach of the CRC in the first 3 years of its operation. Overall, 20% of the industry had heard of the CRC prior to receiving the survey.

In view of the industry's increasing exposure to international competition, the survey also asked about respondents' views of the industry's global standing. Most of the industry thought the Australian industry was sufficiently innovative to cope with international competition.[2]

2.1.3 Innovation Impacts

Overall, 93% of the industry reported a positive impact on profitability arising from their most successful innovation over the past three years.

It was found that businesses may be able to improve their profitability by adopting a larger number of advanced practices, implementing a formal innovation strategy, or employing a greater number of knowledge strategies.

2.2 Characteristics of High Innovators

'High innovators' were defined as those businesses that:

- developed innovations with higher degrees of novelty;
- developed innovations yielding higher levels of profitability;
- adopted a higher number of advanced practices; and
- invested in R&D.

[2] This result is based on the overall sample, and also holds after sub-sector weighting and allowing for non-response bias.

Overall, 81 of the 383 survey respondents were defined as high innovators. The team then looked at their features and found that high innovators were more likely than low innovators to:

- place significant value on employee, technology and knowledge strategies;
- use a broad range of sources of innovation ideas;
- have a formal innovation evaluation program in place;
- rely on research institutions for innovation ideas;
- recruit new graduates;
- capture project learnings for on-going reference;
- reduce clients costs;
- have heard of the CRC for Construction Innovation;
- have successfully claimed the R&D tax concession; and
- monitor international competition.

In terms of the proportion of each industry sector in the high innovator group, the sectors ranked as follows, from most represented to least represented: clients, consultants, suppliers, main contractors and trade contractors. Clients were significantly over-represented in the high innovator group.

3 INTRODUCTION

In 2004, the BRITE Project undertook a major survey of innovation in the Australian construction industry. The survey builds on a pilot innovation survey undertaken by PricewaterhouseCoopers (PWC) for the Australian Construction Industry Forum on behalf of the Australian Commonwealth Department of Industry Tourism and Resources, in 2001. The current report continues with one of the key features of that study, the use of an innovation index to differentiate high innovators from low innovators. This approach enables a focus on the characteristics of the industry's most successful innovators.

An earlier report in the BRITE series assessed recent innovation surveys undertaken internationally in the construction industry, and more broadly. That study identified a number of previous surveys that were seen as representing best practice, and that were particularly relevant to BRITE's objectives. The PWC report was one of these, along with surveys undertaken by Queensland Department of Main Roads (QDMR), National Research Council of Canada (NRCC), the Australian Bureau of Statistics (ABS) and the Organisation for Economic Cooperation and Development (OECD).

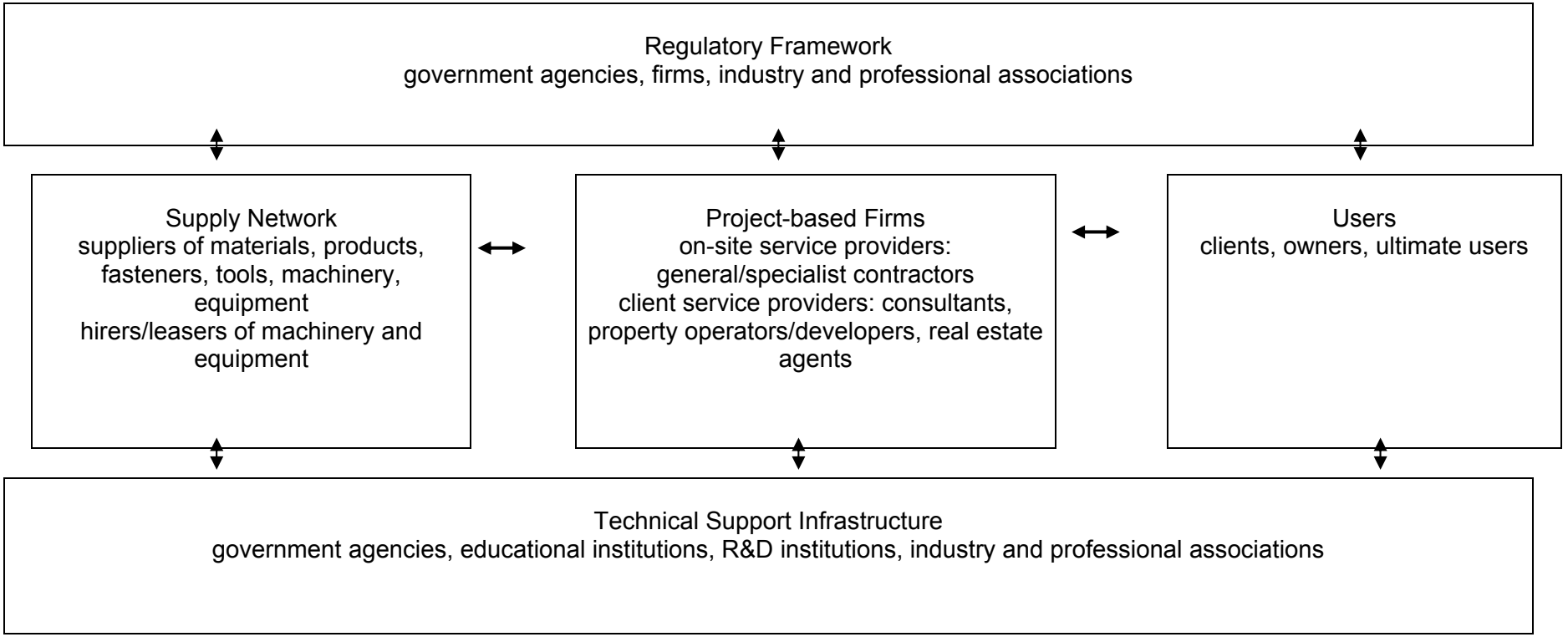
The BRITE questionnaire (Section 8) is based on the learnings of these organisations, together with the requirements of the project's industry partners and guidance provided by the literature. The final survey form also took into account the desirability of producing results that could be compared to previous studies, although due to different contexts and objectives, and difficulties associated with getting timely access to some international questionnaires, the scope for comparison was limited.

The BRITE survey responds to an identified need within the industry to have accurate and timely innovation data upon which to base effective management strategies and public policies. It may be that the need for BRITE to undertake on-going studies of this nature will be influenced by recent moves by the ABS to re-initiate their innovation survey activities and expand them to encompass all key Australian industries, including limited coverage of the construction industry.

3.1 Conceptual Framework

The literature indicates that a broad-based approach to interpretation of construction industry boundaries is essential to understanding economic dynamics in project-based contexts and improving industry growth. Because production in the industry is project-based, employing participants from a number of traditionally defined industries, an understanding of industrial linkages and networks is essential to interpreting the nature of innovation processes. Figure 1 shows the broad range of participants involved in the industry.

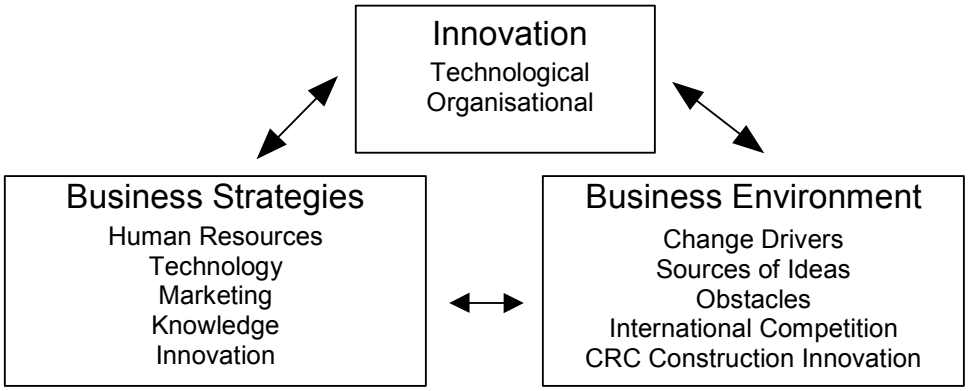
Figure 1 Participants and Potential Relationships in the Building and Construction Industry



(Source: Based on Gann and Salter 1998)

This framework provided input to the structuring of the survey sample, ensuring that the views of all the key players were represented. Figure 2 shows the two key macro-drivers of innovation at firm level.

Figure 2 Overview of Firm-Level Innovation Determinants[3]



The diagram highlights two key types of innovation, five key strategy types and five key elements of the business environment. Business strategies and business environment are the two major influences on firm-level innovation activity (eg. Seaden 1999, 62). These two macro-drivers can be thought of as the internal and external influences, respectively, on an organisation's innovation performance.

The relationships between the macro-drivers and innovation outcomes are shown in all cases as two-way flows, indicating the impact of strategies and environment on innovation, and the influence of innovation, in turn, on these factors. Although the latter dynamics are important, this project focused largely on the determinants of innovation. Similarly, it was beyond the scope of the present study to examine relationships between innovation determinants.

3.2 Methodology

The research questions driving this study were:

- What is the rate of innovation?
- What are the determinants of innovation?
- What is the impact of innovation?
- What are the characteristics of high innovators?
- What are the main sectoral differences in innovation performance?

[3] There are a number of other important levels and relationships in systems of innovation that are beyond the scope of this study.

These questions arose from consideration of the literature on innovation systems, the performance of previous innovation surveys and the needs of the industry partners to the project. The answers to these questions are provided here, and it is anticipated that they will be employed to guide business strategies and government policies aimed at improving business and industry innovation performance. Indeed, the project team will be focused on disseminating the data and analysis presented in this report, to mobilise interest in innovation.

It was decided that the best approach to investigating the research questions was through a large-scale survey. The questionnaire (Section 8) was organised into three sections: innovation activity; business practices and strategies; and industry-wide issues. Questionnaire design was developed jointly by the BRITE team, with significant input from industry partners, and in consideration of the efficacy of previous innovation surveys internationally. In addition to asking generically about innovation activity, the BRITE survey asked about the use of a list of 22 advanced practices, as an alternative measure of organisational (business practice) innovation. The survey also asked about research and development (R&D) activity, as an input indicator of technological innovation.

The survey comprised only 16 questions, to keep the document short and the time required for completion to a minimum, and in an effort to improve compliance and the response rate. For the same reason, no details were collected about the organisation's identity.

While most of the questions required ticking appropriate responses, the survey also collected perceptual data through one open-ended question, which asked about the respondent's ideas to improve the industry's international performance. Quantitative results were derived for this question by manually coding repetitive themes and reporting the frequency with which they occurred. In most cases, multiple codes per respondent were allotted.

A pilot survey was undertaken, covering six respondents from across the sub-sectors to be represented. Following this, some adjustment was made to the key innovation performance questions, mainly to provide examples that were more appropriate to the industry. Yet, it may be that the pilot exercise was too limited, as the main survey resulted in innovation rates substantially higher than comparable studies. This issue is discussed in detail in Section 2.1.1.

The pilot survey also revealed that public-sector clients were alienated by the use of the term 'your business'. Rather than potentially alienating private-sector businesses, by using the term 'your organisation' to cover both the private and public sectors, two versions of the survey were distributed. They both had the same questions, however the client version used the phrase 'your organisation'.

The study population was defined as key organisations in the Australian construction industry. The sampling unit was therefore at organisational level. To make the survey manageable, the study focused on the commercial building and civil engineering sectors (excluding residential building – in line with BRITE industry partner interests). Further, the study was confined to NSW, Victoria and Queensland, although the industry was defined broadly to include main contractors, trade contractors, consultants, suppliers and

clients.[4] Key organisations were defined as those appearing on the pre-qualification lists of government road and building agencies in the three states, together with members of eight selected industry associations. The suppliers and associations chosen for surveying were identified by the government agencies working with the researchers, as those that made the most significant contribution to construction projects.

The surveys were sent directly to the sample by the government agencies and industry associations working with the project team. This meant that survey recipients had a relationship with the survey sender, which is likely to have resulted in a higher response rate than if the researchers had sent the surveys themselves, without introduction.

In all, 1,317 surveys were distributed to the survey population of 3,476 businesses and 383 useable responses were received, giving a sampling rate of 38% and a response rate of nearly 30%. This is a very good result for the construction industry, given that rates of 15-20% are considered reasonable, and that results of a recent Singaporean construction industry study were published in a well-respected journal with a useable response rate of only 4.5% (Ling 2003, 642).

The survey was distributed through the post, rather than electronically via email or the internet. The electronic options were deemed to be sub-optimal for the construction industry, given the performance of previous electronic efforts. The surveys were sent to the contact person on the government agency pre-qualification lists and the industry association memberships lists. These people were mainly managers.

The table overleaf summarises the industry sectors surveyed, providing details of the survey senders, the response rate, the population frame definition and the proportion of the population sampled.

[4] 'Suppliers' are in some cases manufacturers, and in some cases supply goods *and* associated trade services. 'Consultants' are roughly 50% engineers, 25% architects and 25% quantity surveyors.

Table 2 Survey Summary Schedule

Industry Sector	Survey Sender	Date Out 2004	No. Sent	Useable No. Back	Useable Response Rate	Population Frame Size	Population Frame Definition	Proportion of Population Frame Sampled	Sampling Method
Total			**1317**	**383**	**29%**	**3476**		**38%**	
1. MAIN CONTRACTORS			**300**	**93**	**31%**	**1122**		**32%**	
Commercial Building Contractors			**150**	**55**	**37%**	**740**		**20%**	
Commercial Building Contractors - QLD	QDPW	20-Feb	50	9	18%	310	Prequalified firms	16%	Random
Commercial Building Contractors - NSW	OGP	23-Feb	50	30	60%	80	Prequalified firms	63%	Random
Commercial Building Contractors - VIC	Building Commission	25-Feb	50	16	32%	350	Prequalified firms	14%	Random
Road and Bridge Contractors			**150**	**38**	**25%**	**382**		**39%**	
Road and Bridge Contractors - QLD	QDMR	20-Feb	50	12	24%	101	Prequalified firms	50%	Random
Road and Bridge Contractors - NSW	RTA	23-Feb	50	8	16%	71	Prequalified firms	70%	Random
Road and Bridge Contractors - VIC	VicRoads	23-Feb	50	18	36%	210	Prequalified firms	24%	Random
2. CONSULTANTS			**409**	**130**	**32%**	**1549**		**26%**	
Commercial Building Consultants			**150**	**48**	**32%**	**675**		**22%**	
Commercial Building Consultants - QLD	QDPW	20-Feb	50	18	36%	95	Prequalified firms	53%	Random
Commercial Building Consultants - NSW	OGP	24-Feb	50	21	42%	130	Prequalified association members	38%	Random
Commercial Building Consultants - VIC	Building Commission	23-Feb	50	9	18%	450	Prequalified firms	11%	Random

Industry Sector	Survey Sender	Date Out 2004	No. Sent	Useable No. Back	Useable Response Rate	Population Frame Size	Population Frame Definition	Proportion of Population Frame Sampled	Sampling Method
Road and Bridge Consultants			**150**	**52**	**35%**	**874**		**17%**	
Road and Bridge Consultants - QLD	QDMR	20-Feb	50	18	36%	450	Prequalified firms	11%	Random
Road and Bridge Consultants - NSW	ACEA	10-Mar	50	20	40%	150	Prequalified association members	33%	Random
Road and Bridge Consultants - VIC	Vic Roads	23-Feb	50	14	28%	274	Prequalified firms	18%	Random
Quantity Surveyors	AIQS	19-Apr	109	30	28%	200	Firm-level members	55%	Random
3. CLIENTS - PUBLIC SECTOR *			**44**	**23**	**52%**	**44**		**100%**	
Road and Bridge - QLD	QDMR	30-Mar	14			14	District Directors	100%	Census of key clients
Road and Bridge - NSW	RTA	23-Feb	6			6	Regional Managers	100%	"
Road and Bridge - VIC	VicRoads	23-Feb	6			6	Regional Managers	100%	"
Commercial Building - QLD	QDPW	20-Feb	7			7	Key government clients	100%	"
Commercial Building - VIC	Building Commission	25-Feb	11			11	Key government clients	100%	"
4. TRADE CONTRACTORS			**236**	**74**	**31%**	**346**		**68%**	
Electrical and Communication Contractors			**172**	**48**	**28%**	**282**		**61%**	
Electrical and Communication Contractors - NECA - National (NSW/Vic)	NECA	8-Mar	125	43	34%	235	Major contractor association members	53%	Random (Census of key players > 20 employees in NSW)
Electrical and Communication Contractors - ECA - Qld	ECA Qld	29-Mar	47	5	11%	47	Major association members	100%	Census

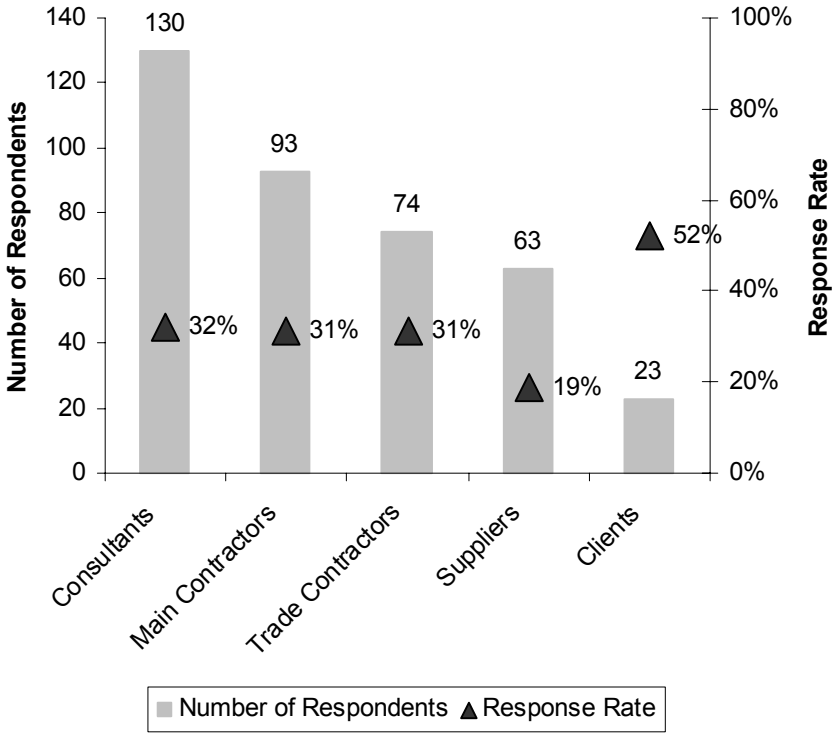
Industry Sector	Survey Sender	Date Out 2004	No. Sent	Useable No. Back	Useable Response Rate	Population Frame Size	Population Frame Definition	Proportion of Population Frame Sampled	Sampling Method
Air Conditioning and Mechanical Contractors			**64**	**26**	**41%**	**64**		**100%**	
Air Conditioning and Mechanical Contractors - AMCA - QLD	AMCA Qld	12-Mar	12	10	83%	12	Major contractor association members	100%	Census of major contractor members; supplier members not covered.
Air Conditioning and Mechanical Contractors - AMCA - NSW	AMCA NSW	29-Mar	9	6	67%	9	Major contractor association members	100%	"
Air Conditioning and Mechanical Contractors - AMCA - VIC	AMCA Vic	29-Mar	43	10	23%	43	Major contractor association members	100%	"
5. SUPPLIERS			**328**	**63**	**19%**	**415**		**79%**	
Glass – AGGA Accredited Glaziers – QLD, NSW, VIC	BRITE	12-Mar	150	23	15%	222	AGGA accredited glaziers	68%	Random
Plaster	BRITE	15-Mar	139	21	15%	139	Plaster and plaster board suppliers/ manufacturers	100%	Census based on Yellow Pages Qld, NSW & Vic
Asphalt - AAPA	AAPA	28-Apr	26	15	58%	26	AAPA members nationally	100%	Census based on AAPA membershi p
Steel - ASI	ASI	15-Mar	13	4	31%	28	Key manufacturers	46%	Key manufactur ers selected by ASI

NOTES:

- * It was not possible to allocate all the client responses by sub-sector.
- CCAA and PCA declined to participate; Office of Government Procurement, NSW Department of Commerce failed to provide a list of key clients, although they posted surveys to their contractors and consultants, with good results
- Lift suppliers census survey sent by BRITE and based on Yellow Pages listings for Qld, NSW and Vic was unsuccessful and dropped as only 3 from 32 forms were returned
- Private sector client census survey sent by BRITE and based on IBIS 'Commercial Property Developers' list for Australia was unsuccessful and dropped as only 2 from 70 forms were returned
- Plaster suppliers were the only participants surveyed directly by the BRITE Project with no support from an Industry Association or Government Agency where a workable response was achieve

Sector response rates are summarised below.

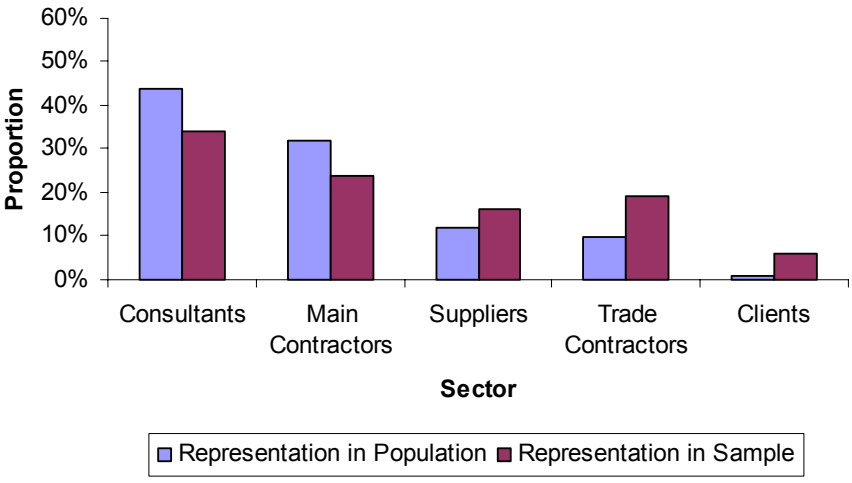
Figure 3 Survey Response Rates by Sector



The chart above shows the raw number of responses from each sector and their response rates. Consultants dominated in terms of raw numbers and clients had the strongest response rate.

Each sector's representation in the sample versus the population is shown .

Figure 4 Sub-sector Representation in Sample and Population



Consultants and main contractors are slightly under-represented in the sample compared to their presence in the industry, while suppliers, trade contractors and clients are slightly over-represented. This is overcome to a large extent through significance testing.

3.2.1 Data Validity and Integrity

The data collected enable statistics to be determined which provide estimates for population parameters. The difference between the actual population parameters and the survey statistics can be estimated by the sampling error. The size of the sampling error is influenced by the sample size, population variability and the survey design. Larger sample size will result in smaller sampling error as will lower population variability. Given cost and time limitations, a stratified sampling approach was taken, allowing smaller samples from homogeneous populations to be surveyed and still achieve reliable survey results. An indicator of the sampling error is the standard error.

The table below provides estimates of standard error.

Table 3 Estimates of Standard Error

Number of respondents	Positive response rate	Standard error
383	90%	1.5%
383	80%	2.0%
383	70%	2.3%
383	60%	2.5%
383	50%	2.6%
100	90%	3.0%
100	80%	4.0%
100	70%	4.6%
100	60%	4.9%
100	50%	5.0%
25	90%	6.0%
25	80%	8.0%
25	70%	9.2%
25	60%	9.8%
25	50%	10.0%

This table indicates that where the whole sample is used for the analysis and a reported proportion is around 70% the standard error is approximately 2.3%. In other words the true population parameter for the estimate is expected to be between 65% and 75%, based on the confidence interval used for the analysis. For all statistical tests a 95% confidence bound was chosen by convention as a measure of significant difference. Thus all statistics noted in this report as statistically significant indicate a likelihood of at least 95% that the result was not due to chance only.

Non-sampling error includes things like sample bias that occurs through self-selection, data entry errors; and respondents misunderstanding a question. Every attempt has been made to minimise the non-sampling error in this survey. For example, use of data entry auditing to assess the data input accuracy, survey question protesting and consistency and validity tests to check for inconsistent responses. The reliability was measured by estimating the internal consistency. In this case Cronbach's alpha was used which provides a measure between 0 and 1. The scores achieved for this survey were between 0.6 and 0.7, which is an acceptable range and indicates consistency in the responses. Further, to minimise response bias the team worked very hard to achieve a good response rate as it is widely accepted that it is more important to achieve a higher final response rate than to have a large initial sample size to minimise the effect of response bias.

This report examines overall survey results, together with the characteristics of high innovators, and comparisons across the five industry sectors shown. The report does not examine data by state, nor by the road and building industries, nor by disaggregated sub-sectors, due to resource constraints.

Section 11 summarises key survey learnings for the benefit of other CRC for Construction Innovation researchers.

4 OVERALL SURVEY RESULTS AND DISCUSSION

This section examines the overall responses to the survey and reports on significant cross-tabulations between questions, in addition to significant results within questions.[5] Results are reported and analysed on innovation activity, innovation determinants and innovation impacts.

Selected results from this section can be compared to a number of previous surveys, including:

- 2004 edition European Union (EU) all-industries innovation survey – although there is no published construction industry data (European Commission 2004);
- 2004 edition Statistics New Zealand all-industries innovation survey - contains results for the construction industry, defined as main contractors in residential building, commercial building and road and bridge construction (Statistics New Zealand 2004);
- 2004 edition ABS all-industry innovation survey – contains results for the construction industry (as defined above) plus architects, engineers, and possibly some of the supplier sectors – although the survey results will probably not be available until 2005 (ABS *forthcoming*);
- 2001 edition Statistics Canada innovation survey of the construction and related industries – (Anderson and Schaan 2001);
- 2002 edition PWC pilot innovation survey (PWC 2002); and
- 2003 edition QUT/CSIRO innovation survey of the Queensland road and bridge industry (Manley 2003).

As discussed in the methodology section, different contexts and objectives mean that opportunities for comparison are limited.

4.1 Innovation Activity

Both technological and organisational innovation is considered in this section.

4.1.1.1 Technological Innovation

Most innovation studies report on technological innovation, as opposed to organisational innovation, which is considered by the OECD even more difficult measure. The 'new-to-industry' rate of technological innovation was 18%, which can be compared to an

[5]All questions were investigated for significance at a macro level, and all relationships between them where investigated at the same level. In many cases, where no significant results emerged at this level, and such results had been expected, a micro statistical analysis was undertaken. However, owing to time constraints relative to the total number of micro relationships that could have been investigated, subjective judgements were made concerning which relationships were pursed in more detail, based on expert opinion. Resource constraints have also precluded comment on all the results that were not statistically significant.

economy-wide rate of 17% for a recent NZ study (a rate for the NZ construction industry is not available). [6]

The survey also collected data on 'new-to-world' technological innovation, which was undertaken by 25 organisations – 6% of respondents. Consultants dominated world-first innovation in the industry, accounting for 17 of the 25 technological instances (suppliers accounted for six and clients for one). The figures may indicate that consultants are more effective in international surveillance compared to other sectors, and so are more confident in claiming world-first status.

Another view of technological innovation is gained by looking at investment in R&D, which is a key input indicator of technological innovation (OECD/Eurostat 1997). Indeed, of the 98 respondents (26%) who stated investing in R&D was a highly important business strategy for them, 95% (94) indicated they had introduced new or significantly improved technologies during the past three years. Businesses that invested in R&D were significantly more likely to be technological innovators than businesses that did not invest in R&D (ChiSq 11.72, df=1).

The data shows that one-quarter of the Australian construction industry invests in R&D, [7] and that these businesses are also significantly more likely to know about the CRC for Construction Innovation and to think the industry is internationally competitive than other businesses (ChiSq = 12.12, df = 4; ChiSq = 18.11, df = 4). However, significance testing showed no relationship between investment in R&D and profitability. It may be that R&D results in other benefits, such as expanding markets, reducing negative environmental impacts and reducing energy consumption. It is also the case that R&D is only an input to innovation outcomes, with the latter relying on a range of business practices and environmental factors discussed later in this report.

Of the 98 organisations that invested in R&D, 37 had not assessed their entitlement for the Commonwealth Government's R&D tax concession scheme, perhaps indicating the need for better policies aimed at increasing the industry's awareness and understanding of the scheme. Alternatively, the data may suggest that the benefits offered by the scheme do not justify the compliance costs. Further research is needed in this area.

Overall, 53% of respondents did not know if they were entitled to claim the R&D tax concession, while 32% knew they weren't entitled to receive the concession, and only 15% knew they were entitled. As noted, one quarter of the industry invest in R&D, so many investors are not receiving the concession.

Although overall one-quarter of the industry *invests* in R&D, the rate of *performance* of R&D within the industry is very much lower. In 2002-2003, the following performers where registered with the ABS:

- 173 engineering consultants,
- 19 trade contractors (with electrical contractors accounting for 90% of these, having more then doubled their performance over the past two years),

---

[6] See Section 10 for a full discussion of innovation rates, and measurement difficulties encountered.
[7] This result is based on the overall sample, and also holds after sub-sector weighting and allowing for non-response bias.

- 18 main contractors,
- 14 surveyors, and
- six architects (ABS 2004a).[8]

Data restrictions make calculation of a rate of performance difficult, however for the main and trade contractor sectors (in building and non-building construction) in 2000-2001 there were 65 business performers of R&D, comprising 0.1% of those sectors (ABS 2004a; 2004b).[9]

The industry's innovation activity relies heavily on the performance of R&D by organisations that formally reside in other sectors, such as CSIRO and Australian universities, increasingly through the CRC for Construction Innovation. Nevertheless, this structure does not explain the low level of interest in the R&D tax concession scheme, as eligibility is based on the *funding* of R&D.

4.1.1.2 Organisational Innovation

The BRITE survey also focused on *organisational* innovation, given its increasing importance to economic growth (Manley 2003). The survey asked which was more important to respondents – technological innovation or organisational innovation. The results showed that these two key types of innovation were equally important, with 50% of respondents to the question supporting each category. This reinforces an increasingly common view in the literature that the historical emphasis on technological innovation as the key driver of growth needs to be broadened to acknowledge the increasingly significant contribution of organisational innovation (Gann and Salter 2000; Drejer 2004).

Indeed, it is frequently observed that the two go hand-in-hand (Seaden et al 2003; Drejer 2004), and survey results support this. For example, it was noted above that there were 25 world first technological innovators in the sample. In fact, there were 26 world first innovators in total, when 10 world first organisational innovators are included. Thus, it can be seen that 90% of the organisational innovators were also technological innovators, with only one business claiming world first *organisational* innovation by itself.

As a means of exploring organisational innovation in detail, and following Statistics Canada, the BRITE survey asked organisations if they had adopted advanced practices from a list supplied, with the following results:

[8] ANZSIC codes: 4113, 4121, 4232, 4233, 4241, 4245, 7821, 7822, 7823.
[9] ANZSIC codes: 41 and 42.

Table 4 Adoption Rates for Advanced Practices, by % Respondents, Australian Construction Industry, 2004[10]

Computerised systems for estimating, inventory control, modelling, asset analysis, project management, etc	74%
Computer networks (LAN or WAN)	68%
Digital photography	68%
Web site	64%
Quality certification (eg ISO 9000)	59%
Design and construct contracts	52%
Written strategic plan	48%
Staff training budget	47%
Computerised project management	41%
Partnering on projects, or other relationship forms of contract	41%
Long-term collaborative arrangements with other businesses	40%
Documentation of technological/organisational improvements developed by your business	34%
Managing contractor	31%
3-D CAD	31%
Alliance contracts	30%
Written evaluation of new ideas in order to develop options for your business	26%
Risk-sharing/performance-incentive contracts	24%
Design/build/fund/operate (DBFO) contracts or public-private partnerships (PPPs)	18%
On-line-remote-construction-management	16%
Intelligent systems	15%

Only 30% of the 20 advanced practices are currently used by more than 50% of the industry. Computer-related practices were the most intensively adopted.

It is particularly encouraging to see robust rates of adoption for practices that can be considered important to innovation outcomes. Firstly, on-going collaborations (40%) are an important method of improving relationships in the industry (given a history of adversarial relationships) (Bresnen and Marshall 2001). They are also a key means of carrying-forward project learnings and redressing problems associated with discontinuity of learning in the project-to-project production environment that characterises the construction industry (Miozzo and Dewick 2004).

Secondly, 3-D CAD (31%) can provide significant business efficiency gains, and recent research suggests that even greater industry-wide benefits will result once 3-D CAD becomes the expected standard (Mitropoulos and Tatum 2000).

Thirdly, alliance contracts (30%) provide extensive improvements in project performance, particularly on large/complex projects (Walker et al 2000). Given that the first road project alliance in the world was undertaken in Brisbane, Australia in 2001 and the first building project alliance in the world was undertaken in Canberra, Australia in 2000 (Manley 2003b; Walker et al 2000), this high rate of uptake is quite startling and should give the Australian industry an international advantage. Partnering (41%) is

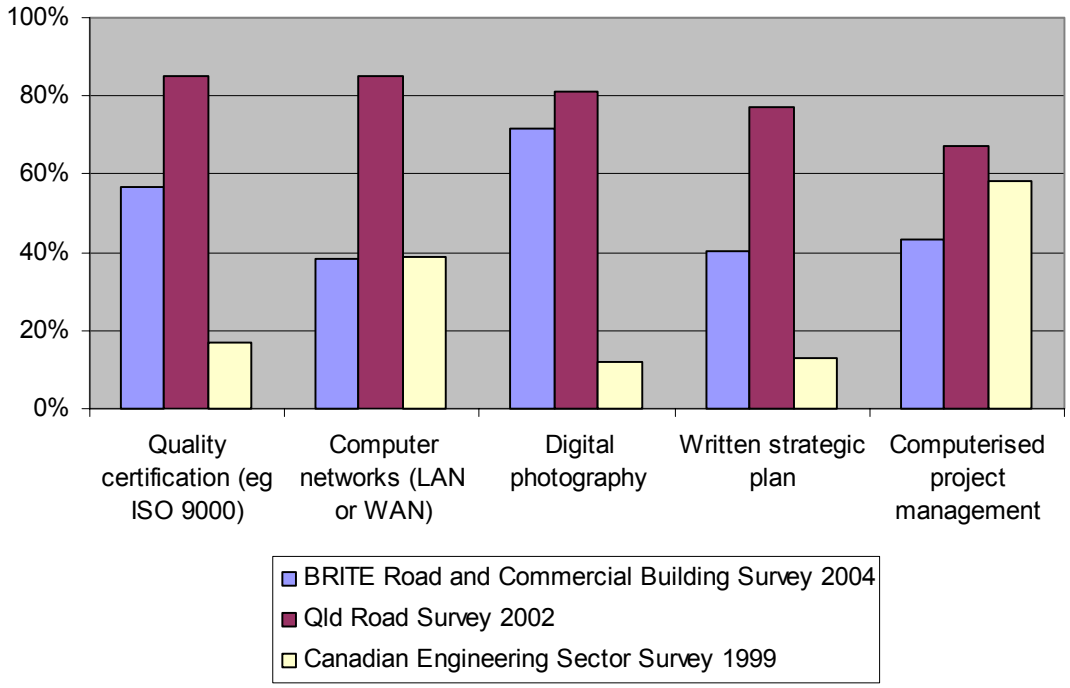
[10] The list was based on one employed by Statistics Canada, and on the results of an industry focus group exercise.

another key means of improving project performance through better relationships and is more suitable than alliancing for smaller/more straightforward projects.

Finally, 34% of respondents document their technological and organisational improvements, while 26% undertake written evaluation of new ideas in order to develop options for their business. These again are promising results, as the innovation literature stresses the importance of formal evaluation strategies for innovation success (Barrett et al 2001). These activities suggest that about one-third of organisations in the sample maintain a culture particularly supportive of innovation.

Several of the advanced practices listed in the BRITE survey were also listed in previous surveys, with comparative results as follows.

Figure 5 Rates of Adoption, by Available Surveys and Commonly Listed Advanced Practices, Construction Industry Contractors, Various Years



Notes: Canadian data was drawn from Anderson and Schaan (2001), based on a sample of 1,800 establishments, compared to 208 organisations in the Queensland study. The Canadian study only considered organisations with revenue greater than $50,000 (Canadian). There was no size threshold in the Queensland or BRITE study; therefore there are likely to be more smaller organisations in those studies, biasing adoption rates downward.

Results from the 1999 Statistics Canada survey of the engineering construction sector generally show lower adoption rates than the other two studies, in part due to the time difference. However, the Canadian results are for contractors in the entire engineering sector, which includes not only roads and bridges, but also relatively high-tech oil, gas, and industrial projects, for instance. This latter effect might have been expected to off-set the time difference. The evidence suggests that Australian contractors may be more

innovative than Canadian contractors, though more rigorous comparison is required in order to draw robust conclusions.

However, the BRITE study shows *lower* adoption rates than the Qld road study. The main differences between the studies are that the BRITE study covers Qld *and* NSW and Victoria, and it covers the road *and* commercial building sectors. Further research would be required to make any conclusions.

As suggested earlier, the BRITE survey revealed a significant relationship between technological innovation and organisational innovation. The results also show that technological innovators adopted an average of nine of the advanced practices shown in Table 4, while organisations without technological innovation adopted an average of only six ($f=22.08$, $p<0.001$). Technological innovators are engaged in significantly higher levels of organisational innovation, than non-technological innovators, by this measure.

Indeed, the rate of organisational innovation, as indicated by adoption of advanced practices, is also related to the *degree* of technological innovation.

Table 5 Technological Novelty by Adoption of Advanced Practices, Australian Construction Industry, 2004

Degree of Novelty of Technological Innovation	Average Number of Advanced Practices Adopted
New-to-firm	7
New-to-world	10

Those respondents who indicated they had introduced new or significantly improved technologies during the past three years that were new only to their organisation had a significantly lesser take-up rate for advanced practices than those with world-first innovation ($f=10.78$, p 0.001).

4.2 Innovation Determinants

This section covers survey questions about innovation strategy, business strategies, innovation drivers, innovation obstacles, industry groups encouraging or blocking innovation, sources of innovation ideas and knowledge of the CRC for Construction Innovation and international competition.

4.2.1 Innovation Strategy

Table 6 Key Strategy Employed to Maximise Value of Respondent's Most Successful Innovation in the past 3 years, by % Respondents, Australian Construction Industry, 2004

Continuing development program	36%
Staff-related strategies	20%
Formal evaluation program	15%
Customer/user feedback	14%
No formal strategy	13%
Other	3%

Just over one-third of businesses relied on 'continuing development programs' in an effort to derive maximum value from their innovations. However, the literature shows that 'formal evaluation programs' are a key determinant of innovation success (Barrett et al 2001), and only 15% of respondents ran such programs. Indeed, the most common 'key innovation strategy' for 'new-to-world' technological innovators was 'formal evaluation programs'. Further, businesses with 'formal evaluation programs' had adopted significantly more of the advanced practices listed in Table 4, compared to businesses with 'no formal strategy' (12 versus seven) (f=3.92 p 0.002). Given that adoption of advanced practices is a form of organisational innovation, the results indicate a relationship between formal evaluation and success in both technological and organisational innovation.

4.2.2 Business Strategies

In addition to examining key innovation strategies, the survey asked about the importance to the respondent's business of another four sets of strategies – human resources, technology, marketing and knowledge – comprising 22 strategies (see Figure 14 to Figure 17 for individual analysis of each set). These strategies are considered in the literature to be the drivers of innovation (Anderson and Schaan 2001). The proportion of businesses nominating each strategy as 'highly important to the success of your business', is as follows.

Table 7 Business Strategies, by % of Respondents Finding Them Highly Important to Business Success, Australian Construction Industry, 2004

Business Strategies	Percent
Building relationships with existing clients	85.1%
Actively encouraging your employees to seek out improvements and share ideas	80.4%
Enhancing your business's technical capabilities	76.0%
Attracting new clients	74.7%
Providing or supporting training programs for your employees	69.7%
Recruiting experienced employees	68.7%
We have robust relationships with key organisations in the industry	65.0%
Introducing new technologies	62.1%
Delivering products/services which reduce your clients' costs	60.6%
Providing a broader range of services to your clients	56.4%
Use of multi-skilled teams	52.7%
Participating in the development of industry standards and practices	48.0%
Increasing your market share	46.2%
Protecting your business's intellectual property	44.6%
Recruiting new graduates	44.1%
We actively monitor advances in related industries that might be applicable to our business	42.8%
When we make changes, we measure how well the changes have worked	39.9%
Participating in apprenticeship programs	38.6%
We actively monitor international best practice in our field	35.8%
We have a formal system for transferring project learnings into our continuous business processes	31.9%
We have a formal system to encourage staff to share ideas	30.5%
Investing in research and development (R&D)	25.6%
We reward staff for maintaining networking linkages with strategically useful industry participants	22.2%

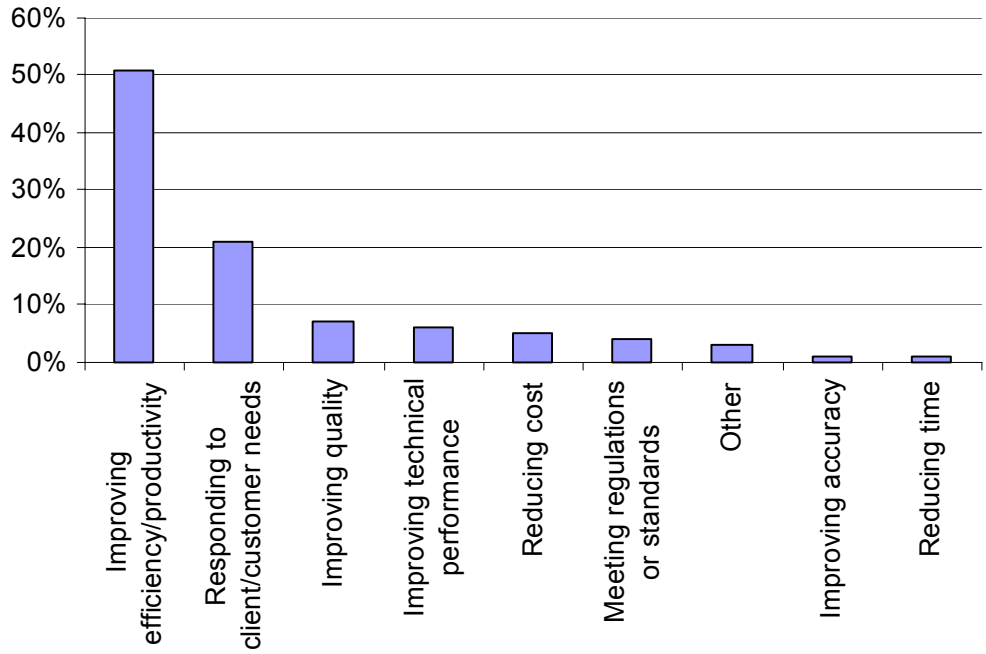
The results show that knowledge and human resource strategies are of key importance to the industry. This is a positive result, as these strategies can be considered to provide more substantive competitive advantage than marketing strategies. On the down side, R&D strategies rank poorly, perhaps reflecting the industry's tight profit margins. Further, the low importance attached to 'transferring project learnings into continuous business processes' is probably of concern, given research findings indicating that knowledge losses between projects are a major cause of inefficiency in the industry (Dubois and Gadde 2002).

The second highest ranking strategy 'actively encouraging your employees to seek out improvements and share ideas' was employed by 308 respondents, however only one-third of these had a formal system in place to back it up (114 respondents also had 'a formal system to encourage staff to share ideas'). This is an important finding; many businesses pay lip service to the importance of knowledge diffusion, however, improved business performance relies on having formal robust policies in place (Love et al 2004).

Finally, there was a weak but significant positive relationship between the number of business strategies employed, and the rate of organisational innovation as measured by the adoption of advanced practices (data too complex to reproduce; Pearson's correlation coefficient = 0.241, $p<0.001$)

4.2.3 Innovation Drivers

Figure 6 Key Reason for Undertaking Innovation, by % Respondents, Australian Construction Industry, 2004



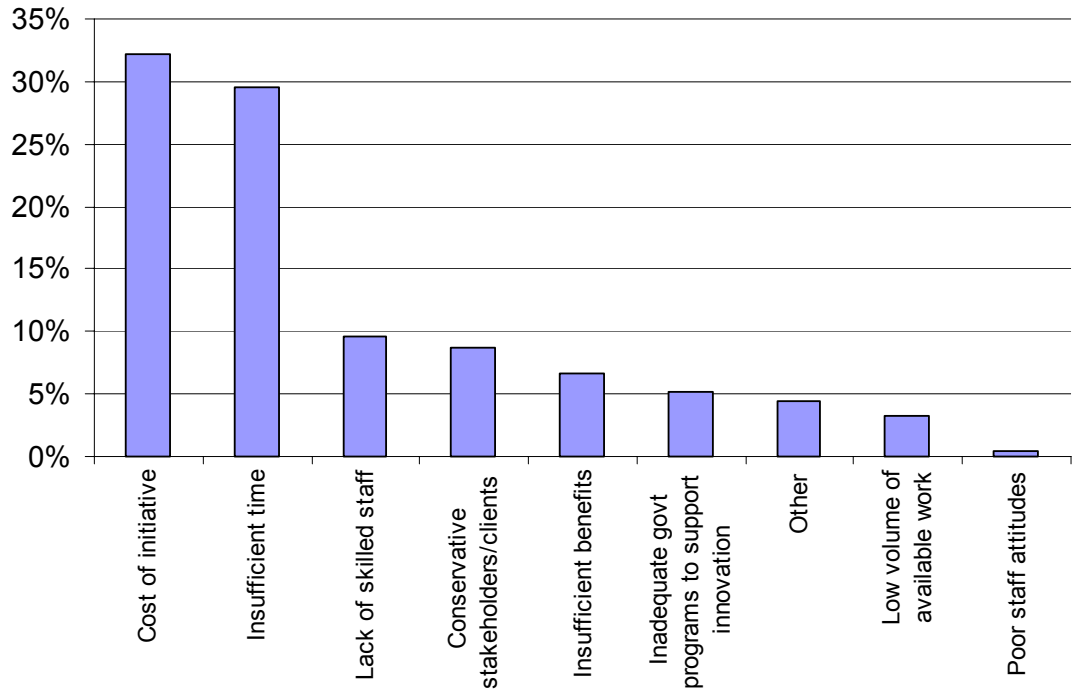
The desire for efficiency/productivity improvements drives just over half of all innovation undertaken by the industry; this and 'customer needs' are the two key motivators nominated by respondents.

Technical performance and quality are more important than cost. It seems that the increasing attention paid by Australian public-sector clients to value-driven tender selection is encouraging cultural change in the appropriate direction.

4.2.4 Innovation Obstacles

The following chart shows that cost and time clearly stand out as the two dominant innovation obstacles. These findings are likely to be driven by the relatively poor profitability levels in the industry, compared to the industry internationally (PWC 2002, 49).

Figure 7 Key Obstacle to Developing More Innovation, by % Respondents, Australian Construction Industry, 2004



The chart shows that cost and time accounted for 58% of the obstacles nominated by respondents, pointing to the need to prioritise current efforts aimed at improving industry profitability. The NZ survey produced very similar results. It measured factors that hampered innovation over the past 3 years to a high degree. The results highlight the same top three factors, in the same order of importance – though 'lack of appropriate personnel' is a more significant problem in the NZ industry, as it ranked only just below cost and time (Statistics NZ 2004, 59).

Similarly, the PWC survey and the Queensland road innovation survey found time and cost to be key obstacles, although in the Queensland road study, conservative stakeholders were more of a problem than time (PWC 2002, 47; Manley 2003, 24). This last point may suggest that the building sector is more pressed for time than the road sector, and/or that road stakeholders are more conservative (which may be the case given a higher proportion of public-sector clients in the road sector). The OECD survey also ranked 'cost' as the number one obstacle to innovation, with 'lack of skilled personnel' ranking fourth after 'lack of finance' and 'excessive risk' ('time' was not provided as an option) (European Commission 2004, 34).

Compared to the BRITE sample response distribution, the following significant differences in key obstacles by sector were found: consultants are more likely to be obstructed by 'cost', main contractors by 'conservative stakeholders/clients', trade contractors by 'time' and suppliers by 'other' key obstacles (ChiSq = 69.38, df=32).

Analysis of supplier text responses showed little consistency, except three respondents who indicated that their businesses were too small.

4.2.5 Industry Groups Encouraging or Blocking Innovation

Analysis of innovation drivers and obstacles is expanded by considering the role different groups in the industry play in either encouraging or blocking innovation.

Figure 8 Industry Group, by % of Respondents Perceiving Them to Encourage and Block Innovation, Australian Construction Industry, 2004

Encouragers	%
Large/repeat clients	59
Architects	55
Engineers	51
Manufacturers	46
Building designers	44
Main contractors	43
Developers	38
Project managers	38
One-off clients	27
Trade contractors	27
Other suppliers	26
Organisations that set industry standards	26
Quantity surveyors	19
Funders	15
Government regulators	11
Letting agents	7
Insurers	5

Blockers	%
Government regulators	47
Insurers	42
Funders	28
Organisations that set industry standards	28
One-off clients	25
Quantity surveyors	23
Letting agents	22
Developers	19
Project managers	19
Main contractors	18
Trade contractors	18
Engineers	17
Large/repeat clients	15
Building designers	12
Architects	10
Manufacturers	7
Other suppliers	5

The two charts show consistent findings; groups that feature as high level encouragers of innovation also feature as low level blockers, as would be expected. The most obvious and consistent findings between the two charts are that the key encouragers of innovation are large/repeat clients, architects and manufacturers, while the main blockers are perceived to be government regulators, insurers and funders. These findings are consistent with anecdotal evidence, and dominant views in the literature. Indeed, the PWC (2002, 46) survey also found that clients, suppliers and consultants were leading innovation drivers within the industry.

4.2.6 Sources of Innovation Ideas

Another view of innovation drivers is provided by considering sources of ideas.

Table 8 Key Sources of Innovation Ideas, by % of Respondents, Australian Construction Industry, 2004

Rank	Source	%
1	In-house staff	68%
2	Professional or trade associations	45%
3	Conferences/workshops	39%
4	Previous projects	38%
5	Clients or customers	35%
6	Journals/magazines	33%
7	Suppliers	29%
8	Technical support providers	29%
9	Competitors	22%
10	Consultants	21%
11	Overseas sources	20%
12	Research Institutions	10%
13	Trade contractors	10%
14	Main Contractors	7%

This ranking reflects that which emerged in recent economy-wide EU surveys, where internal sources similarly dominated. Clients and suppliers were ranked more highly in the EU surveys (European Commission 2004, 24).

The table shows that ‘In-house staff’ are a key source of innovation ideas for more than half the industry, highlighting the dangers of out-sourcing and underlining the importance for organisations of maintaining strong internal skill-sets and attracting creative employees. The high profile of ‘trade associations’ highlights the value of their contribution to the industry. ‘Previous projects’ rank fourth, drawing attention to the need for organisations to have effective knowledge transfer mechanisms between projects.

One in five organisations monitor ‘overseas sources’ of ideas, which would play an important role in the industry becoming more internationally competitive. ‘Research institutions’ are a relatively unimportant source of innovation ideas. This may be because such institutions play a more important role in other stages of the innovation process, such as development of ideas. Or it may indicate that such institutions need to invest more effort in diffusing the results of their research. In any event, world-leading

innovators were more likely to source information from research institutions than was expected.[11]

On average, respondents nominated only four key sources of ideas. It may be that broader surveillance would improve innovation performance in the industry; however that may be difficult given time and cost obstacles discussed earlier.

Finally, a correlation analysis between the number of key sources consulted by an organisation and the number of advanced practices they adopted resulted in a significant positive relationship (data too complex to reproduce - Pearson correlation coefficient 0.237). Hence it would appear that if a business wanted to increase its successful adoption of advanced practices (a measure of organisational innovation), a useful strategy may well be to expand the sources of ideas about innovation they consult.

4.2.7 Knowledge of CRC and International Competition

The survey asked about knowledge of the CRC for Construction Innovation and knowledge of international competition, hypothesising that such knowledge would be a determinant of innovation levels. This is shown to be true in Section 5.

Given the mandate of the CRC for Construction Innovation to promote the industry's performance through innovation, the survey sought to determine the reach of the CRC in the first 3 years of its operation. Overall, 20% of the industry had heard of the CRC prior to receiving the survey.[12]

Given the industry's increasing exposure to international competition, the survey also asked about respondents' views of the industry's global standing.

Table 9 % of Respondents Believing the Industry is Sufficiently Innovative to Cope with International Competition, Australian Construction Industry, 2004

Yes	52%
No	21%
Don't Know	27%

Most of the industry thought the Australian industry was sufficiently innovative to cope with international competition. The findings of the PWC survey (2002, 46) on international innovation profitability rates suggest this is a misconception, while the results of the ABS (*forthcoming*) survey will provide further evidence. Sixty-nine of the respondents who thought the Australian industry was not sufficiently innovative gave

[11]Given the sample distribution. This result is not statistically significant, because of the small numbers in each test cell.

[12] This result is based on the overall sample, and also holds after sub-sector weighting and allowing for non-response bias.

their opinion of what could be done to improve the situation. Text analysis resulted in 111 ideas being identified, falling into the following categories.

Table 10 Respondents Suggestions for Improving the International Competitiveness of the Australian Construction Industry, 2004

More Education and Demonstration Projects	19%
Increase Government Assistance	13%
Increase Project-Based Recognition, Rewards, Incentives	11%
Less Conservative Attitudes	11%
Improve Client Contribution to Good Processes and Performance	10%
Improve Relationships & Cooperation	6%
More Whole-of-life Approach	5%
Remove Lowest Cost Tendering	5%
More Help from Unions	4%
Improve Contractual /Legal Arrangements	4%
Reduce Regulation/ Intervention	4%
More Large Projects	4%
Increase Competition	4%

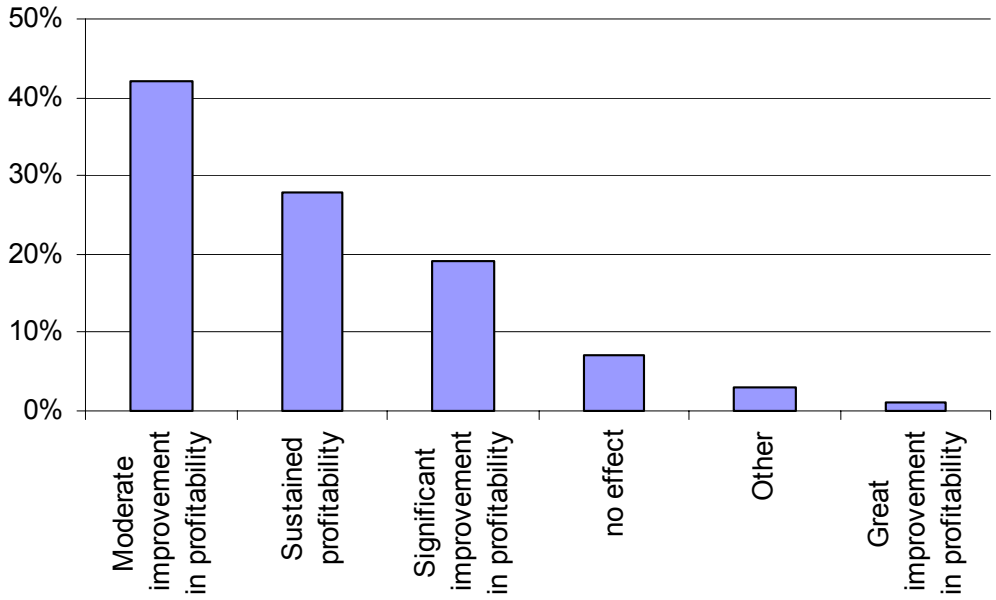
The need for better education, demonstration and government assistance tops the list of priorities. The finding concerning government assistance relates to the finding in Section 4.1.1.1 that the R&D tax concession scheme may not meet the needs of the industry.

4.3 Innovation Impact

The survey asked about respondent's most successful innovation over the past three years and found that for 93% of the sample, this innovation had a positive impact on profitability, while for 7% there was no impact on profitability (it may be that there were other benefits that were not captured by the survey). No respondents indicated a negative impact on profitability.

The NZ survey found, for the construction industry, that 84% of businesses reported increased profitability as the result of innovation over the period 2001-2003 (Statistics NZ 2004, 102). This is broadly consistent with the BRITE results.

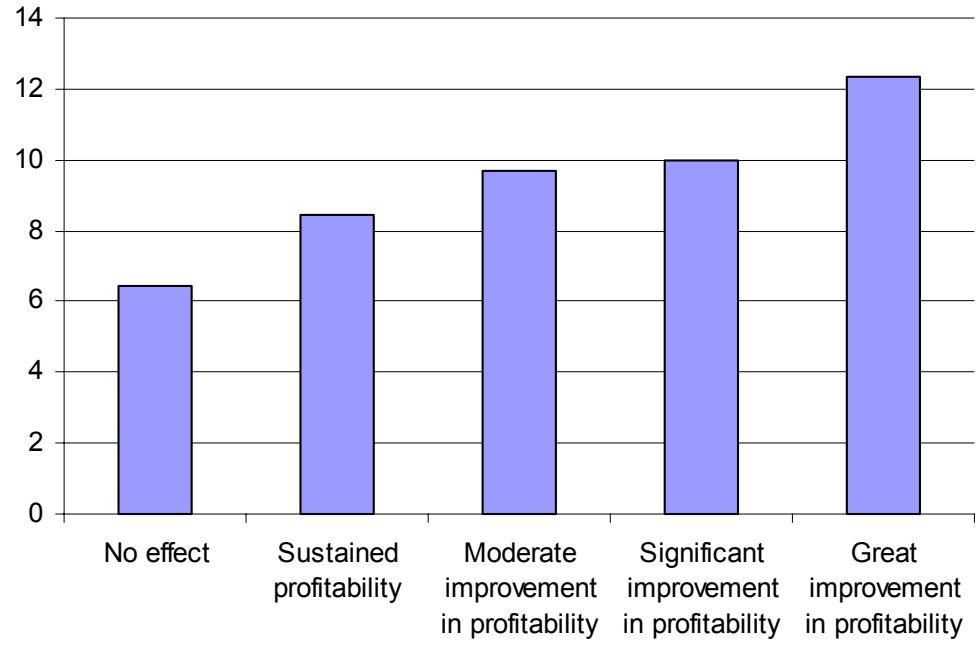
Figure 9 Profitability Impact of Most Successful Innovation in the past 3 years, by % Respondents, Australian Construction Industry, 2004



The most common impact was a moderate improvement in profitability, experienced by nearly half of the respondents to this question. Ten respondents nominated the 'other' response and all of these comments related to benefits, other than improved profitability, flowing from the innovation. Given that this question related to the organisation's most successful innovation over the past three years, it can be seen that, in terms of profitability at least, the impact of a single innovation is relatively modest, with only one-in-five respondents recording a 'significant or great improvement in profitability'.

Significance testing found positive relationships between profitability and the scope of an organisation's adoption of advanced practices; innovation strategies; and other business strategies.

Figure 10 Average Number of Advanced Practices Adopted, By Innovation Profitability Impact, Australian Construction Industry, 2004



The average number of advanced practices increased as profitability impact increased. A correlation analysis between profitability impact and advanced practices resulted in a weak but significant positive result (Kendall's tau_b Correlation Coefficient 0.143). This suggests that businesses adopting a greater range of advanced practices may generate greater profits.

Significant results were also found correlating innovation strategy choices with reported profitability impacts. For significance testing, profitability results were separated into two groups – 'no effect/sustained profitability' versus 'moderate/significant/great improvement'. There was a significant and positive relationship between reliance on 'continuing development programs' and improvements in profitability flowing from innovation.

Table 11 Number of Businesses using a 'continuing development program', by Profitability Impact, Australian Construction Industry, 2004

	No Effect/Sustained Profitability	Improved profitability
Number of businesses using a 'continuing development program'	25	80

ChiSq	df
25.81	5

There was also a significant and positive relationship between businesses with 'no formal strategy' and lower levels of profitability.

Table 12 Number of Businesses with 'no formal strategy', by Profitability Impact, Australian Construction Industry, 2004

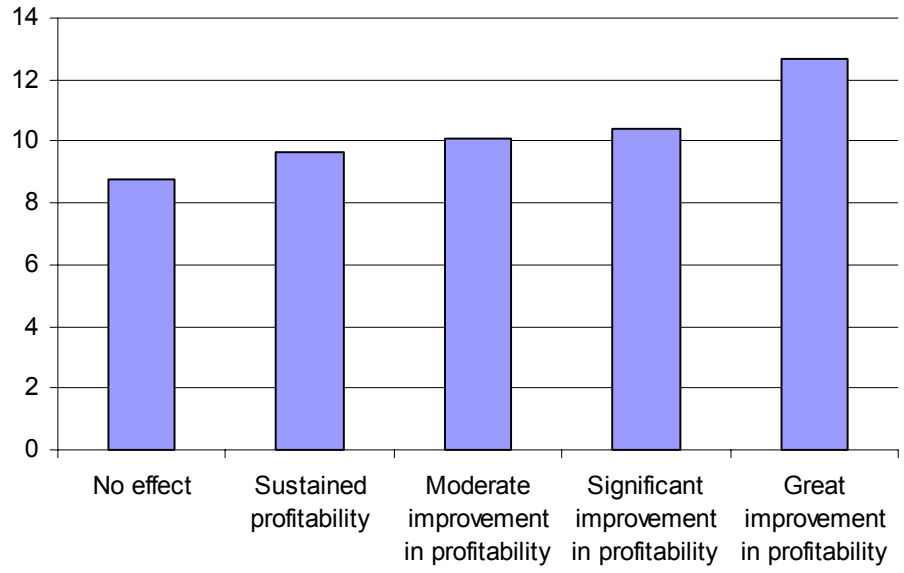
	No Effect/Sustained Profitability	Improved profitability
Number of businesses with 'no formal strategy'	23	13

ChiSq	df
25.81	5

The data show that innovation strategy choices can have a significant impact on profitability levels.

Profitability was also related to use of a broader range of business strategies.

Figure 11 Average Number of Business Strategies Employed, by Profitability Impact of Innovation, Australian Construction Industry, 2004

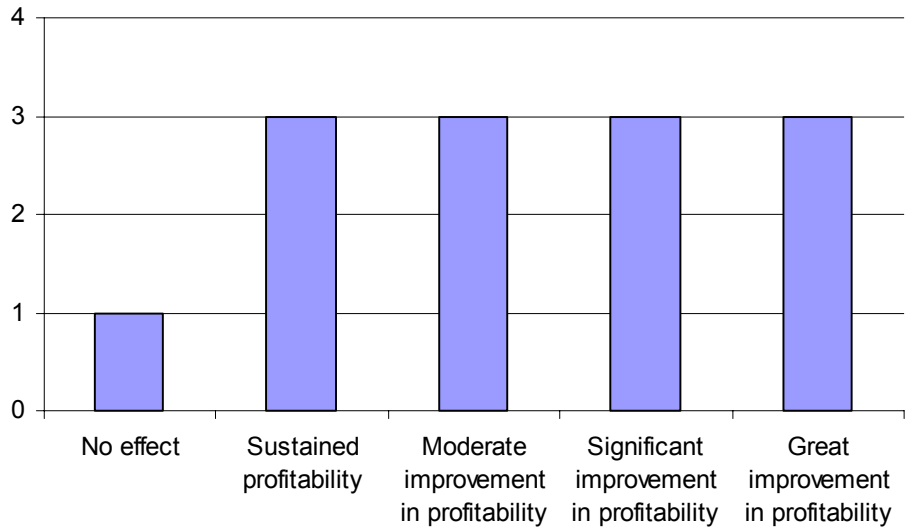


For this sample, as the number of business strategies employed increases, the impact of innovation on profitability increases. Results that are more likely to apply to the whole industry were found in relation to the knowledge strategies listed in the survey. These were:

- We have robust relationships with key organisations in the industry;
- We actively monitor international best practice in our field;
- We actively monitor advances in related industries that might be applicable to our business;
- We have a formal system for transferring project learnings into our continuous business processes;

- When we make changes, we measure how well the changes have worked;
- We reward staff for maintaining networking linkages with strategically useful industry participants; and
- We have a formal system to encourage staff to share ideas

Figure 12 Average Number of Knowledge Strategies Employed, by Profitability Impact of Innovation, Australian Construction Industry, 2004



Those who indicated no effect from their most successful innovation over the past three years agreed with an average of only one of the knowledge statements, while all other profitability groups agreed with an average of three. This was a significant difference ($f = 3.6$, $p<0.01$), highlighting the importance of the knowledge strategies amongst the full range of business strategies, by this measure.

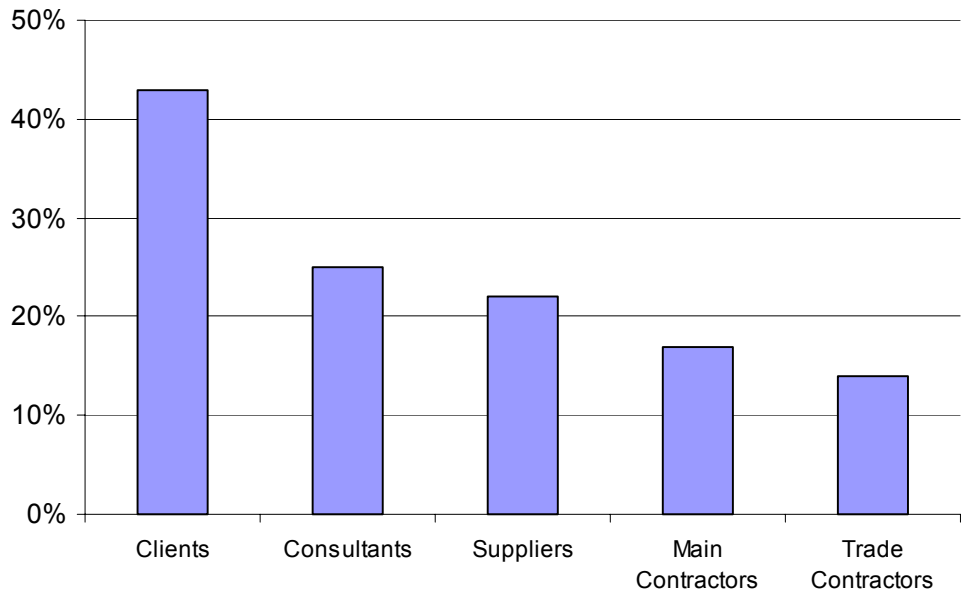
The absence of a greater number of significant findings for profitability (given links in the literature between innovation activity and business performance, eg. OECD 2000), is probably related to innovation benefiting business outcomes other than profitability (outcomes such as market share that were not part of the survey due to space constraints).

5 CHARACTERISTICS OF HIGH INNOVATORS

The characteristics of high innovators were distilled via statistical significance testing, after the high innovator group was identified by an innovation index. Each respondent was allotted an innovation index score based on four innovation indicators in the survey, namely the degree of innovation novelty, the impact of innovation on profitability, the level of adoption of advanced practices listed in the survey and the importance placed on investing in R&D. The scores were ranked and the top 21% was defined as the high innovator group, the bottom 21% was defined as the low innovator group, and the remainder formed the mid innovator group. Index development is described in Section 9. This section compares the high and low innovation groups.

The identity of high innovators is as follows: 32 consultants, 16 main contractors, 14 suppliers, 10 trade contractors and 10 clients. The chart below shows the proportions of each sector in the high innovator group

Figure 13 % of Sectors Falling into the High Innovator Group, Australian Construction Industry, 2004



Nearly half of the client sample fell into the high innovator group, while only 21% of the overall sample fell into this group. This result is influenced by the fact that the client sample consists only of large public sector repeat clients, with no one-off or private

sector clients.[13] There were significantly more clients in the high innovator group than expected, and significantly more suppliers than expected in the *low* innovator group (ChiSq=37.18, df=8).

The fact that suppliers are not shown as leaders is related to the fact that the supplier sample is dominated by glaziers and plasterers and it appears these sub-sectors are not greatly innovative in themselves (though they may encourage innovation in other sectors). Certainly, most of the businesses concerned would be classified as SMEs and few are manufacturers. In the literature, suppliers are noted as innovation drivers, however these are manufacturing suppliers as a rule (eg. Arditi et al 1997).

Trade contractors are the least innovative group in the industry overall (despite being the strongest sector in the more narrow measure - 'new-to-industry' technological innovation). However, anecdotal evidence suggests they occupy a strategic position in relation to innovation in the industry, with both close relationships with manufactures (closer than the other sectors) and intimate knowledge of on-site conditions (more so than other sectors). This may lead them to encourage innovation in sectors other than their own. Further research is required in this area.

The characteristics of high innovators provide ideas for improving the industry's innovation performance. As would be expected, the four key questions taken to reflect innovation capability and success, and upon which the innovation index was based, revealed significant differences between high and low innovators. Compared to low innovators, high innovators were statistically more likely to:

- develop innovations with higher degrees of novelty;
- develop innovations yielding higher levels of profitability;
- adopt a higher number of advanced practices; and
- invest in R&D.

The BRITE team defined high innovators along these dimensions (see Section 9). The remainder of this section examines the firm characteristics that are associated with high innovators.

The questionnaire asked which of a number of listed innovation strategies respondents employed to get the most from their most successful innovation of the past 3 years, with the following results for high/low innovators.

[13] The Property Council of Australia declined to participate in the study.

Table 13 Key Innovation Strategy by Innovator Group, Australian Construction Industry, 2004

Key Innovation Strategy	High	Low
Continuing development program	32%	27%
Formal evaluation program	24%	12%
Staff-related strategies	17%	14%
Customer/user feedback	15%	12%
No formal strategy	7%	33%
Other	5%	2%
Total	100%	100%

High innovators were significantly more likely to have a 'formal evaluation program', while the low innovators were significantly more likely to have 'no formal strategy'. (ChiSq = 27.51, df=10). This relates to findings in Table 6 that the use of 'formal evaluation programs' was linked to success in organisational innovation, and to findings in Table 12 that 'no formal strategy' was linked to low profitability levels.

Business strategies generally are a key driver of innovation. As mentioned earlier, the survey asked about the importance to the respondent's business of four additional sets of strategies – human resources, technology, marketing and knowledge. The proportion of high/low innovators nominating each strategy as 'highly important to business success', is shown in the four charts to follow.

Figure 14 % of Innovator Groups Using Human Resource Strategies, Australian Construction Industry, 2004

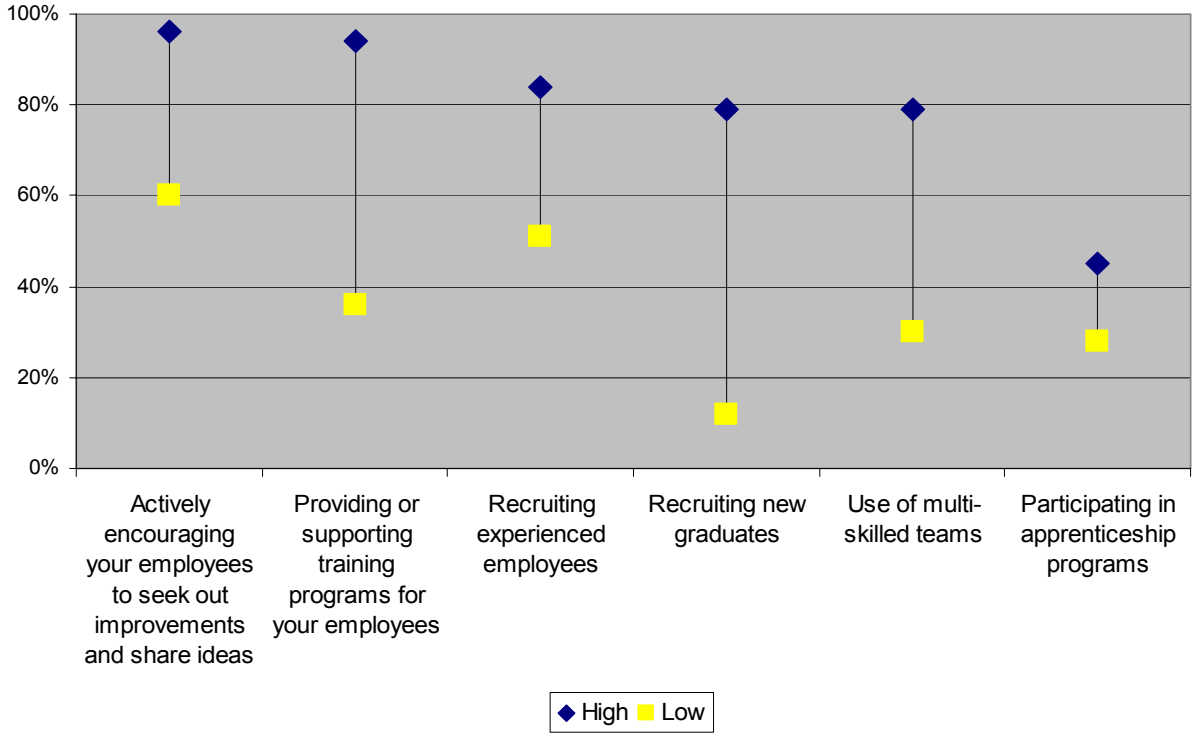


Figure 15 % of Innovator Groups Using Technology Strategies, Australian Construction Industry, 2004

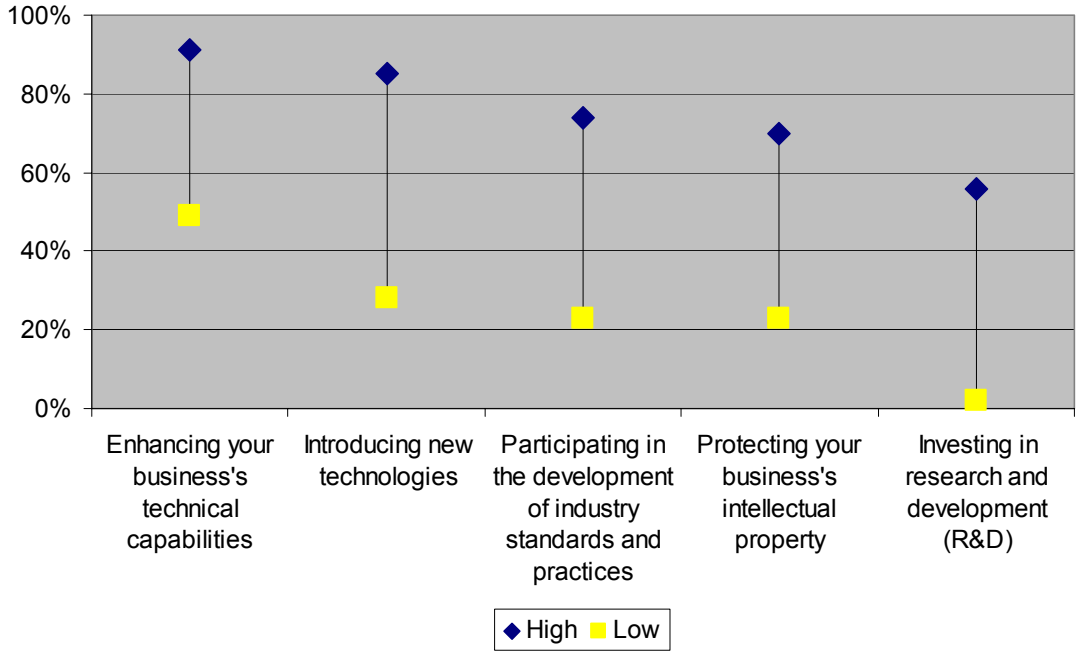


Figure 16 % of Innovator Groups Using Marketing Strategies, Australian Construction Industry, 2004

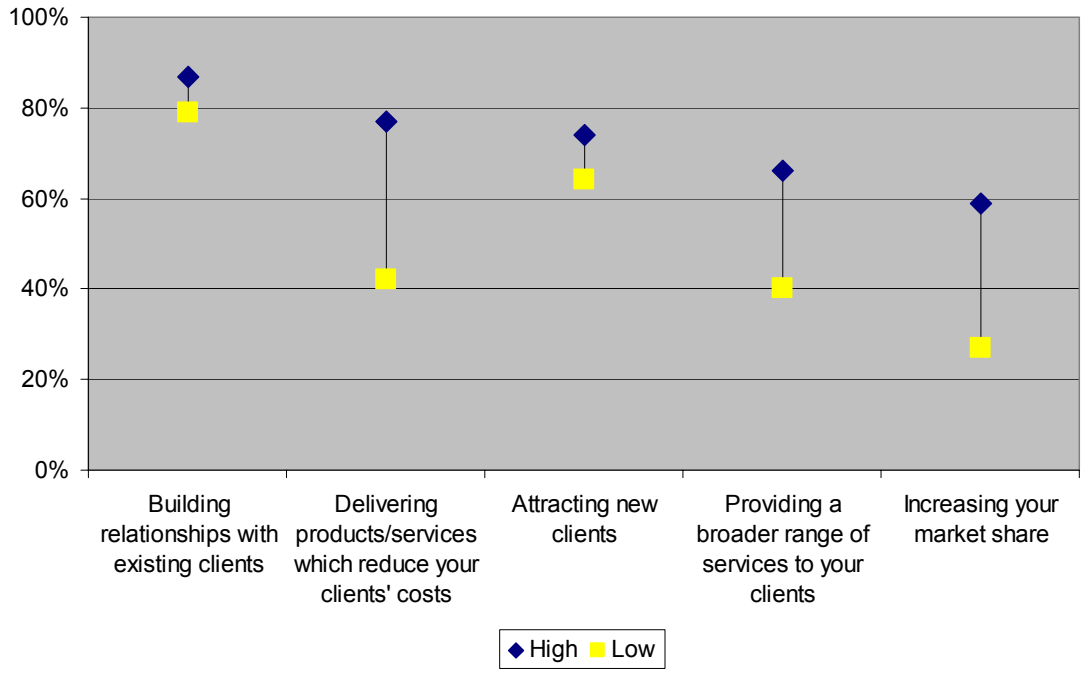
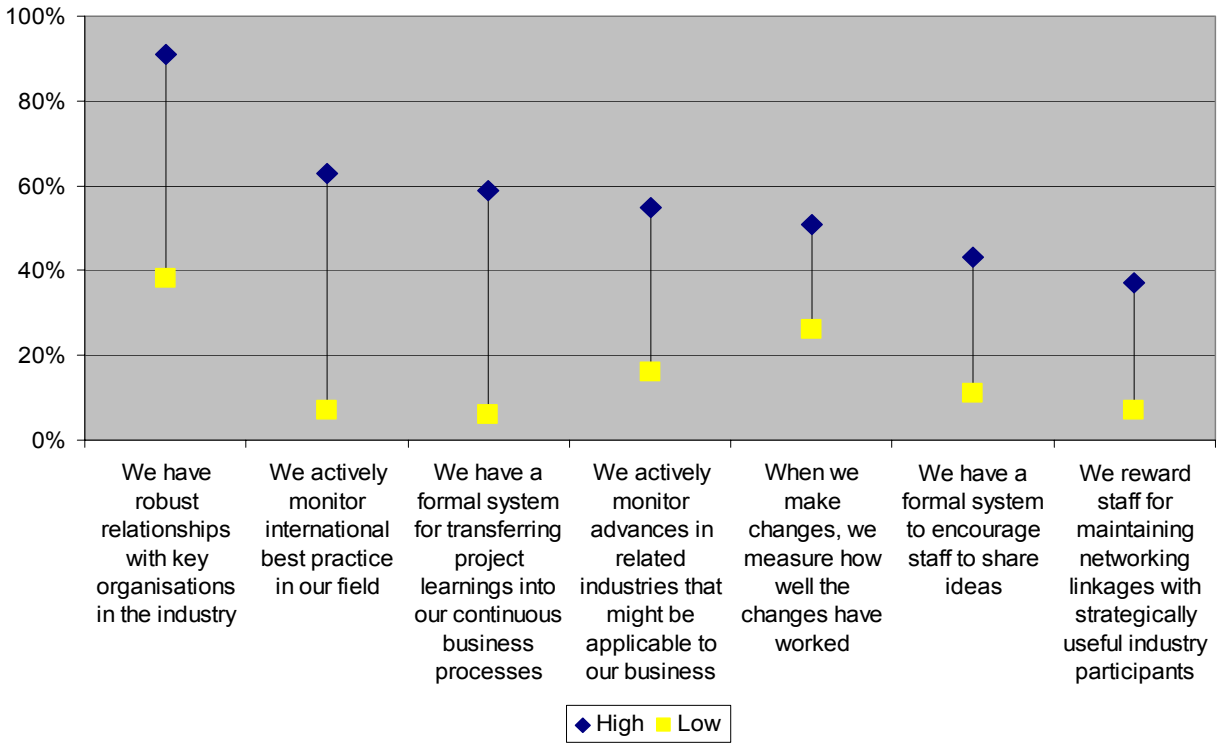


Figure 17 % of Innovator Groups Using Knowledge Strategies, Australian Construction Industry, 2004



High innovators used each of the 22 strategies more intensively. There are several areas of major difference. Compared to low innovators, high innovators were much more interested in monitoring international best practice; capturing project learnings; reducing client costs and recruiting new graduates.

Low innovators were more interested in monitoring advances in related industries than overseas developments; and more interested in experienced employees than new graduates, reflecting their relative lack of participation in training programs.

The relatively low importance that low innovators attach to 'transferring project learnings into continuous business processes' is concerning for the reasons discussed earlier, while their lack of participation in training programs diminishes not only their own potential, but that of the industry.

Considering the relative importance of the above strategies, across the four charts, results were ranked for the top three strategies for each innovator group.

Table 14 Rankings of All Business Strategies, By Innovator Group, Australian Construction Industry, 2004

Business Strategy	High	Low
Actively encouraging your employees to seek out improvements and share ideas	1st	3rd
Providing or supporting training programs for your employees	2nd	
Enhancing your business's technical capabilities	3rd	
We have robust relationships with key organisations in the industry	3rd	
Attracting new clients		2nd
Building relationships with existing clients		1st

These rankings show the overall importance of employee strategies for the success of businesses, particularly in the high innovator group. It seems that while high innovators have the in-house skills (and resources to develop such skills) to be able to rely on their employees as key drivers of success, low innovators are not in this position and see existing clients as more important.

High innovators also stand out in terms of the *average number* of listed strategies employed, as shown.

Table 15 Average Number of Important Business Strategies by Innovator Group, Australian Construction Industry, 2004

Innovator Group	HR Strategies	Technology Strategies	Marketing Strategies	Knowledge Strategies	All Strategies
High	5	4	4	4	17
Low	2	1	3	1	7

High innovators use on average twice as many business strategies than low innovators (f=95.89, p=<0.001). There are stark differences between the two groups shown, except for marketing strategies. Low innovators rely more heavily on such strategies, compared to the other strategy types shown.

The survey asked specifically about respondents' entitlement to claim the Commonwealth Government's R&D tax concession, given that R&D is a key input indicator of technological innovation, as discussed earlier.

Table 16 Entitlement to Claim R&D Tax Concessions, by Innovator Group, Australian Construction Industry, 2004

	High	Low
Yes	40%	0%
No	25%	37%
Don't Know	35%	63%
Total Respondents	100%	100%

High innovators are less uncertain about their eligibility and are more likely to be entitled to claim the concession (ChiSq = 49.36 df = 4). High innovators would appear to have structured their business strategies in a way that maximises their access to this scheme, compared to the other groups. Certainly the R&D investment data, upon which the innovation index is partly based, is dominated by high innovators (see Section 9).

'Sources of ideas' are another key driver of innovation.

Table 17 % of Respondents using Sources of Ideas, by Innovator Group, Australian Construction Industry, 2004

	High	Low
In-house staff	90%	42%
Previous projects	50%	26%
Conferences/workshops	49%	36%
Clients or customers	43%	31%
Technical support providers	34%	14%
Overseas sources	30%	2%
Consultants	29%	10%
Professional or trade associations	28%	63%
Suppliers	26%	35%
Research Institutions	23%	6%
Journals/magazines	23%	37%
Competitors	17%	12%
General contractors	7%	6%
Trade contractors	7%	14%

Many of these sources were used significantly more often by high innovators than low innovators, comprising:

- 'in-house staff' (Chi Sq 43.89, df=2),
- 'previous projects' (ChiSq 10.09, df=2),
- 'technical support providers' (ChiSq 11.61, df=2),
- 'overseas sources' (ChiSq 22.25, df=2),
- 'consultants' (ChiSq 9.53, df=2), and
- 'research institutions' (ChiSq 19.27, df=2).

Only one source was used significantly more often by low innovators and this was 'professional or trade associations' (ChiSq 20.11, df=2).

High innovators used on average 5 sources, while low innovators used on average only 3 sources; high innovators used significantly more sources than expected (f=7.46, p=0.001).

The next table reviews high/low innovator opinions of whether the Australian property and construction industry is sufficiently innovative to cope with international competition.

Table 18 Perceptions of International Competition, By % of Innovator Groups, Australian Construction Industry, 2004

Perception of International Competition	High	Low
Australian Industry Sufficiently Innovative to Cope	68%	43%
Australian Industry not Sufficiently Innovative to Cope	21%	7%
Don't Know	11%	50%
Total Respondents	100%	100%

A higher proportion of both groups thought the Australian industry was sufficiently innovative to cope with international competition; as mentioned early in this report, this may be a misconception.

Further, the more innovative a respondent was, the more likely they were to believe the Australian industry could cope with international competition, while uncertainty was greatest amongst low innovators (ChiSq = 37.63, df = 4).

With regard to knowledge of the CRC for Construction Innovation, high innovators were more likely than low innovators to have heard of it prior to receiving the survey (ChiSq 17.58, df=4), as shown.

Table 19 % of Innovator Groups with Prior Knowledge of the CRC for Construction Innovation, Australian Construction Industry, 2004

	High	Low
Yes	31%	11%
No	65%	88%
No Response	4%	1%
Total Respondents	100%	100%

6 SECTORAL RESULTS

6.1 Innovation Activity

The following two charts show descriptive results by sector for 'new to industry' and 'new to world' innovation.

Figure 18 'New to Industry' Technological Innovation, % of Respondents by Sector, Australian Construction Industry, 2004

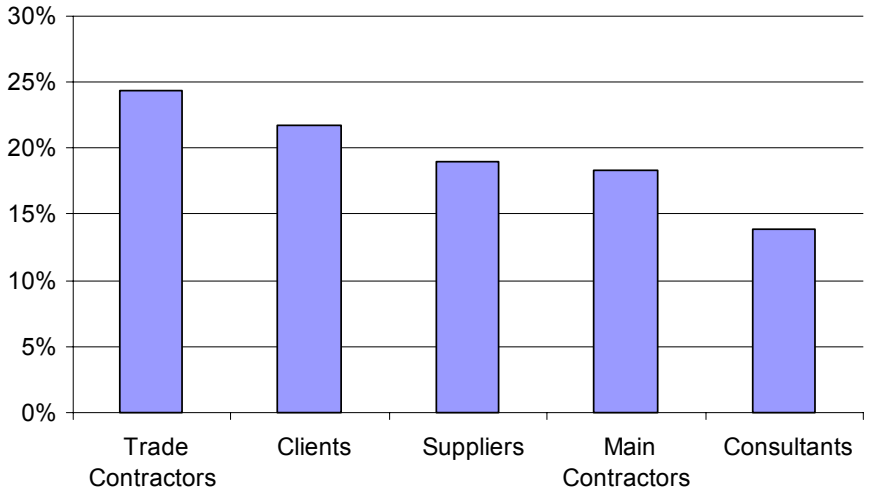
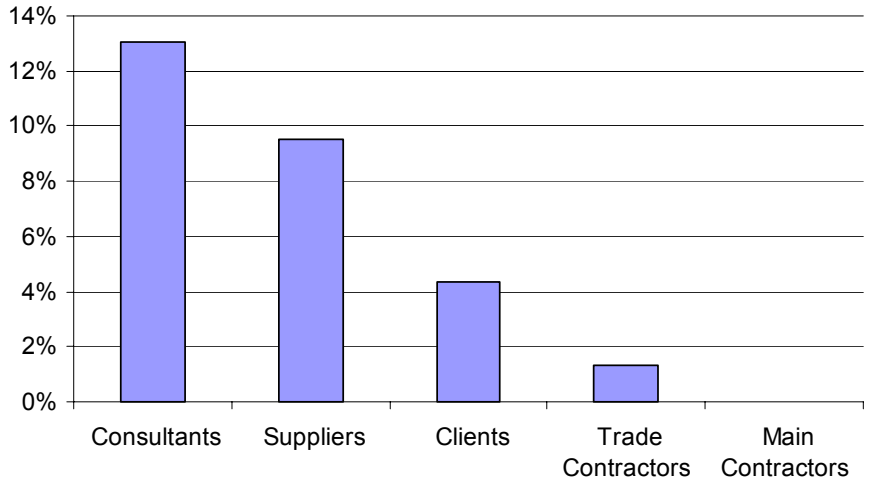


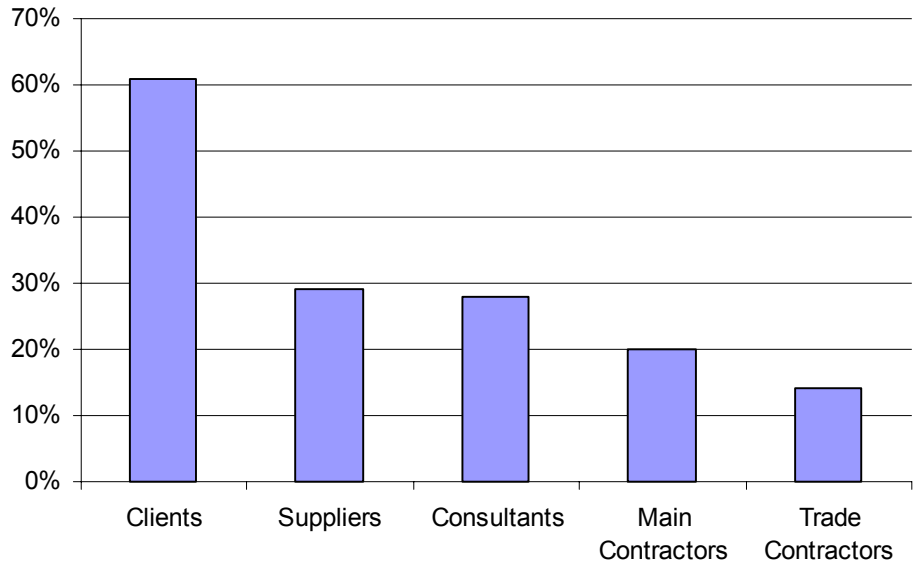
Figure 19 'New to World' Technological Innovation, % of Respondents by Sector, Australian Construction Industry, 2004



Consultants had a higher representation in the new-to-world category than expected, (however there was also an over representation of consultants that had no new technologies in the past three years). Main contractors and trade contractors were under represented in the 'new-to-world' category (Chi-Sq 30.49 df=16).

The next chart reviews R&D investment as an indicator of technological innovation.

Figure 20 Businesses Investing in R&D, by % of Sectors, Australian Construction Industry, 2004



Clients were the most likely group to have invested in R&D, reflecting that these are public-sector clients, with a broader mandate than private-sector clients, specifically including a role to lead the industry, including it seems, in R&D leadership.

Suppliers are the next most likely group to invest in R&D and this reflects the fact that there are manufacturers among them, seeking to improve the quality of their outputs through R&D (remembering that suppliers are not constrained by the project-to-project nature of production faced by consultants and contractors). Suppliers mostly deal with standardised output, the improvement of which is likely to yield greater returns than improvement in customised outputs, as often produced by consultants and contractors.

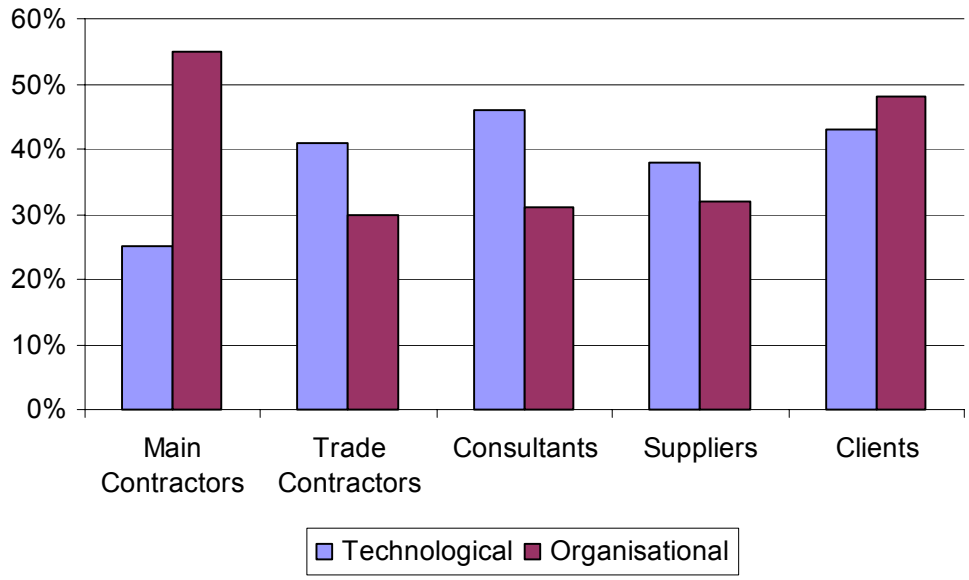
Although suppliers rank well on R&D, it was shown in Figure 13 that they are over-represented as *low* innovators. This is because they rate relatively poorly as adopters of advanced practices (Figure 22) and in terms of reaping high profits from innovation (Figure 25) (both of which are elements of the innovation index).

Interestingly, consultants also rank relatively highly, probably reflecting the R&D activity of engineers (rather than architects or quantity surveyors) investigating technical solutions to problems.

Main and trade contractors are the least likely groups to invest in R&D and this could reflect a greater need for organisational innovation in improving the performance of projects (see Figure 21 below).

The survey also asked which was more important to respondents – technological innovation or organisational innovation.

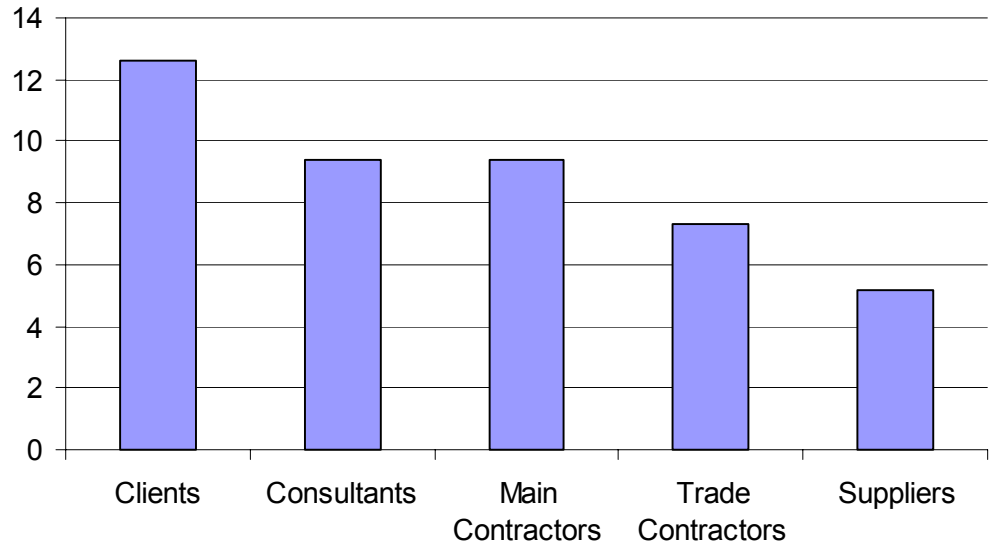
Figure 21 Type of Innovation Contributing Most to Business Success, by % Sectoral Respondents, Australian Construction Industry, 2004



Main contractors have the clearest opinion about which type of innovation contributes most to business success, strongly favouring organisational. Similarly, more clients value organisational innovation over technological innovation. All other sectors find technological innovation of more value to their businesses. Certainly, main contractors and clients play a key role in managing project processes, where organisational changes can be of great value, while the other sectors can be seen to rely more on technical solutions and developments.

As a means of exploring organisational innovation, and following Statistics Canada, the BRITE survey asked organisations if they had adopted specific advanced practices from a list of 22 supplied, with the following sectoral results.

Figure 22 Average Number of Advanced Practices Adopted, by Sector, Australian Construction Industry, 2004



Clients lead in terms of advanced practices; these are public sector clients and it might be expected that they would attempt to set a good example for the industry. The supplier result reflects the fact that they are often not site-based, and were not required to complete the 'contracts' section of the listed practices.

6.2 Innovation Strategy

The following chart shows the key strategies used by the sectors to ensure maximum value from innovation.

Table 20 Key Strategy Employed To Maximise Value of Most Successful Innovation over the past 3 years, by % Sectoral Respondents, Australian Construction Industry, 2004

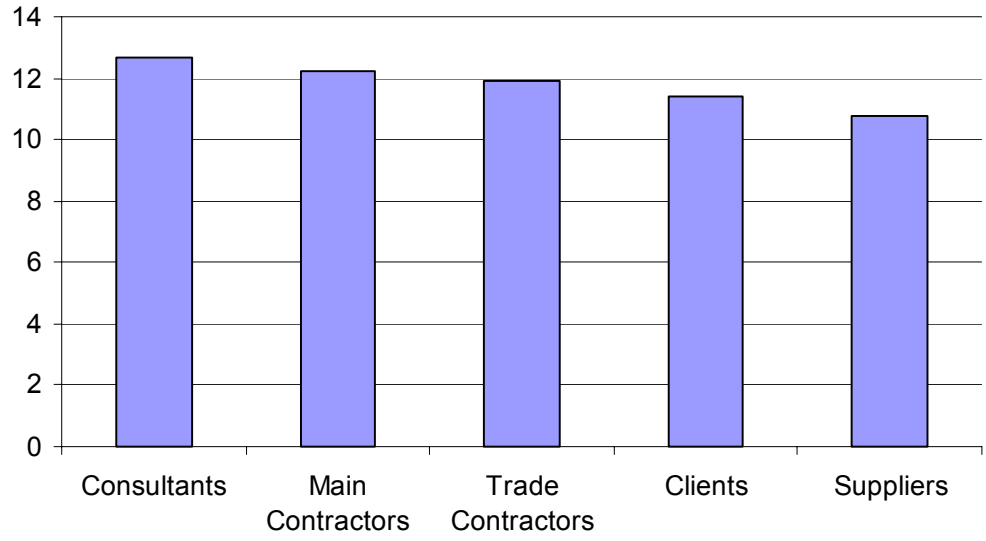
Key Strategy	Main Contractors	Trade Contractors	Consultants	Suppliers	Clients
Continuing development program	34%	27%	25%	32%	22%
Staff-related strategies	17%	18%	18%	10%	9%
No formal strategy	14%	9%	12%	6%	4%
Formal evaluation program	9%	11%	12%	14%	26%
Customer/user feedback	9%	9%	13%	10%	17%
Other	2%	3%	0%	3%	13%

All sectors except clients overwhelming favoured 'continuing development programs' to maximise the value of their innovations. Clients were more evenly spread across the options, with 'formal evaluation programs' dominating. Previous results show the importance of *formal* strategies to innovation and profitability (eg. Table 6, Table 12).

6.3 Business Strategies

In addition to examining key innovation strategies, the survey asked about the importance to the respondent's business of another four sets of strategies – human resources, technology, marketing and knowledge – comprising 22 strategies – all of which are considered to be innovation drivers.

Figure 23 Average Number of Business Strategies Adopted, by Sector, Australian Construction Industry, 2004



The five industry sectors use a similar number of strategies, on average.

6.4 Innovation Drivers

The survey also asked *directly* about innovation drivers.

Table 21 Key Reason for Undertaking Innovation, by % Sectoral Respondents, Australian Construction Industry, 2004

Key Driver	Main Contractors	Trade Contractors	Suppliers	Consultants	Clients
Improving efficiency/productivity	46%	38%	30%	44%	48%
Responding to client/customer needs	16%	14%	21%	16%	26%
Reducing cost	5%	4%	5%	3%	4%
Meeting regulations or standards	4%	8%	5%	0%	4%
Improving technical performance	3%	8%	0%	8%	4%
Improving quality	3%	5%	5%	8%	4%
Other	3%	3%	5%	2%	0%
Reducing time	2%	0%	2%	0%	0%
Improving accuracy	0%	0%	2%	2%	0%

All sectors were primarily driven by the need to improve efficiency and productivity, while the next most important driver for all sectors was 'responding to client/customer needs', with clients themselves being most likely to nominate this driver.

6.5 Innovation Obstacles

Table 22 Key Obstacle to Developing More Innovations, by % Sectoral Respondents, Australian Construction Industry, 2004

Key Obstacle	Main Contractors	Trade Contractors	Consultants	Suppliers	Clients
Insufficient time	26%	38%	31%	21%	13%
Cost of initiative	23%	26%	39%	29%	39%
Conservative stakeholders/clients	14%	7%	4%	11%	9%
Lack of skilled staff	10%	16%	3%	11%	13%
Insufficient benefits	10%	4%	7%	2%	9%
Inadequate govt programs to support innovation	10%	3%	3%	3%	9%
Other	4%	1%	2%	13%	4%
Low volume of available work	3%	0%	5%	2%	4%
Poor staff attitudes	0%	3%	0%	0%	0%

Both main and trade contractors were most likely to nominate time as the key obstacle to more innovation, while consultants, suppliers and clients are more concerned about cost. While these differences are relatively minor, the dominance of these two obstacles taken together is striking, drawing attention again to the possibility that poor profitability in the industry acts a resource constraint to innovation.

6.6 Industry Groups Encouraging or Blocking Innovation

Table 23 Industry Group, by % Sectoral Respondents Perceiving Them to Encourage Innovation

Industry Groups Encouraging Innovation	Main Contractors	Trade Contractors	Consultants	Suppliers	Clients
Architects	75%	58%	87%	82%	37%
Large/repeat clients	71%	93%	83%	77%	58%
Engineers	71%	47%	79%	59%	95%
Main contractors	63%	40%	57%	70%	74%
Manufacturers	60%	75%	49%	86%	37%
Building designers	60%	53%	60%	68%	58%
Developers	56%	49%	51%	41%	63%
Project managers	41%	47%	53%	52%	84%
Organisations that set industry standards	35%	42%	29%	32%	42%
One-off clients	32%	29%	41%	43%	37%
Trade contractors	32%	47%	26%	57%	26%
Other suppliers	29%	51%	24%	50%	21%
Funders	21%	20%	13%	16%	58%
Government regulators	19%	9%	10%	20%	37%
Quantity surveyors	16%	18%	35%	32%	16%
Letting agents	9%	11%	9%	11%	
Insurers	7%	9%	1%	11%	11%

Main contractors and consultants were most likely to nominate architects as encouraging innovation; trade contractors were most likely to nominate large/repeat clients; clients themselves were most likely to see engineers in the role of innovation encouragers; while suppliers were most likely to see manufacturers as innovation encouragers.

While consultants and suppliers saw themselves as the most important innovation encouragers, contractors and clients did not see themselves in the same light. These results make sense when one considers that manufacturers are generally acknowledged by industry analysts to be key innovation drivers, as noted earlier, while consultants are explicitly in the 'ideas business' and could be expected to drive innovation. Certainly these two groups rank in the top three as high innovators, along with clients. This suggests clients are being modest about their role, while main and trade contractors are

the two lowest ranked sectors in the high innovator group and could be seen as accurately perceiving their roles (see Figure 13).

Table 24 Industry Group, by % of Sectoral Respondents Perceiving Them to Block Innovation

Innovation Groups Blocking Innovation	Main Contractors	Trade Contractors	Consultants	Suppliers	Clients
Government regulators	60%	58%	68%	75%	37%
Insurers	49%	47%	67%	68%	37%
Quantity surveyors	40%	38%	26%	27%	16%
Organisations that set industry standards	37%	36%	37%	45%	26%
One-off clients	34%	38%	33%	30%	26%
Trade contractors	34%	22%	24%	18%	16%
Funders	32%	38%	42%	43%	11%
Large/repeat clients	29%	7%	17%	23%	32%
Project managers	29%	29%	25%	23%	5%
Developers	24%	33%	25%	27%	-
Letting agents	24%	36%	28%	39%	16%
Engineers	18%	36%	16%	34%	5%
Main contractors	16%	44%	22%	20%	11%
Building designers	15%	29%	13%	11%	5%
Manufacturers	12%	7%	9%	9%	11%
Other suppliers	9%	7%	8%	5%	5%
Architects	9%	31%	7%	11%	16%
Other	-	4%	-	-	5%

The sectors (including government clients) were unanimous in their concern about the role of government regulators and insurers, as the two most likely blockers of innovation across the industry.

6.7 Sources of Innovation Ideas

Table 25 Key Sources of Innovation Ideas, by % of Sectoral Respondents, Australian Construction Industry, 2004

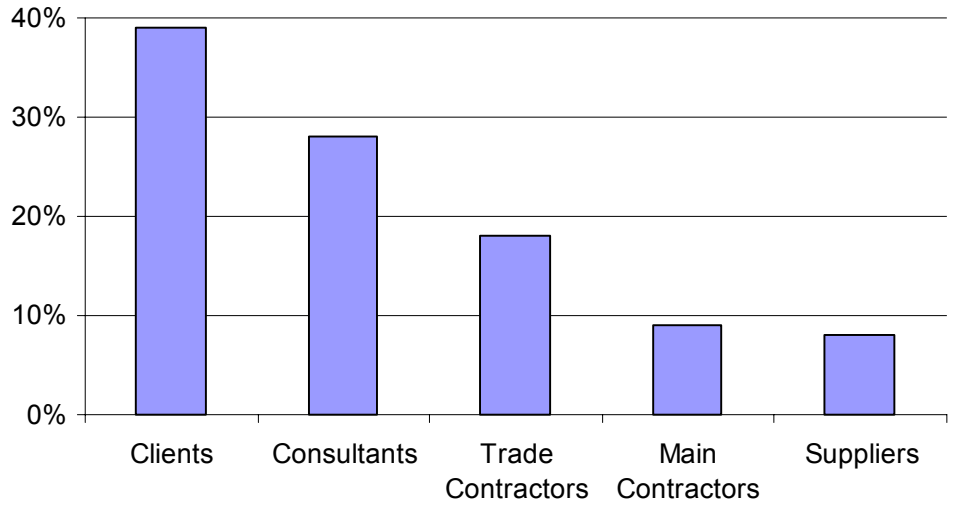
	Main Contractors	Trade Contractors	Consultants	Suppliers	Clients
In-house staff	66%	64%	73%	59%	87%
Previous projects	42%	45%	39%	13%	57%
Professional or trade associations	42%	54%	45%	40%	39%
Conferences/workshops	37%	36%	40%	35%	70%
Clients or customers	37%	34%	35%	38%	26%
Journals/magazines	34%	34%	38%	27%	13%
Competitors	30%	27%	18%	22%	4%
Technical support providers	28%	30%	29%	21%	48%
Consultants	28%	15%	20%	10%	43%
Overseas sources	19%	15%	24%	27%	4%
Suppliers	18%	51%	17%	41%	39%
Trade contractors	12%	9%	5%	22%	0%
Research Institutions	10%	3%	14%	8%	22%
General contractors	9%	4%	6%	6%	9%

All the sectors nominated the same key source of innovation ideas – 'in-house staff'.

6.8 Knowledge of CRC and International Competition

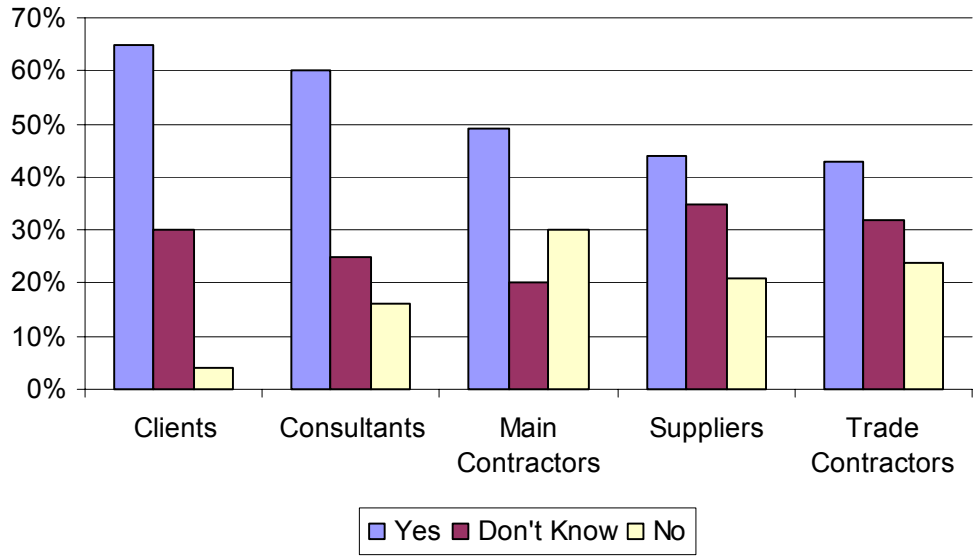
Overall, 19% of respondents had heard of the CRC prior to receiving the survey.

Table 26 % of Sectoral Respondents With Knowledge of the CRC for Construction Innovation Prior to Receiving the Survey, Australian Construction Industry, 2004



Clients and consultants were more likely than expected to have heard of the CRC previously, while main contractors and suppliers were less likely (ChiSq = 28.26, df = 8). Another factor expected to be related to innovation levels of businesses, was knowledge of international competition (the links between innovation and knowledge of the CRC and international competition are shown in Section 5). Overall, half the industry thought they could cope with international competition, 20% thought the industry is not sufficiently innovative and 27% were uncertain. A sectoral breakdown follows.

Figure 24 % of Sectoral Respondents Believing the Industry is Sufficiently Innovative to Cope with International Competition, Australian Construction Industry, 2004

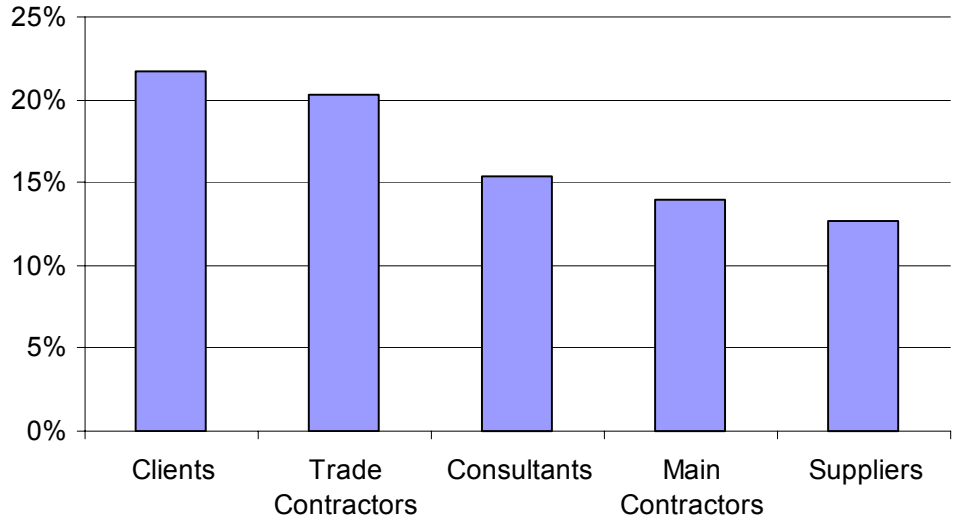


Clients and consultants were most optimistic about the industry's international competitiveness. More main contractors than expected believed that the industry is sufficiently innovative to cope with international competition, while suppliers were more likely to be uncertain than expected (ChiSq = 17.69, df = 8).

6.9 Innovation Impact

The following chart reports results for the impact on profitability of respondent's most successful innovation over the past three years.

Figure 25 Businesses Achieving Significant or Great Impact on Profitability from Innovation, by % of Sectoral Respondents, Australian Construction Industry, 2004



There is relatively little difference in profitability, by this measure, by sector.

7 CONCLUSIONS

The results presented in this report suggest that there are relatively simple strategies available to businesses in the Australian construction industry to improve their innovation performance. Despite the industry's innovation rate being respectable compared to NZ standards for 'new-to-industry' innovation, soon to be released ABS data is expected to confirm expectations that for lower levels of innovation novelty ('new-to-firm' innovation), the industry needs to do better. The incentive to improve innovation performance is underscored by survey findings that innovation leads to increased profitability.

In considering options open to businesses to improve their innovation outcomes, three approaches are apparent.

Firstly, businesses can usefully adopt and/or extend strategies that are highlighted in the literature as key to successful innovation outcomes, and in need of greater uptake by the industry. These include:

- procedures to transfer project learnings into continuous business processes;
- formal systems to encourage staff to share ideas;
- evaluation programs to monitor internal innovation activity; and
- investment in R&D.

Secondly, the characteristics of high innovators point to possible areas of industry improvement. These characteristics include the strategies discussed above, together with a number of other key strategy and environment factors that are particularly accessible to low innovators, including: placing greater value on employee, knowledge and technology programs; consulting a broader range of sources of innovation ideas; adopting a greater number of advanced practices; forming relationships with research institutes; reducing client costs and recruiting new graduates.

Thirdly, profitability data highlights the value of adopting a broad range of advanced business practices and knowledge strategies. Such activity leads to improved business profitability, and *advanced practices* and *knowledge strategies* are also two of the factors that distinguish high innovators from low innovators.

Attention to the above issues may improve innovation rates, however, the fundamental structural problem of inadequate firm-level profitability limits the potential of the entire industry. Although the industry appears responsive to key innovation drivers, such as the need to reap efficiency improvements to meet client needs, resource constraints born of low profit margins impede their efforts. Key industry stakeholders are already aware of the need to improve industry profitability as a means of improving industry performance. The survey results underscore the urgency of these changes by drawing attention to resource constraints on better innovation performance.

Further research is required to better understand the impact of constrained profitability, especially in relation to risk-reward relationships associated with industry innovation. Under-utilisation of the R&D tax concession also needs to be investigated. More generally, it would be useful to map innovation activity over time as an input into business decision making and government policy making. Although planned ABS innovation surveys will assist in this regard, industry researchers will still be required to request unpublished findings, interpret data and compile tailored reports. Finally, the survey revealed 26 world-first innovators in the industry and future research could usefully examine their activities in detail, as a means of drawing lessons from this element of best practice.

7.1 Recommendations

Findings from the survey indicate that businesses wishing to improve their innovation performance should consider:

A1 Enhancing in-house skill levels by employing new graduates and providing employee training programs, rather than relying on recruiting experienced employees.

A2 Focusing on reducing clients' costs.

A3 Actively monitoring inter-industry and international developments.

A4 Developing formal systems to (i) integrate project-based learnings into on-going business processes and to (ii) encourage staff to share ideas.

A5 Adopting procedures to formally evaluate their success in adopting advanced technologies and practices.

A6 Investing in R&D, possibly utilising the R&D Tax Concession and/or Australian Research Council Linkage Grants to subsidise costs.

A7 Growing linkages with universities and other research institutions.

A8 Implementing a broader range of the technology, knowledge and human resources strategies listed in this document.

A9 Consulting a broader range of the sources of innovation ideas listed in this document.

A10 Adopting a broader range of the advanced practices listed in this document.

Commonwealth and State government agencies interested in improving the environment for construction innovation should consider:

B1 Implementing programs to assist skill development within industry associations, given the central role the associations play in providing ideas to low innovators.

B2 Reviewing the value and accessibility of the R&D Tax Concession Scheme for small and medium-sized enterprises within the construction industry, given the industry's low rate of access.

B3 Reviewing the effectiveness of programs aimed at promoting industry awareness of international competition, given that a quarter of the industry is unsure of Australia's ability to cope with it.

B4 Stronger resourcing of education and training programs, given that the construction industry relies more on organisational innovation than the manufacturing industry, and therefore is less able to gain value from other government initiatives such as the R&D Tax Concession.

B5 Improving regulation of the construction industry to reduce its negative impact on innovation, in part by improving national consistency and moving more rapidly/fully from prescriptive to performance-based approaches.

The above recommendations reflect the overarching vision of the Australian construction industry, as reported in a recent national study, Construction 2020 (Hampson and Brandon 2004). That vision stresses the need for an improved business environment, particularly in relation to regulation, education and training.

APPENDICES

Section 8	Appendix A	Survey Questionnaire
Section 9	Appendix B	Innovation Index Development
Section 10	Appendix C	Survey Innovation Rates
Section 11	Appendix D	Survey Methodology Learnings

8 Appendix A: Survey Questionnaire

The BRITE Innovation survey questionnaire for 2004 is shown overleaf.

BRITE Survey: Innovation in the Property and Construction Industry	THE **BRITE** PROJECT CRC Construction Innovation

This survey is being undertaken by the BRITE Project of the Cooperative Research Centre for Construction Innovation. The main objective of the BRITE survey is to gain information about innovation in the Australian property and construction industry, enhancing work by the Australian Bureau of Statistics. Innovation improves business performance and economic growth.

The survey will provide insights into successful innovation strategies and will lead to a better understanding of industry best practice.

The survey covers clients, contractors, consultants and suppliers, including owner-operators, small businesses, large companies and government departments. The survey will be repeated every two years to benchmark performance. The results will be available at www.brite.crcci.info from November 2004. Findings will also be reported in trade magazines and academic journals.

Inquiries: Dr Karen Manley, CMP, QUT, GPO Box 2434, Q, 4001
Phone: 07 3864 1762 Fax: 07 3864 9151 Email: k.manley@qut.edu.au

Return: In reply-paid envelope or fax

Section 1: Innovation Activity

Innovation involves either developing entirely new technologies and advanced practices, or using existing technologies and advanced practices for the first time.

Q1. Has your business introduced any new or significantly improved technologies during the past three years? (including new or significantly improved services, materials, products, plant, equipment, advanced computer software/hardware, etc, but excluding routine changes) YES ☐ NO ☐

Q2. Were any of these technologies new to your business and: (Tick any that apply)
a) New to Australia ☐
b) New to the industry ☐
c) New to the world (previously unseen) ☐

Q3. Has your business introduced any new or significantly improved advanced business practices during the past three years? (including formal initiatives involving markets, human resources, financial systems, strategic plans, collaboration, relationship management, health, safety, environment, etc, but excluding routine changes) YES ☐ NO ☐

Q4. Were any of these advanced business practices new to your business and: (Tick any that apply)
a) New to Australia ☐
b) New to the industry ☐
c) New to the world (previously unseen) ☐

Q5. Please indicate which of the following key types of innovation have contributed most to the success of your business over the past three years? If not relevant, go to Q8.

	Tick ONE
Technologies	
Advanced Business Practices	

Q6. Thinking about an innovation that 'stands out' in your mind as the most successful for your business over the past three years:

Q6(i). What key strategy did you use to ensure that this innovation added maximum value to your business?

	Tick ONE
Formal evaluation program	
Staff-related strategies	
Continuing development program	
Customer/user feedback	
No formal strategy	
Other	

Q6(ii). To what extent has this innovation impacted on the profitability of your business over the past three years?

	Tick ONE
No effect	
Sustained profitability	
Moderate improvement in profitability	
Significant improvement in profitability	
Great improvement in profitability	
Other	

Q7. What is the key reason that drives your business to adopt or develop new technologies or advanced practices?

	Tick ONE
Improving efficiency/productivity	
Improving technical performance	
Improving quality	
Improving accuracy	
Reducing cost	
Reducing time	
Responding to client/customer needs	
Meeting regulations or standards	
Other	

Q8. What is the key obstacle to your business adopting or developing more new technologies or advanced practices?

	Tick ONE
Cost of initiative	
Insufficient time	
Conservative stakeholders/clients	
Lack of skilled staff	
Poor staff attitudes	
Insufficient benefits	
Inadequate govt programs to support innovation	
Low volume of available work	
Other	

Section 2: Business Practices and Strategies

Q9. Which of the following are the key sources of ideas or information about new technologies or advanced practices for your business?

	Tick any that apply
In-house staff	
Previous projects	
Professional or trade associations	
Suppliers	
Conferences/workshops	
Clients or customers	
Technical support providers	
Research Institutions	
Journals/magazines	
Consultants	
Overseas sources	
General contractors	
Trade contractors	
Competitors	
Other	

Q10. Please indicate which of the following advanced practices your business currently uses?

		Tick any that apply
Organisational	Long-term collaborative arrangements with other businesses	
	Quality certification (eg ISO 9000)	
	Staff training budget	
	Written evaluation of new ideas in order to develop options for your business	
	Documentation of technological/organisational improvements developed by your business	
	Written strategic plan	

Computerised Practices	Computer networks (LAN or WAN)	
	Web site	
	Computerised systems for estimating, inventory control, modelling, asset analysis, project management, etc	
	3-D CAD	
	Computerised asset analysis (eg. HDM4)	
	Computerised project management	
	Digital photography	
	Office-to-site video links or video conferencing	
	On-line-remote-construction-management	
	Intelligent systems	

Contracts	Alliance contracts	Suppliers need not complete	
	Risk-sharing/performance-incentive contracts		
	Design and construct contracts		
	Design/build/fund/operate (DBFO) contracts or public-private partnerships (PPPs)		
	Managing contractor		
	Partnering on projects, or other relationship forms of contract		

Q11. Which of the following business strategies do you consider are highly important to the success of your business?

		Tick any that apply
Human Resource Strategies	Actively encouraging your employees to seek out improvements and share ideas	
	Recruiting experienced employees	
	Recruiting new graduates	
	Participating in apprenticeship programs	
	Providing or supporting training programs for your employees	
	Use of multi-skilled teams	

Technology Strategies	Enhancing your business's technical capabilities	
	Introducing new technologies	
	Investing in research and development (R&D)	
	Participating in the development of industry standards and practices	
	Protecting your business's intellectual property	

Marketing Strategies	Delivering products/services which reduce your clients' costs	Clients need not complete	
	Increasing your market share		
	Building relationships with existing clients		
	Attracting new clients		
	Providing a broader range of services to your clients		

Q12. Are you entitled to claim the R&D tax concession? **YES ☐ NO ☐ Don't Know ☐**

Q13. Please indicate which of the statements below apply to your business:

	Tick any that apply
We have robust relationships with key organisations in the industry	
We actively monitor international best practice in our field	
We actively monitor advances in related industries that might be applicable to our business	
We have a formal system for transferring project learnings into our continuous business processes	
When we make changes, we measure how well the changes have worked	
We reward staff for maintaining networking linkages with strategically useful industry participants	
We have a formal system to encourage staff to share ideas	

Section 3: Industry-Wide Issues

Q14. Do you think the Australian property and construction industry is sufficiently innovative to cope with international competition? **YES ☐ NO ☐ Don't Know ☐**

Q14(i). If not, what do you think would encourage better innovation performance?

.....

Q15. Had you heard of the Cooperative Research Centre for Construction Innovation prior to receiving this survey? **YES ☐ NO ☐**

Q16. Do you think the following industry participants play a role in either encouraging or blocking innovation in the industry?

	Tick any that apply	
	Block Innovation	Encourage Innovation
Large/repeat clients		
One-off clients		
Main contractors		
Trade contractors		
Manufacturers		
Other suppliers		
Architects		
Building designers		
Engineers		
Quantity surveyors		
Developers		
Project managers		
Funders		
Insurers		
Letting agents		
Organisations that set industry standards		
Government regulators		
Other		

Comments:

You have finished the survey. Your generous cooperation is very much appreciated.
- Thank You – See results November 2004 at www.brite.crcci.info

9 Appendix B: Innovation Index Development

An index measuring responses to the 2004 BRITE Innovation Survey for selected key questions was created to separate the top innovators from low innovators. The questions chosen for index development represented a mix of input and output measures – covering innovation capability and innovation success, and reflecting variables employed in existing indexes, such as PWC (2002).

9.1 Index Development

The index measures:

- the degree of novelty of each respondent's most important technological and organisational innovation,
- the impact of each organisation's most successful innovation from the past three years on profitability,
- the adoption rate of existing business practice innovations by each organisation,
- the importance respondents placed on investing in R&D.

The statistical results for the four questions are shown below:

Table 27 Degree of Technological Innovation by Innovator Group, Australian Construction Industry, 2004

Innovator Group	Degree of Technological Innovation					Total
	None	Organisation	Industry	Australia	World	
High	3	11	23	30	15	82
Mid Range	47	81	42	40	10	220
Low	47	28	5	1	0	81
Total	97	120	70	71	25	383

There is an over representation of high innovators at each level (excluding the 'none' category) (Chi-Sq 103.9 df=8).

Table 28 Degree of Organisational Innovation by Innovator Group, Australian Construction Industry, 2004

Innovator Group	Degree of Organisational Innovation					Total
	None	Organisation	Industry	Australia	World	
High	4	27	20	24	7	82
Mid Range	67	111	28	11	3	220
Low	49	29	2	1	0	81
Total	120	167	50	36	10	383

Again, there is an over representation of high innovators at each level (excluding the 'none' category) (ChiSq = 120.2, df=8).

Table 29 Impact on Profitability by Innovator Group, Australian Construction Industry, 2004

Impact on Profitability	Innovator Group			Total
	High	Mid Range	Low	
No effect	0	13	8	21
Sustained profitability	17	56	12	85
Moderate improvement in profitability	36	76	14	126
Significant improvement in profitability	23	29	6	58
Great improvement in profitability	2	1	0	3
Other	4	5	1	10
Total	82	180	41	303

High innovators achieved greater profitability than low or mid innovators, on average (ChiSq = 25.97, df=10).

Table 30 % of Innovator Group Using Advanced Practices, Australian Construction Industry, 2004

Advanced Practices	Innovator Group			
	High	Mid Range	Low	Total
Computer networks (LAN or WAN)	96%	73%	27%	262
Web site	94%	70%	17%	246
Computerised systems for estimating, inventory control, modelling, asset analysis, project management, etc	94%	81%	37%	285
Quality certification (eg ISO 9000)	89%	63%	17%	226
Digital photography	87%	74%	32%	260
Written strategic plan	85%	49%	6%	182
Staff training budget	79%	46%	15%	179
Partnering on projects, or other relationship forms of contract	77%	40%	6%	155
Computerised project management	73%	41%	5%	155
Design and construct contracts	73%	57%	16%	198
Alliance contracts	72%	25%	2%	116
Long-term collaborative arrangements with other businesses	71%	37%	15%	152
Risk-sharing/performance-incentive contracts	66%	16%	1%	91
Documentation of technological/organisational improvements developed by your business	63%	33%	9%	131
3-D CAD	61%	29%	6%	118
Managing contractor	54%	31%	9%	119
Written evaluation of new ideas in order to develop options for your business	48%	25%	6%	99
Design/build/fund/operate (DBFO) contracts or public-private partnerships (PPPs)	46%	15%	-	70
Intelligent systems	45%	9%	2%	58
Office-to-site video links or video conferencing	40%	5%	-	44
On-line-remote-construction-management	39%	14%	-	63
Computerised asset analysis (eg. HDM4)	30%	8%	-	43

High innovators used all the advanced practices more intensively than the other two groups.

Table 31 Average Number of Current Advanced Practices by Innovator Group, Australian Construction Industry, 2004

Innovator Group	Mean
High	15
Mid	8
Low	2

High innovators used significantly more advanced practices, on average, than mid and low innovators (f=334.76, p<0.001).

Table 32 Number of Businesses Investing in R&D, by Innovator Group, Australian Construction Industry, 2004

Investing in research and development (R&D)	Innovator Group			Total
	High	Mid Range	Low	
No	36	170	79	285
Yes	46	50	2	98
Total	82	220	81	383

A significantly higher number of respondents than expected from the high innovator group stated that investing in R&D was a highly important business strategy, conversely there was a significantly smaller number than expected from the low innovator group who stated that investing in R&D was a highly important business strategy (ChiSq 63.77, df=2).

9.1.1 Novelty Score

A points system approach was used to rank the respondents based on their responses to the first four questions in the survey. Each respondent scored points based on whether they had introduced any innovations in the past three years and the degree of novelty. Each respondent who responded 'Yes' to Q1 received a point and they then received further points depending on their response to Q2. Those who ticked more than one box received points equal to the highest category. A similar method was applied for Q3 and Q4. The aggregate of these points was the score achieved for each respondent.

9.1.2 Impact Score

Each of the scores achieved above was 'weighted' by the respondent's answer to Q6(ii) about the impact of the organisation's most successful innovation on profitability. A linear scale was chosen to weight the impact. Impact points ranged from one for 'no effect' to five for 'great improvement in profitability'.

9.1.3 Adoption Score

The adoption score was based on a count of the number of advanced practices the respondent's organisation currently employs, from a list of 22 types at Q10.

9.1.4 R&D Investment Score

Respondents who considered 'investing in research and development (R&D)' an important strategy to the success of their business, at Q11(ix), also received a point. This was added to the cumulative scores.

9.2 Reliability Analysis

The questions used to create the innovation index were tested for reliability. Cronbach's Alpha was used to test the relationships between individual items in the scale. The results were encouraging with most scores being between 0.6 and 0.7. The closer the score is to 1 the better the score. These scores are therefore acceptable, indicating consistency in the responses and confirming the suitability of the approach described above as a basis for index development.

9.3 Sensitivity Analysis

Three index models were trialled:

- an additive model;
- a multiplicative model; and
- a weighted multiplicative model.

The models were applied to each respondent and the results compared for consistency with the top and bottom quartiles drawn out for sensitivity assessment. Results of analysis showed that each of the models achieve the same subset of respondents as 'top innovators' and 'poor innovators'. Due to this consistency, and the results of reliability analysis, the classification of respondents as top and poor innovators has a great deal of integrity. The development of this model represents an important contribution to best practice in the field of index development for innovation measures and we plan to publish a paper on the topic.

10 Appendix C Survey Innovation Rates

The overall rate of technological innovation revealed by the BRITE survey was 75% across the industry (and there were no significant differences between sectors). This rate is very high compared to international rates just released.

Recent EU and NZ surveys both found overall economy-wide innovation rates of 44%, while the construction industry's rate was much lower, at 25% in NZ (there was no construction industry data published for the EU). ABS innovation survey results will be released later this year, and their economy-side rate is expected to be similar to the EU and NZ results.

There is not a straightforward explanation for the high rate revealed by the BRITE survey. The BRITE questionnaire asked about the introduction of 'technologies', while the OECD, ABS and NZ surveys asked about 'products'. The BRITE team chose the 'technologies' approach following work by Statistics Canada specifically related to the construction industry. It was felt by Statistics Canada and the BRITE team that the construction industry would not relate well to the 'products' term employed by the OECD, ABS and NZ surveys, which was developed with the manufacturing industry in mind (unfortunately, the Canadian study was not geared to produce an innovation rate, so no comparison with the BRITE data is possible).

Even given these considerations, it is hard to believe that the construction industry is more innovative than international all-industry averages – let alone considerably more innovative (especially given PWC (2002) data showing low levels of innovation in an international context). The team believes that respondents over-reported innovation, possibly because 'advanced computer software' was listed as an example. Despite the survey form requesting that routine introductions be excluded, it seems that this instruction failed to have the intended impact. Unfortunately, pilot testing did not pick up this problem and in future it would seem that testing a larger pilot sample would be wise (BRITE tested a dozen units from across the four sectors).

It might also be that using third-party survey senders, which involves a limited ability for sampling control, resulted in less than rigorous random sampling.[14] Despite instructions and assurances, it could be that some senders favoured their better performers. For an organisation such as the CRC for Construction Innovation to get a reasonable survey response rate it seems that such senders are crucial (as opposed to the ABS with their 'compulsory powers'). Yet, it is difficult to see how sampling rigor could be improved, given that the BRITE team repeatedly conveyed the importance of *random* sampling.

[14] In those cases it was requested. For several sub-sectors, a census was undertaken.

Although there is no evidence that better performers were sampled by any sender, the very high innovation rate and absence of a single compelling reason, suggests that this may have occurred in some cases. Given these considerations, it may be that the ABS is best placed to produce comparative *rates* of innovation over time, where strict randomness is required (although our industry's rate will be biased downward by the manufacturing-based questioning, the data will still accurately gauge performance over time).

The BRITE team does not plan to publicise the 75% figure for the overall rate of technological innovation. Instead the team will be analysing the ABS results and disseminating knowledge about those outcomes, when they are released.

The survey results reported here are not affected by this apparent over-reporting problem. The ability to describe and analyse innovation behaviour is not compromised by having a larger pool of innovators than expected. This is particularly so, given that an innovation index based on four survey questions is employed to identify *high* innovators and analyse their characteristics, as a key means of improving industry performance (following the approach taken by PWC 2002).

As the above discussion illustrates, and as the experience of the OECD and ABS attest, innovation rates are notoriously difficult to measure (Pattinson 2002). A new way around this is to collect data based on the 'degree of novelty' of the innovation. The latest ABS innovation survey has taken this approach (data not yet available), as did the NZ and BRITE surveys. Indeed, moving from 'new-to-firm' innovation to 'new-to-industry' and 'new-to-world' innovation tends to neutralise the apparent BRITE over-reporting problem. The main part of this report discusses innovation rates only by these higher degrees of novelty.

11 Appendix D: Survey Methodology Learnings

This section provides a summary of the lessons learned through the BRITE survey experience. The following findings are intended to be of benefit to other CRC for Construction Innovation researchers.

1. Use of external survey senders is problematic as they may make independent decisions, contrary to the advice provided to them, that result in inconsistent treatment of sub-sector samples. The BRITE Project team suspects that some government agencies and/or industry associations may have wanted their constituents to be cast in a favourable light and so did not send surveys randomly as instructed, sending them instead to their largest players.

2. Although managing external survey senders is difficult, it may be necessary to ensure reasonable response rates, given that the external senders are chosen because they have a strong relationship with potential respondents (for example, industry associations and their members or government agencies and their prequalified businesses).

   Sample lists based on phone book references are likely to be useless. For example, a BRITE census of lift suppliers based on Yellow Pages listings for Qld, NSW and Vic was unsuccessful and dropped, as only 3 from 32 forms were returned. Similarly, a private sector client census survey sent by BRITE and based on an IBIS 'Commercial Property Developers' list for Australia was unsuccessful and dropped as only 2 from 70 forms were returned. These examples highlight also that the larger and more powerful an organisation is, the less likely they are to respond to surveys. Indeed, plaster suppliers were the only participants surveyed directly by the BRITE Project with no support from an industry association or government agency where a workable response was achieved.

3. The BRITE Project did not collect data about the identity of businesses or respondents in an effort to assure potential respondents of anonymity, reduce respondent time required and encourage higher response rates. In hindsight, this may not be a good policy. Reminders had to go to the whole sample, star performers could not be easily identified for follow-up discussions and, as there is no ‘evidence’ of the seniority of the person completing the survey form, source data could not be checked. A useful alternative may be to place a letter label on the envelopes being sent out, *and* on the back of the survey.

4. Giving a short time frame for response, eg. 5 working days, appears to have been useful as it seems to have prevented potential respondents putting the survey on the ‘never-never’ pile. The downside to this is that many respondents phoned worrying that they were too late for the deadline. Many respondents may have not responded because they feared their survey response would be too late to count.

5. Providing a survey reminder made a big difference to the response rate, increasing it considerably. It seems useful to send the reminder within one week of the initial 5 working day deadline. The team has experience of employing a 2nd reminder in the past (time constraints prevented this for the BRITE survey) and this can also make a significant difference to response rates, though less so than the first reminder.

6. It is important to have a sufficiently long field-work phase to allow time for reminders to go out and late returns to come in. This is especially important where the survey project manager is relying on external senders (eg. industry associations), as this involves considerable delay. The BRITE team recommends allowing approximately three months for the fieldwork phase, especially for large surveys (eg. 1,000 units) with complex sending methodologies (eg. multiple sends and/or reminders). Also, a reasonable amount of time needs to be allowed to gain permissions from potential survey senders, especially if industry associations need to seek the approval of their members at a quarterly meeting.

7. In hindsight, it would have been useful to have broken the survey's 'consultant' sample into engineers and architects, for comparative purposes.

8. The BRITE team observes that previous internet surveys in the construction industry have not performed well, as the large number of SMEs means that many potential respondents do not have computers, skewing survey results.

9. For mail surveys, questionnaire length is particularly important. The BRITE team recommends five pages or less for good response rates. Also, tick-box questions perform best, with the BRITE survey achieving close to 100% completion across such questions. Previous experience with text questions has revealed to the team that respondents will answer a limited number of short text questions reasonably willingly. Too many required text responses, complex questions, requests for lengthy details, or requests for financial information, on the other hand will tend to irritate respondents and result in non-response.

10. Other little things to remember: number surveys and database entries to enable cross-checks; enter the return date on the result spreadsheet so that respondent behaviour can be analysed in terms of 'time to return' and response to reminders versus initial call; and code surveys if necessary.

BIBLIOGRAPHY

Anderson, F. and Schaan, S. (2001) *Innovation, Advanced Technologies and Practices in the Construction and Related Industries: National Estimates*. Canada: Statistics Canada/NRRC.

Arditi, D., Kale, S., and Tangkar, M. (1997). "Innovation in construction equipment and its flow into the construction industry." *Journal of Construction Engineering and Management*, 123(4), 371-378

Australian Bureau of Statistics (ABS) (2004a) Unpublished data from *2002-2003 Research and Experimental Development, Businesses, Australia, Cat. 8104.0.* Canberra: ABS.

Australian Bureau of Statistics (ABS) (2004b) Unpublished data from *Australian Business Register.* Canberra: ABS.

Australian Bureau of Statistics (ABS) (*forthcoming*) *2004 Innovation Survey*. Canberra: ABS.

Barrett, P. S., and Barrett, L. C. (2003). "Research as a kaleidoscope on practice." *Construction Management & Economics*, 21(7), 755-766.

Barrett, P. S., Sexton, M. G., Miozzo, M., Wharton, A. P., and Leho, E. (2001). "Innovation in small construction firms." Base Report for the EPSRC / DETR:IMI Construction-Link. Available at http://www.scpm.salford.ac.uk/pbarrett/Research%20Projects/Project%20-%20i2i2%20-%20base%20report%20-%20index.htm

Bresnen, M., and Marshall, N. (2001). "Understanding the diffusion and application of new management ideas in construction." *Engineering Construction & Architectural Management*, 8(5), 335-345.

Drejer, I. (2004). “Identifying innovation in surveys of services: a Schumpeterian perspective.” *Research Policy, 33*, 551-562.

Dubois, A., and Gadde, L. (2002). "The construction industry as a loosely coupled system: implications for productivity and innovation." *Construction Management and Economics*, 20, 621-631.

European Commission (2004) *Innovation in Europe – Results for the EU, Iceland and Norway*. Data 1998-2001. Luxembourg: European Commission.

Gann, D. M., and Salter, A. J. (2000). "Innovation in project-based, service-enhanced firms: the construction of complex products and systems." *Research Policy*, 29(7-8), 955-972.

Hampson, K. and Brandon, P. (2004) *Construction 2020: A Vision for Australia's Property and Construction Industry*. Brisbane: Cooperative Research Centre for Construction Innovation.

Ling, F. Y. Y. (2003). "Managing the implementation of construction innovations." *Construction Management and Economics, 21*, 635-649.

Love, P. E. D., Huang, J. C., Edwards, D. J., and Irani, Z. (2004). "Nurturing a learning organization in construction: a focus on strategic shift, organizational transformation, customer orientation and quality centred learning." *Construction Innovation*, 4(2), 113-126.

Manley, K. (2003) Innovation in the Queensland Road and Bridge Industry. Brisbane: QUT/CSIRO/QDMR.

Manley, K. (2003b) The BRITE Project. Innovation Case Study No 3: Motorway Alliance Drives Performance Improvement. Brisbane: QUT.

Manley, K. and Swainston, M. (2004) 'Innovation in the Building and Construction Industry', *Road Systems and Engineering Forum*, Queensland Department of Main Roads, Bardon, Queensland, August 5th.

Miozzo, M., and Dewick, P. (2004). "Networks and innovation in European construction: benefits from inter-organisational cooperation in a fragmented industry." *International Journal of Technology Management*, 27(1), 68-92.

Mitropoulos, P., and Tatum, C. B. (1999). "Technology Adoption Decisions in Construction Organizations." *Journal of Construction Engineering and Management*, 125(5), 330-338.

Mitropoulos, P., and Tatum, C. B. (2000). "Forces Driving Adoption of New Information Technologies." *Journal of Construction Engineering and Management*, 126(5), 340-348.

OECD (2000) *A New Economy? The Changing Role of Innovation and Information Technology in Growth*. Paris: OECD.

OECD/Eurostat (1997) Proposed Guidelines for Collecting and Interpreting Technological Innovation Data (Oslo Manual). Paris: OECD.

Pattinson, W. (2002) 'Developing a Strategy for Innovation Statistics: Establishing User Requirements'. *ABS Innovation Statistics in Australia, Background Paper*. Canberra: ABS.

PWC (2002) Innovation in the Building and Construction Industry – Survey Report. Canberra: ACIF/ISR.

Saha, S. K., Hardie, M., and Jeary, A. (2003). "Attitudes to 3D and 4D CAD systems in the Australian construction industry." *Proceedings of the Second International Structural Engineering and Construction Conference*, Roma, Italy.

Seaden, G., Guolla, M., Doutriaux, J., and Nash, J. (2003). "Strategic decisions and innovation in construction firms." *Construction Management & Economics*, 21(6), 603-621.

Statistics New Zealand (2004) *Innovation in New Zealand*. Wellington: Statistics New Zealand.

Walker, D., Hampson K. and Peters, R. (2000) *Relationship-Based Procurement Strategies for the 21st Century*. Canberra: Ausinfo.