Design and Documentation Quality Survey

Comparison of Designers' and Contractors' Perspectives

A Survey Investigating Changes in Design and Documentation Quality within the Australian Construction Industry and it's Effect on Construction Process Efficiency

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Table of Contents

List of Tables

List of Figures

Executive Summary

Background

The CSIRO Division of Building, Construction and Engineering – in collaboration with the Australian Construction Industry – recently undertook an investigation into the issues affecting design and documentation quality and their impact on the efficiency of the construction process. To carry out this task, a national survey, targeting designers, main contractors and trade contractors, was undertaken. Through this survey, the main factors affecting design and documentation quality, as well as the most significant impacts on the efficiency of the construction process in Australia, have been identified.

To carry out the study, the industry was partitioned into two sectors – designers and contractors – with each being surveyed separately using different survey forms. The various industry organisations representing both designers and contractors were actively involved in the development and distribution of the survey documents.

The overall aims of the study were to:

- identify those issues which affect design and documentation quality;
- determine whether there has been any changes over the past 15 years in the levels of design and documentation quality;
- determine what impact changing design and documentation quality standards may have on construction process efficiency; and
- assess the impact of these changes on project cost and time.

The aim of this report is to provide a detailed comparison of the results of both the designers' and contractors' surveys and to highlight any similarities or differences in the responses from the members of the different industry organisations surveyed. A complete analysis of the results coming from either the designers' or contractors' surveys are looked at individually and are the subject of separate reports.

Survey Questionnaire

The survey forms used both the designers' and contractors' surveys were developed from the results of industry workshops. The designer's questionnaire consisted of ten sections and was designed to obtain the following information:

- the level of importance of various design and documentation quality attributes in determining overall design and documentation quality;
- the issues affect design and documentation quality;
- the changes to the quality of design and documentation that have occurred over the past 15 years;
- the changes to design fee levels that have occurred over the past 15 years;
- whether there is any relationship between changes in design fee levels and changes in design and documentation quality; and
- a comparison between private and public sector clients .

In addition to these issues, the survey also enabled designers to consider a number of concepts relating to both the provision of design services and issues affecting the procurement of design services.

The contractor's questionnaire consisted of four sections, designed to obtain the following information:

- the changes in the level of design and documentation quality;
- areas of design and documentation deficiency;
- the nature and extent of the impact of design and documentation deficiency on construction process efficiency; and
- organisational profiles and general comments.

In addition to these issues, the survey also enabled contractors to compare design and documentation quality between the public and private sectors as well as determine the impact that different procurement methodologies have on the quality of design and documentation provided. Both surveys also provided sections for company profile information and for general comments.

Survey

The designer's questionnaire was distributed to 2974 design firms comprising Architects, Engineers, Landscape Architects, Quantity Surveyors and Land Surveyors. The response from all disciplines surveyed totalled 491 – an overall response rate of 16.6%. The contractor's questionnaire was distributed to 2436 individuals and firms, representing various head contractor and trade contractor organisations. The trade contractor organisations involved, included mechanical contractors, electrical contractors, plumbing contractors, steel fabricators and steel detailers. The responses to the contractor's questionnaire from all respondents surveyed totalled 327 – which represented a total response rate of 13.4%.

With all states and industry associations being represented, the number of responses to both the designers' and contractors' surveys ensures that the survey results are generally representative of each particular sector of the industry. Overall, the response rates were considered reasonable for this type of survey and provide ample data to allow statistically significant differences to be uncovered.

Results

Overall

The respondents were classified by a number of factors based on information obtained from the organisational profile section of the survey. Based on the analysis carried out, it was determined that of the factors identified, only the organisation association of the contractor or in the case of the designers, the respondents discipline factor was consistently of statistical significance.

Design and Documentation Quality

Importance of design and documentation issues

In the designer's survey, the level of importance that specific design and documentation attributes had in determining the overall project design and documentation quality was investigated. In relation to *design*, the attributes considered to be most important were:

- *functionality* – the design effectively serves the purpose for which it was intended; and
- *relevancy* – ensuring that project requirements are met.

The attributes considered to be least important were:

- *innovation* – incorporating innovation in the design solution; and
- *expressiveness* – provides symbolic expression and feeling.

When considering the attributes of *documentation*, the attributes considered to be most important were:

- *accuracy* – documents being free of errors, conflicts and inconsistencies; and
- *clarity* – documents being legible and easily read and interpreted.

The attribute considered to be of least importance was:

- *standardisation* – the use of standard details and specifications.

Changes in levels of design and documentation quality

Having determined the level of importance of the various attributes that determine design and documentation quality, the surveys then sought to assess the respondent's perception of the extent of change in the various areas of design and documentation quality over the past 12 to 15 years. This objective would be achieved by comparing the different levels of incorporation attained for each of the design and documentation quality attributes at the three time periods indicated. As the level of incorporation of a number of attributes of design and documentation quality helps to determine overall quality any improvement in the level of incorporation should be reflected in the quality of the design and documentation. The issues surveyed in the two questionnaires were generally the same, however the contractors form only contained thirteen of the twenty-two design issues asked of the designers, as it was felt the other eight issues were not relevant to the contractors.

In addition to looking at the attributes of design and documentation quality, contractors and designers were specifically asked to consider whether in their opinion there had been a decline in the quality of both design and documentation over the past 12 to 15 years. In relation to both design and documentation, the respondents' perception was that the quality for both had declined. They also indicated that the decline in documentation quality had been the more significant.

In spite of the fact that the majority of respondents had previously indicated a decline in overall design quality over the past 12 to 15 years, the combined response for all design quality attributes listed initially indicated a small overall improvement in their level of incorporation over the same period. Further investigation however, revealed that the apparent improvement was due to a smaller number of respondents indicating a significant improvement in the level of incorporation of some design attributes, thereby affecting the overall averages. The attribute that showed the greatest improvement according to both designers and contractors was:

- consideration of *ecological sustainability* issues.

Designers also believe there has been considerable improvement in the level of incorporation of design attributes relating to:

- consideration of *whole life-cycle* issues.

Contractors on the other hand, indicated that there were other issues – significantly pertaining to reducing the cost of construction – that they felt had increased in their level of incorporation. These attributes include:

- *material efficiency* – ensuring the efficient use of materials;
- *innovation* – incorporating innovation in design solutions; and
- *economy* – ensuring design solutions are cost effective.

Of the twenty-two design quality attributes listed for designers, only eight showed a decline in their level of incorporation over the past 12 to 15 years. Interestingly, only two of these eight

issues were also given to the contractors to assess. The attributes that showed the greatest decline were:

- equitable balance in the *ratio of junior to senior staff* used; and
- ready *availability of experienced design personnel*.

In contrast to contractors, designers generally believe that *innovation* – incorporating innovation in design solutions – had declined in its level of incorporation. The only attribute that both contractors and designers agree had declined was:

- the *proper examination of design proposals* – to prevent ambiguity, omissions and errors.

Another area of design that received less attention now than it did 15 years ago, according to contractors, was:

- *constructability* – incorporating constructability principles.

Although there was a high degree of variation in the responses between the contractor organisations for this issue, designers generally believed that this attribute had actually improved over the same time period.

When asked to consider the changes that had occurred in relation to the documentation quality attributes listed, both contractors and designers indicated a significant overall decline in the level of incorporation of the attributes over the past 12 to 15 years, which was consistent with the previous results indicating a decline in overall documentation quality. The attributes showing the greatest decline were identified as:

- *completeness* – drawings and other documents provide all the information required; and
- *final checking* – drawings and other documents are properly checked prior to release.

According to contractors only one of the documentation attributes listed had improved in its level of incorporation, while designers indicated four issues had showed an overall improvement over the past 12 to 15 years. The attribute that both agree had improved and in fact showed the greatest improvement was:

- *standardisation* – use of standard details and specifications in drawings and other documentation.

While designers also believed that *conformity* – documents indicate the requirements of standards and statutory regulations – had also improved, contractors indicated a marginal decline in its level of incorporation.

The major difference in the level of incorporation of design and documentation issues between designers and contractors was the ratings that each of the attributes obtained. According to contractors, most design and documentation quality attributes achieved a level of incorporation rating that was significantly lower than what designers believe it to be, over all time periods. On average, contractors rated design attributes at around 20% below the level that designers did, at each time period. In contrast however, the contractors' assessment of documentation attributes ranged from between 19% lower 12 to 15 years ago, to almost 47% lower, now.

Contractors were also asked whether the overall quality of design and documentation was greater in the public sector than in the private sector. Although a higher percentage indicated the quality of private sector design and documentation was at least as good, if not better than in the public sector, the results were generally not conclusive. However when designers were asked if fee levels were greater in either the public or private sectors, the results showed that a greater proportion indicated that fees were higher in the private sector. Comparing the two

sets of data showed a moderate to high correlation between the higher fee levels and the higher design and documentation quality, in the private sector.

Issues affecting design and documentation quality

The impacts of a number of issues affecting design and documentation quality were investigated in the designer's survey. It was the opinion of designers that those issues occurring most frequently were:

- *unrealistic expectations by clients* – in relation to fees, service, timing, etc.;
- *low fee structures*; and
- *insufficient profits* – being generated to enable the training of staff.

However, when asked to consider which issues had the greatest impact on design and documentation quality, the issues identified were:

- *proliferation of 'backyard' operators* – prepared to work for minimal fees;
- *low fee structures*; and
- *insufficient overall design time*.

Overall, these results generally indicated that when the frequency of occurrence of the issues affecting design and documentation quality increase, then their level of effect becomes increasingly detrimental. These results are also consistent with the comments made by contractors, who indicated that inadequate design fees, a lack of professional standards and insufficient design time are major contributors to poor quality design and documentation.

Areas of design and documentation deficiency

Contractors were asked to rate the frequency of occurrence of specified design and documentation problems and their perception of the level of effect each issue had on the design and documentation quality when it occurred. Supplementing this, they were also asked whether they believed there had been an increase in the overall frequency of occurrence of the problems over the past 15 years.

Overall, contractors indicated that documentation deficiency issues occur more frequently than the design deficiency issues, but that the effect of both was highly detrimental to construction process efficiency. Documentation issues providing the greatest concern to contractors were documents lacking:

- *clarity;* or
- having *conflicting* or *incorrect information.*

The design issues that occur most frequently and have the greatest effect on the construction process, include:

- *Inadequate* or *insufficient design work being carried out;* and
- *insufficient design coordination* – causing clashes between the services and building elements.

Procurement of Services

Issues affecting the procurement of design and documentation services

The designers' survey investigated a number of issues affecting the procurement of design and documentation services including the designers' perceptions of what is important to both ***private*** and ***public*** sector clients and how well clients understand the design and documentation process.

When asked to consider the client's understanding of the value of various aspects of the design function, designers generally felt that neither *public* nor *private* sector clients understood the true value of the design function. Of most concern to designers was:

- the *need to interpret and expand* on inadequate and changing client briefs;
- the *lack of understanding by clients* as to the high litigation risks involved in selecting designers based on minimum cost; and
- that there was *insufficient time being allowed* for designers to not only produce high quality design and documentation, but also to adequately incorporate innovation and life cycle considerations.

It was also the opinion of designers that not only did clients not associate increases in project costs with poor quality design and documentation, but that they also did not relate the quality of design and documentation to the level of fees provided and the time made available to complete the work.

When considering the criteria used for design firm selection, the vast majority of designers perceived the level of design fees to be the most important selection criteria in obtaining work from either client group, with issues such as experience, qualifications and quality assurance being only of secondary consideration.

When the issue of time was considered, designers felt that overall there was insufficient time being allowed for designers to not only produce high quality design and documentation, but also to adequately incorporate innovation and life cycle considerations. Designers also felt that if more time were made available for the process of design and documentation, then the level of quality would be improved.

Effect of procurement methods on design and documentation quality

Included in both the designers' and contractors' surveys was a section dealing with the effects of the procurement method on design and documentation quality. Designers and contractors were asked to rate the quality of design and documentation produced under three different project delivery methods – *traditional, design and construct* and *management* – over the past 15 years.

When considering the quality of design and documentation achieved under each procurement method, the designers indicated that overall quality has declined under all three procurement methods over the past 15 years, with the level of decline being greatest under the *traditional* method and least under the *management* method. In spite of this, the designers still perceive that the *traditional* method provides the highest standard of design and documentation quality. While the contractors agree that the greatest decline in design and documentation quality has occurred under the *traditional* method, it is their belief that overall design and documentation quality levels produced under the *traditional* method have now dropped below the levels indicated for the other two procurement methods.

While it is the designers' belief that the overall quality of their work ranges between *average* and *good*, it is the contractors' contention that the current standard of design and documentation is rated between *average* and *poor*, with documentation quality being much closer to *poor*. This difference of opinion is considered to be a problem, as it would appear that designers do not monitor or obtain feedback from the ultimate customers of their work – the contractors. With the rate of decline showing no signs of changing, designers will need to take drastic action to reverse the trend and restore designer confidence within the contracting groups.

According to the designers the *traditional* procurement method is still the most widely used procurement method, currently being used on 63% of projects undertaken. An analysis of the results indicates that this represents 50% of all design income, a figure that is directly comparable to the 44% of total turnover as indicated by the contractors. However, *traditional* procurement method usage has declined significantly over the past fifteen years. This decline in its use has been taken up by an increase in the use of both *design and construct* and *management* procurement methods, with *design and construct* being the more popular method of the two. With the *traditional* procurement method also showing the greatest decline in design and documentation standards, its selection as a method of procurement should require serious consideration.

The perceived decline in quality may however be due, in part, to a significant decline over the past fifteen years, in the availability of time to carry out the design and documentation function. Designers also indicated that the amount of available time had declined most under the *Traditional* method and least under *Management* methods. Looking at the changes in the level of service required by clients under each procurement method also showed a similar situation, with levels of service required declining most under the *Traditional* method and least under *Design and Construct*. By reducing planning and design time and by limiting the design service, clients themselves appear to be directly contributing to the decline in design and documentation quality standards.

Changes in levels of design fees

According to designers, the level of design fees required to provide a proper service and produce a quality product, have only declined marginally over the past 12 to 15 years, with the level of fees required for *simple* projects declining the most at just under 5%. These decreases in the required fee levels are most likely due to improvements in information technologies, which allow for improved efficiencies within the design processes.

However, the fee levels that designers considered were needed to be submitted to actually win the work, showed an average decline of approximately 21% for all three project complexity levels over the past 12 to 15 years. Similarly, when comparing the difference between the fee levels *submitted* now to the fee levels *required* now, the responses revealed that the disparity between the two fee levels represented an average decline in real designer fee income of approximately 24% for all three project complexity levels. It would appear therefore, that the levels of fees being obtained, are well below those that designers believe are required to provide quality design and documentation services and have been steadily declining over the past 12 to 15 years.

Impact of reduced fees

In section 8 of the designers' survey, designers were asked to indicate what – if any – effect reduced design fee levels would have on the attributes of design and documentation quality. Based on the responses provided, it is the opinion of designers that reduced design fee levels have a highly detrimental effect on most design quality attributes, with the two attributes affected most being:

- *innovation* – incorporating innovation in the design solution; and
- *provision of in-house and external training* – to ensure continuing professional development of design staff.

Similarly, the responses provided in relation to the documentation quality attributes, indicated that reduced design fee levels also have a highly detrimentally effect on documentation quality, with the attributes affected most being:

- *completeness* – drawings and other documents provide all the information required; and

- *certainty* – drawings and other documents do not require changes or amendments.

These overall results correspond very closely with the design and documentation quality attributes that designers considered have declined most over the past 12 to 15 years.

Changes in levels of service provided

The designers considered that the majority of the design service components – which are required to ensure overall design and documentation quality – have declined over the over the past 12 to 15 years. The areas to have declined the most were:

- *providing complete and accurate documentation* and design detailing;
- *checking that dimensions are correct* and appropriate; and
- *coordinating design details* from various other consultants.

Not unexpectedly, the areas that have shown the greatest improvement over the same period were:

- *using CAD* for the production of drawings; and
- *using information technology* to improve project communications and assist with document transfer.

Construction Process Efficiency

The nature and extent of the impact of design and documentation deficiency on Construction Process Efficiency (CPE)

According to the contractors, deficiencies occurring in design and documentation provided by consultants have been steadily increasing over the past 12 to 15 years and have also caused corresponding increases in the extent of inefficiency within the construction process. Poor quality design and documentation has directly contributed to increases in the quantities of RFI's, variations, rework, cost over-runs, extensions of time and contractual disputes. As a consequence, contractors have indicated that decreases in project quality and increases in overall project costs and duration result.

The increased occurrence of these non-desirable elements affecting construction process inefficiency, has meant that the managerial and administrative workload has increased to such an extent that the time and cost expended on managing these problems now represents approximately 72% and 64% of the total project administrative time and cost allowances, respectively. Of major concern, are the additional costs – that to a large degree end up being absorbed by contractors – which are caused by the delays and disruption in trying to clarify inadequate, impractical, conflicting or ambiguous design and specification documentation.

The overall price of design and documentation deficiency to clients and developers, is higher project costs and longer project durations, with most contractors adding a percentage to the tender price submitted for a project to allow for poor quality design and documentation. The actual percentage added is generally determined by the contractors' assessment of the quality of design and documentation provided. Similarly, the expected project duration allowance is also extended based on the standard of design and documentation provided.

By reducing design fees to minimise costs, clients and developers again by their own actions, appear to be contributing to the problems that lead to inefficiencies in the construction process and increases in overall project costs.

Other changes in the past 15 years

Designers were asked to consider other changes that had occurred in the construction industry over the past 12 to 15 years and what impact they had on design and documentation quality. The industry changes to which the designers indicated the greatest level of agreement, were:

- the trend of clients to *'shop around'* more for design services; and
- the tightening of economic conditions.

When asked to consider what effect these various changes had on design and documentation quality, those changes that were identified as having the greatest benefit were:

- advances in computer software improving the level of service able to be provided; and
- the implementation of IT improving communication within the industry.

However, those changes indicated by the designers to have the greatest detrimental effect on design and documentation quality were identified as:

- the design function being de-valued from a clients perspective; and
- the tightening of economic conditions.

Organisational profiles

To try to determine an overall profile of design and contractor firms working in the construction industry, the surveys investigated a number of different organisational attributes. Based on the analysis of the data provided, design firms generally have the following characteristics:

- they have been in business for less than 20 years;
- they employ less than 10 staff;
- the majority of the work they undertake is carried out under the *traditional* procurement method, with only about half involved in either *design and construct* or *management* type procurement methodologies;
- they obtain the majority of their design income from the *civil engineering, government* and *commercial* construction sectors;
- obtain the majority of their income through *lump sum* fees; and
- are more likely to have their own in-house QA system or no QA system at all, than be fully accredited to ISO 9000 standards.

While contracting firms generally have the following characteristics:

- a high proportion have been in business in their state for more than 15 years;
- most companies employ more than 16 employees;
- the majority of the work they undertake is carried out under the *traditional* method, with 89% of contractors carrying out work under this system;
- a large proportion of the companies turnover is from the *government*, *heavy industrial* and *commercial* sectors; and
- more than half of the respondents companies have quality assurance or are currently in the process of becoming certified.

Respondents comments

Section 11 of the designers survey and Section 4 of the contractors survey included provision for respondents to comment on the questionnaire, the issues raised within it and any other issue considered to be relevant to the overall topic in general. Of the 491 responses received from designers, 204 (42%) included comments, with the number of comments from the various disciplines and states being in proportion to their overall response rates. Similarly, 153 (47%) of the 327 contractor respondents took the time to provide comments on their survey form.

An analysis of the comments indicated that in the opinion of designers, low design fees, insufficient design time and a lack of understanding by the clients of the true value of design professionals have led to a decline in design and documentation standards, which have then in turn led to reduced construction process efficiency and increased project costs. The contractors' comments indicate that there is a major problem with the current standard of design and documentation within the Australian construction industry and that the poor standard is affecting construction process efficiency, which in turn is leading to higher project costs and extended project durations. In trying to determine a cause for these problems, it was the opinion of contractors that inadequate fee levels, poor professional design standards and insufficient project time allowances have all directly contributed to the current quality problems.

Conclusions and recommendations

The results of the surveys clearly show a need for clients and developers to allocate adequate funds and time to the planning and design phases of a project, in order to maximise construction process efficiency and minimise overall project costs. Improvements in construction process efficiency will only result from creating an awareness of the value of quality design and documentation and through the introduction of selection criteria that prioritises the consideration of the designer's skills, capabilities and experience over designer fee levels.

1 Introduction

1.1 Background

For some time, industry analysts have portrayed the Australian construction industry as being uncompetitive and inefficient when compared to overseas, with the quality of design and documentation produced being of major concern to many parties within the industry (Syam, 1995). As the quality of the design and documentation produced has a major influence on the overall performance and efficiency of construction projects (Burati *et al*, 1992; Kirby *et al*, 1988), it is vitally important that issues affecting design and documentation quality be identified and addressed.

Designers provide the graphic and written representations that allow contractors and subcontractors to transform concepts and ideas into physical reality. However, it is the quality of the design and documentation provided which determines how effectively and efficiently this transformation occurs. Inadequate and deficient design and documentation impacts directly on the efficiency of the construction process by leading to delays, rework and variations, which in turn contribute to increases in project time and cost (Tilley and Barton, 1997).

In an ideal world, the design and documentation provided for construction projects would be complete, precise and unambiguous. Unfortunately, contractors are often supplied with project documentation that is considered to be substandard or deficient due to incomplete, conflicting or erroneous information. Design and documentation quality is greatly determined by the level of professional services provided, with the quality of these services generally being determined by how the services are selected and how the fees are negotiated (DeFraites, 1989). Where designers are selected on the basis of low design fees, then the level and quality of the service provided is likely to be limited and generally translates into additional project costs to the owner.

A recent study of the relationship between fee structure and design deficiency showed that design deficiency had a non-linear inverse relationship with project design fees (Abolnour, 1994) and that project costs due to design deficiency increase sharply when design fees are reduced below their optimal level (Abolnour, 1994; McGeorge, 1988). The concept of reducing total project costs by increasing expenditure on the design process has also been well documented through the principles of value engineering (Green, 1990) and value management (Barton, 1996). It would appear therefore, that the truism, *'you get what you pay for'*, is very appropriate when it comes to procuring design services.

But what is design and documentation quality and how is it measured? One definition relating to design quality (McGeorge, 1988) states:

> *"a good design will be effective (i.e., serve the purpose for which it was intended) and constructable with the best possible economy and safety."*

However, while the design itself needs to be "effective", it also needs to be communicated effectively through the documentation (*i.e.*, drawings, specifications, Bills of Quantities). When documentation quality is considered, a number of attributes – such as timeliness, accuracy, completeness, coordination and conformance – are looked at to determine the level of quality achieved (Tilley *et al*, 1997). Therefore, by measuring the extent to which

attributes of design and documentation quality are incorporated, we can determine the quality of design and documentation achieved (Tilley *et al*, 1997).

With this in mind, CSIRO Division of Building, Construction and Engineering proposed to investigate design and documentation quality within the Australian construction industry, with the overall aim of the study being to:

- identify those issues which affect design and documentation quality;
- determine whether there has been any changes over the past 15 years in the levels of design and documentation quality;
- determine what impact changing design and documentation quality standards may have on construction process efficiency; and
- assess the impact of these changes on project cost and time.

To carry out this investigation, it was decided to conduct a national survey of both the design professions and various head and trade contracting organisations. To ensure that the survey addressed only pertinent issues, industry workshops were undertaken as part of the background investigation stage of the study. These workshops, designed to obtain a cross-section of up-to-date industry opinion on the issues, provided valuable industry information that was used in the development of the survey questionnaires.

The purpose of this report is to not only provide project sponsors with the results of the comparative analysis of the designers and contractors' surveys conducted by the CSIRO, but also to provide the industry as a whole with conclusions that identify the causes and effects of design and documentation deficiency and recommendations to reduce their incidence or minimise their impact.

1.2 Survey Questionnaires

To study this problem a number of alternatives were considered. Ultimately a postal survey was selected, as it was decided that this method would provide a reasonable quantity of reliable information, sufficient to allow a valid statistical analysis to be carried out within the budgetary constraints of the project. During construction of the questionnaires, consideration was given to question length and clarity to minimise the chance of misinterpretation of the questions and to maximise the reliability of the responses. To ensure that the survey only addressed pertinent issues, all the various industry sponsor organisations – through a Project Steering Committee - were actively involved in the development of the survey documents, by providing:

- advice on what information was likely to be available from the industry,
- comments on the development of survey questions and format, and
- advice on specific issues that should be included in the questionnaires.

The design professions to which the questionnaires were sent, along with their representative industry associations, are as shown in Table 1.1:

Table 1.1 Design professions and their representative industry associations

Design profession	Representative industry associations
• Architects	• RAIA – Royal Australian Institute of Architects
• Engineers	• ACEA – Australian Consulting Engineers Association &
	• IEAust – Institute of Engineers, Australia
• Landscape Architects	• AILA – Australian Institute of Landscape Architects
• Quantity Surveyors	• AIQS – Australian Institute of Quantity Surveyors
• Land Surveyors	• ACS – Association of Consulting Surveyors

The designer's questionnaire was set out into eleven sections to obtain from the design professions the following information:

- what issues were important in determining design and documentation quality;
- whether over the past 15 years, there has been any changes in the levels of design and documentation quality and if so, determining the extent of that change;
- those issues which affect the procurement of design services, for both the public and private sectors;
- what issues were affecting design and documentation quality and determining their level of impact;
- whether different procurement methodologies had an impact on the level of design and documentation quality achieved;
- whether there has been any changes over the past 15 years in the levels of service provided by design firms;
- what – if any – changes have occurred to fee levels over the past 15 years and whether there were any differences between the fee levels obtained from public and private sector clients;
- what effect reduced fee levels have on the quality of design and documentation provided;
- how other changes in the industry have impacted on design and documentation quality; and
- an overall profile of design firms within Australia, for comparative purposes.

The contracting groups to which the questionnaires were sent along with their representative industry association, are shown in Table 1.2:

Table 1.2 Contracting groups and representative industry associations

Contracting group	Representative industry associations
• Head Contractors	• AIB – Australian Institute of Building &
	• MBA – Master Builders Associations (all states and territories)
• Air-Conditioning/Mechanical Contractors	• AMCA – Air conditioning and Mechanical Contractors Association
• Electrical Contractors	• ECA – Electrical Contractors Associations (National and Queensland)
• Plumbing Contractors	• MPA – Master Plumbers Association
• Steel Fabricators &	• AISC – Australian Institute of Steel Construction
• Steel Detailers	

The contractor's questionnaire was set out into four sections to obtain from the various contracting groups, the following information:

- whether over the past 15 years, there has been any changes in the levels of design and documentation quality and if so, determining the extent of that change;
- what are the major areas of design and documentation deficiency, how frequently do they occur and what impact do they have on the efficiency of the construction process;
- whether different procurement methodologies have had an impact on the level of design and documentation quality achieved;
- whether there were any differences in the quality design and documentation produced for either public and private sector clients;
- what impact design and documentation quality has on cost and time estimates for tendering purposes;
- what proportion of the non-desirable elements of construction can be attributed to design and documentation deficiencies;
- whether over the past 15 years, there has been any changes in the extent of non-desirable elements of construction;
- whether over the past 15 years, there has been any changes in the managerial or administrative cost and time allowed to look after these non-desirable elements of construction;
- an overall profile of contracting firms within Australia, for comparative purposes.

Questionnaires for both the designers' and contractors' surveys were distributed by the relevant industry organisation for each design discipline or contracting group, to what they considered to be a representative sample of their members.

1.3 Response Demographics

The designer's survey questionnaire was distributed to 2974 design and related consultancy firms nationally. In total 491 responses to the designer's questionnaire were received – which represents a total response rate of 16.6% – with most disciplines being well represented (see Figure 1.1). The only discipline not to achieve a strong response rate was the surveying discipline, which was only able to provide a 3% response rate.

It should be noted however that a number of surveyors who responded indicated that their role in the design process is limited and that a number of issues raised were not relevant to their businesses. These types of concerns are likely to have contributed to their poor response rate.

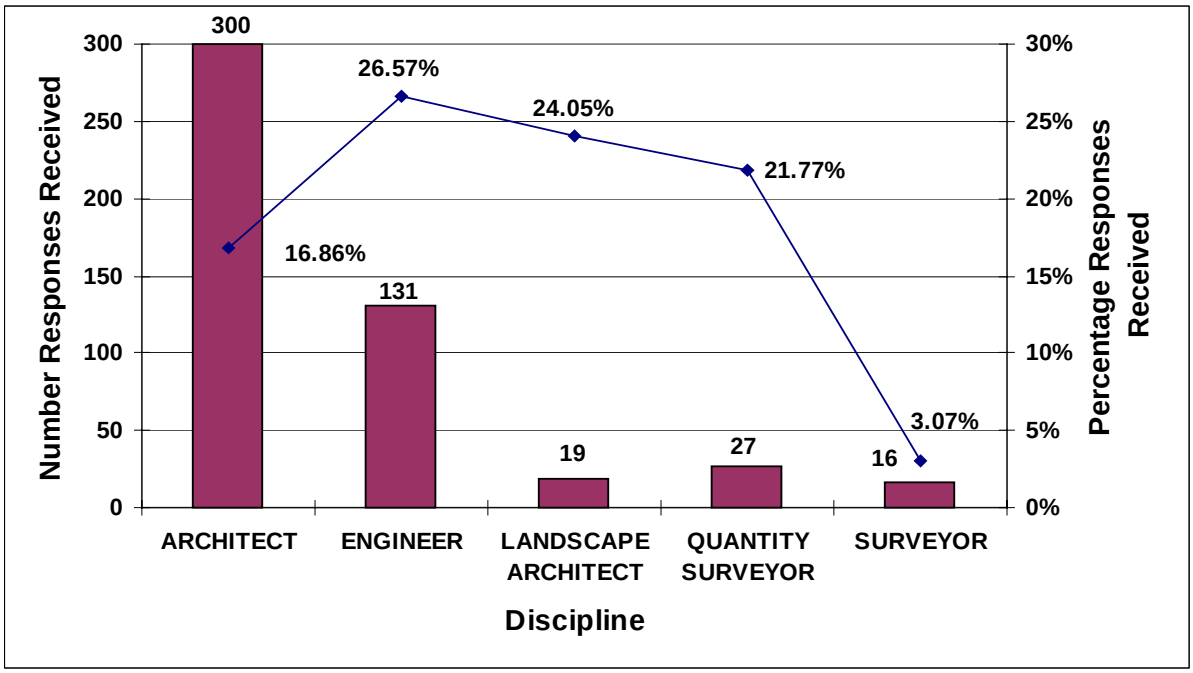

Figure 1.1 Designer survey responses – by discipline

It is also important to note that this was a national survey and, as can be seen in Figure 1.2, all states and territories were well represented.

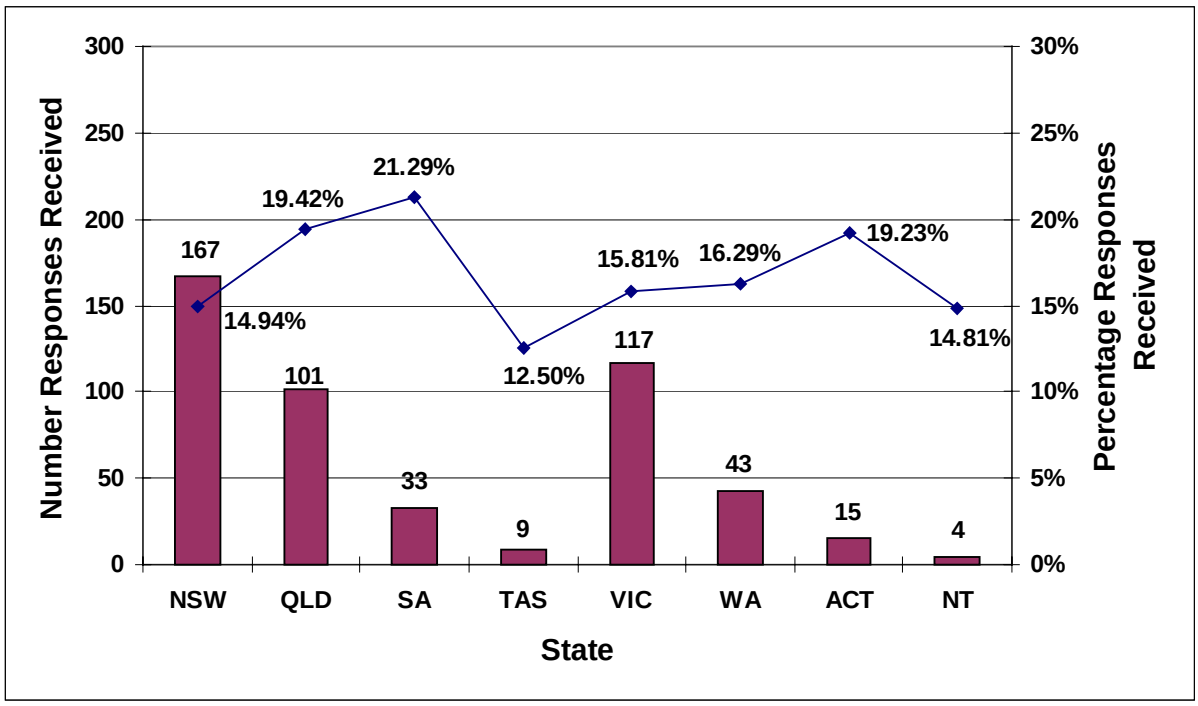

Figure 1.2 Designer survey responses – by state/territory

As can be seen from the chart, although New South Wales and Victoria provided the bulk of the actual responses, South Australia and Queensland provided the highest response rates. These results are considered reasonably good for this type of survey, and indicate that the responses are generally representative of the design consultant sector of the industry.

The contractor's survey questionnaire was distributed to 2436 individuals and firms representing various head and trade contracting organisations nationally. The overall number of responses to the contractor's questionnaire from all disciplines surveyed totalled 327 – which represents a total response rate of 13.4% – with most contracting groups being well represented (see Figure 1.3).

As can be seen, the only construction group not to achieve a strong response rate was the plumbing group, which was only able to provide a less than 3% response rate. Unfortunately, there are no explanations as to why the response rate from the plumbing group should be so low, as one would have expected plumbers to have had the same interest in the issues raised as any of the other contracting groups surveyed.

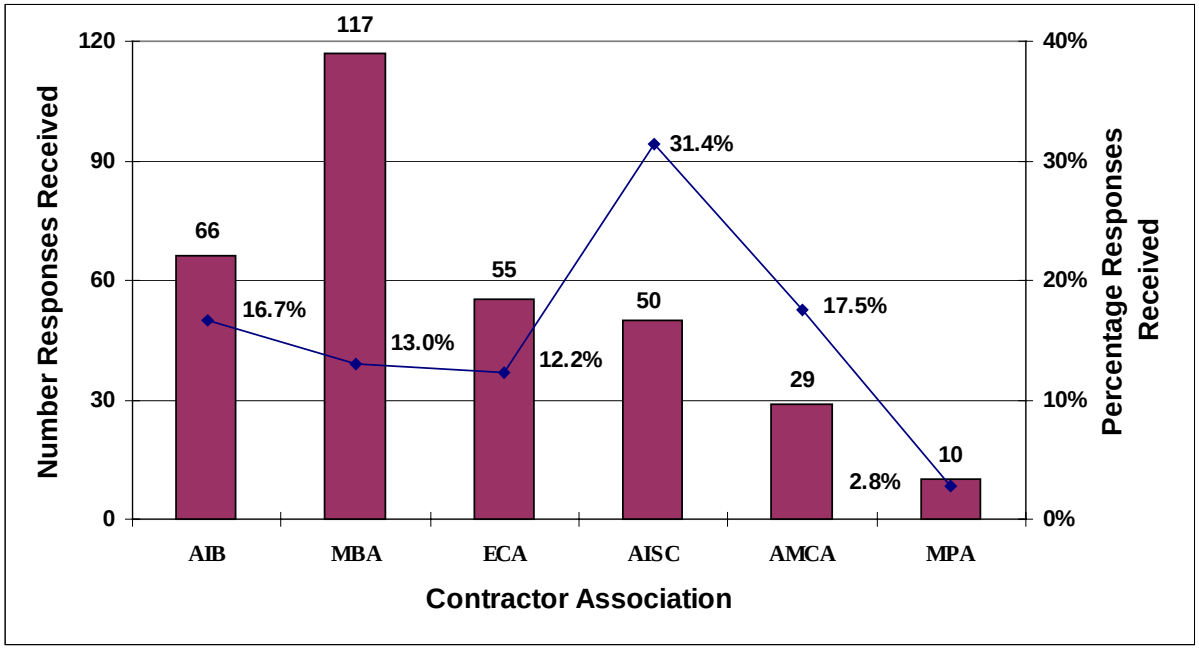

Figure 1.3 Contractor survey responses – by construction group associations

As with the construction groups, most states and territories were also well represented (see Figure 1.4) thereby reinforcing the fact that this was a national survey.

As can be seen from the chart, Queensland and New South Wales provided the bulk of the actual responses, Queensland and Tasmania registering the highest response rates. Although the response rates from the Northern Territory and New South Wales were less than expected, overall the results are considered reasonably good for this type of survey, and indicate that the responses are generally representative of the contracting sector of the industry.

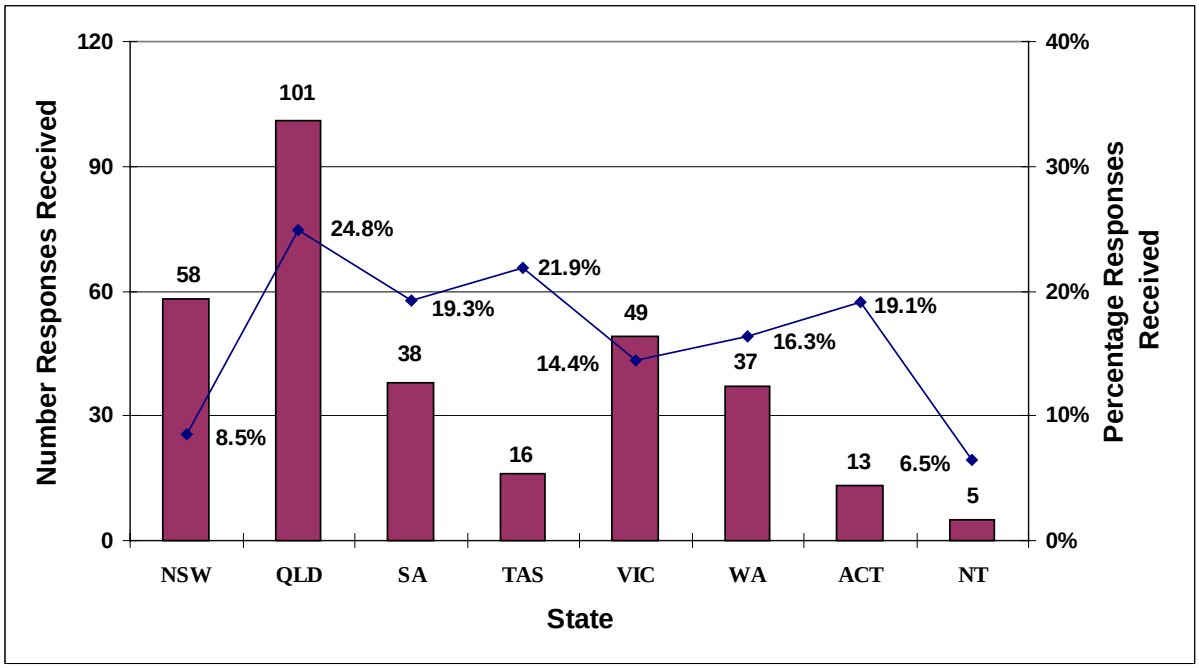

Figure 1.4 Contractor survey responses – by state/territory

Although the overall total number of responses received for both questionnaires were less than hoped for, the overall quantity and range of responses are considered statistically significant and ensures that the results of the analysis can be considered to be generally representative of both the design consultant and contracting sectors of the industry, as a whole.

1.4 Statistical Analysis

During the development of the survey questionnaires concerns about perceptions of lack of validity and reliability of some surveys were addressed. Care was taken with formation of questions to create a non-biased survey to ensure the respondent was not influenced in anyway. With this particular survey, the close involvement with industry has insured the relevancy of the survey questions.

During question formulation sound development procedures were followed (Xu and Halstead-Nussloch, 1995). Some of the principles followed for the formation of the questions were:

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

The general instructions provided with the questionnaire included an introduction to the questionnaire's purpose, assurance of confidentiality, how the respondent was chosen and how and when to return the questionnaire. The questions were grouped into sections, to help structure the questionnaire and provide a flow and both positive and negative items were intermingled to avoid acquiescential responses. Each individual section had an introduction, giving a brief explanation of the section and its purpose. Question instructions provided the respondent with the procedure required to answer the question (ie: tick only one box.). Demographic questions were left until the end of the questionnaire.

The majority of questions are closed questions, requiring the respondent to chose an answer from a limited choice. This form of questioning was used to enable respondents to easily and quickly complete the questionnaire and also allows coding of the answers for responses to be statistically analysed. These types of formats also increase the comparability of responses.

The responses from the returned survey forms were then entered into a Microsoft Access database. It was chosen for its capacity to integrate tables (or parts of) into 'queries' (or sub-tables). The statistical analysis was carried out using the SAS statistical analysis package, while most of the charts were produced using Microsoft Excel. The advantage of using modern statistical software is that many of the statistical tests needed are included in the procedures and as such multiple tests can be implemented simultaneously, providing immediate confirmation of the results.

To analyse the responses a number of standard statistical procedures were utilised. The dominant style of responses from these types of surveys is category or scaled response form. Despite its long history and widespread contemporary use for measuring strength of opinion, category scaling has a number of serious weaknesses. Category scales mostly represent only ordinal levels of measurement. This can hinder legitimate access to many of the powerful statistical methods based on interval assumptions that are available today for the description, prediction and modelling of relationships. However, given the category scales chosen, it is possible to treat many of the question responses in interval fashion, and use the more powerful statistical tests that were deemed necessary. To ensure confidence could be placed in the analysis both parametric and non-parametric tests were carried out on most question responses.

While parametric tests are more powerful than their non-parametric counterparts, for them to be reliable, certain underlying assumptions need to be met. The underlying assumptions used included that the population is normally distributed and the variances are equal. The responses were also tested to determine how they met the assumptions.

The tests for normality carried out included:

- the Kolmogorov-Smirnov test of normality,
- the Geary test,
- the Chi squared test of normality and
- a studentised range test of normality.

The results of these tests indicated whether or not the data met the first assumption. To confirm the second assumption was also met, the following tests were completed:

- a ratio of sample variance F test and
- Bartlets test of equality of variances.

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

The confidence limits and critical region are represented by α, the percent of "type I" error (the probability of rejecting the null hypothesis when it is in fact true and should not be rejected) and are arbitrarily assigned. Since the responses are only a sample of the population the confidence interval, which is the range between the upper and lower confidence limit, is used to assess the precision of the responses compared to the expected population mean response.

The power of a test is the percent of "type II" error, β (the probability of not rejecting the null hypothesis when it is in fact false and should be rejected) there is in the analysis (Zar, 1996). The power is determined by the number of responses, *n*, the number of groups compared, κ, the sample variance, s^2 and the confidence limit imposed, α. Given the relationship between the number of responses, the sample variation and the power of the test, an assessment of the number of responses was made to determine the appropriate α to assign. Through out this analysis a 95% confidence interval and a 5% critical region for hypothesis tests were used.

Descriptive statistics in the form of frequency and univariate analysis were performed to describe the response data. Measures of central tendency and dispersion, histograms, and frequency distributions provide a summary of the data and allow assessment of the parametric qualities of the data.

To determine if there were any differences in the responses in any of the contractor categories within the Australian construction industry, respondents were coded for a number of different factors, as shown in Table 1.3:

Table 1.3 Response analysis factors

Response analysis factors	Factor description
• *Years*	• Years of operation in their state
• *Size*	• Size of organisation – based on number of employees
• *QA*	• Level of quality assurance attained
• *State*	• The state in which the respondent works
• *E-mail*	• The e-mail capacity of the respondent
• *Field*	• The respondents industry association or discipline

These six factors, when combined, provided 15 two-way interactions.

A procedure that enables a simultaneous analysis of the effect of more than one factor on population means is termed a factorial analysis of variance (FANOVA). This procedure was used to test the effect of the various factors on the responses. In addition, a FANOVA can also test for the interaction among factors. Non-parametric tests for multi-factor analysis, have generally been found to be unacceptable. Zar (1996) suggests a multifactor extension of the Kruskal-Wallis test was found to perform poorly and should not be used. Therefore, it would be more statistically sound to use the single factor Kruskal-Wallis test on each factor.

If a factor had a statistically significant effect on the mean response then further tests were completed to determine any natural groups in the factors and the size of the effect.

Parametric multiple comparison tests of factor means used include:
- Fishers least significant differences,
- Duncans multiple range test and
- Tukey's honestly significant differences.

These tests were carried out to determine at which levels the differences occurred. These particular tests were chosen as Tukey's is a more conservative test of differences than most and is generally perceived to be a better test for unequal sample sizes however Duncans test is

claimed to have greater power (Einot and Gabriel, 1975). The non-parametric equivalent used was the median scores test.

The non-paired T-Test is a parametric test of the differences between the mean score responses. This test was used to determine if there were differences in the responses of the designer's and the contractor's perception of attributes of design and documentation quality. The size of the differences in the responses between the two groups can be measured by a statistic called the effect size. An effect size is measured by dividing the difference in the mean responses by the standard deviation of the responses, thus it is a standardised measure and can be compared across a range of questions. Cohen (1990) provides a descriptive measure of effect sizes that suggests an effect size of 0.6 is a moderate effect, while an effect size of 1.2 is large.

The mean responses from the various factors for the survey were tested and only the *Field* factor was statistically significant through out the analysis. The mean responses for this factor differed in magnitude for some issues, the differences however were generally small and do not impact on the outcome of the survey as a whole. Therefore although the *Field* factor was statistically significant, due to the relative size of the differences the overall mean response is generally considered representative and so is therefore used through out this report. Where the magnitude of the difference is notable, the differences have been included in the report as a characteristic for the issue. Other factors and combinations of factors were, at times, of statistical significance but in practice the differences were very small and their existence does not alter the findings of this analysis. However, again for completeness, their existences have been noted where they occur.

A correlation procedure using Kendals *tau* and Spearmens *rho* measures of association and also rank correlation for agreement in multiple judges (Kanji, 1998) were used to test the level of agreement between respondents and respondent groups and the strength of the association. A further measure of agreement used was Kendalls coefficient of concordance.

Simple linear regression assumes that both variables being tested, dependent and independent, are continuous. The data collected from the questionnaire will have at the most only one continuous variable. For this analysis, a procedure called 'regression with replication and testing for linearity' will be used. This altered regression procedure allows multiple percentages of use at the three given time periods. Through this regressional technique, the data will be analysed by each procurement system individually. From the three regression lines (one for each procurement system), it will then be possible to compare the slopes. This can be done by a procedure known as analysis of covariance (ANCOVA) (Zar, 1996)

To reduce the number of variables a factor analysis was also performed. Principally, a factor analysis creates a set of uncorrelated latent variables from the original variables that explain much of the variance in the responses. The new variables are extracted from the original set and the correlation structure determines the association between the original set and the new variables. To carry out a factor analysis, the data needs to be normally distributed and there should be a sufficiently large number of respondents and correlated variables (Gorsuch, 1983). These assumptions being met, the output variables can then be used to complete further analysis.

Assessments of the possible causal nature of the relationships were also made. Observational or survey response data are limited in determining causal relationships as the variables are not randomly assigned. This is an important aspect of causal analysis. When evaluating these responses to assess the casual nature of the relationships, the work of Sir Austin Bradford Hill

(1965) was employed. Hill argued that to determine causality, consideration should be given to the following factors:

- Strength of association – the strength of the association was first on the list of requirements. Ideally the association should be strong to infer causation although a slight association does not automatically exclude the possibility of causation.
- Consistency – have different persons, in different places, circumstances and times repeatedly observed it?
- Specificity – Is it specific and limited to those observations where the effect occurs?
- Temporality – which is the cart and which the horse?
- Gradient – If the association is one which can reveal a gradient, then we should look carefully for such evidence.
- Plausibility – It will be helpful if the causation we suspect is plausible although depends on current knowledge.
- Coherence – The cause-and-effect interpretation of our data should not seriously conflict with the generally known facts – it should have coherence
- Experiment – Occasionally it is possible to appeal to experimental or semi-experimental evidence. Here the strongest support for the causation hypothesis may be revealed.
- Analogy – In some circumstances it would be fair to judge by analogy.

Each of these characteristics should be assessed before we can infer causation. Although if some cannot be substantiated, this does not prohibit causality. Holland in his assessment of the Hill criteria groups plausibility, coherence and analogy together, as he believes they require expert opinion. He also suggests the most important of Hills criteria are strength of the relationship and consistency (Holland, 1986). In this report, the responses are tested for compliance with these criteria.

2 Survey Results

Following the entry of the responses into a simple relational database, a statistical analysis of the data was undertaken to enable a full understanding of the respondent's perspective. The results from this analysis are detailed below.

2.1 Design and Documentation Quality

2.1.1 Overview

This section assesses the perceptions of the contractors and designers regarding the current design and documentation quality and how it has changed over the past 15 years. In addition, we discover which issues designers believe are important in determining overall design and documentation quality. Issues that designers believe affect the quality of design and documentation are also investigated, as are the areas of design and documentation deficiency.

It should be noted that the designers survey canvassed some issues not covered in the contractors' survey, due to the lack of relevance of these issues to the contractors. While including the information on the issues not presented to the contractors, this report will focus mainly on those issues that both groups were surveyed about. The design issues presented to designers are listed in Table 2.1 whilst the design issues presented to the contractors are displayed in Table 2.3. The documentation issues presented to both groups are detailed in Table 2.2

The level of importance of the design and documentation issues was initially assessed. The results show that designers believe all of the issues surveyed are important in determining design and documentation quality although *functionality* and *relevancy* are considered to be the most important design issues whilst *accuracy* and *clarity* head the list for documentation. At the other end of the scale, although still regarded as important are *expressiveness* for design and *standardisation* for documentation. The responses also show that, based on the ratings given, documentation issues overall are more important than design issues indicating that documentation quality may be deemed to be slightly more important than design quality.

An assessment of the respondents' perceptions of design and documentation quality was then carried out. The results of the analysis reveal that both designers and contractors believe there has been a decline in the overall quality of design and documentation over the past 15 years and that the decline in quality of documentation has been greater than that of design.

Both contractors and designers were asked to rate the level of incorporation for a number of attributes of design and documentation quality for three distinct time periods. The responses to the questions enable not only an assessment of the change in the level of incorporation for these attributes, but also helps to determine the change in overall design and documentation quality. This is due to the premise that the level of incorporation of various attributes of design and documentation quality has a direct bearing on the overall level of design and documentation quality achieved.

The responses for these questions indicated an improvement in the overall average level of incorporation for design issues for both designers and contractors over the past 15 years, initially indicating an improvement in the overall quality of design. However, this result conflicted with their overall perceptions of changes to design quality, in which 52% of designers and 69% of contractors indicated a decline. Further investigation revealed that those who indicated the quality of design had not declined, had a slightly more positive

response for all issues than those who indicated the quality of design had declined, even though they started from a slightly lower position, thereby affecting the overall averages. This discrepancy between the two results, may also appear to indicate that not all of the design quality attributes are considered to be of equal weighting and that those attributes which were shown to have declined, may have a greater impact on the perception of overall design quality, than those attributes which showed an improvement.

According to designers, the greatest increase in level of incorporation of a design attribute had been in the *consideration of whole life-cycle* issues – which also recorded the lowest level of incorporation – and the *consideration of ecological sustainability* issues. *Relevancy – ensuring the project requirements are met* was the design attribute perceived to have attained the highest level of incorporation. The two issues to record a significant decline in the overall mean rating for level of incorporation were the *equitable balance in the ratio of junior and senior staff used* and *ready availability of experienced design personnel*. These issues highlight one of the major concerns of the design sector of the construction industry – staffing. The other issues noted to have declined were not covered in the contractors' survey, due to lack of relevancy. Contractors on the other hand felt that the attributes showing the greatest improvement, included *ecological sustainability* and *material efficiency*. The issues showing the greatest decline however, included the *proper examination of design proposals* and *constructability*.

In contrast, both designers and contractors indicated that the level of incorporation of documentation quality attributes had declined over time, confirming their perceptions that the overall quality of documentation has also declined, although contractors were much more definite. According to designers, most documentation attributes either maintained their level or declined. The exceptions to this were *standardisation* and *conformity*, which showed a slight increase in their level of incorporation. Contractors on the other hand felt the only attribute showing an improvement, was *standardisation*. The issues showing the greatest decline however, included *accuracy* and *completeness*. This analysis has determined that there is far greater concern with regard to documentation quality than there is to design quality.

When considering the issues affecting the design and documentation quality, it is the opinion of designers that neither *private* nor *public* sector clients, properly understand the true value of the design function, the cost and time required to carry out the design function properly or their own impact on design process efficiency. Based on the responses provided, the main concerns of designers overall were that clients expected them to be able to interpret and expand on inadequate briefs, did not understand the high litigation risks involved in selecting designers based on minimum cost and did not understand that the quality of design and documentation is determined by the level of fees provided and the time available.

Contractors were asked to indicate the frequency of occurrence and the level of effect for a number of design and documentation problems identified. The contractors' responses indicate that the documentation issues occur more frequently than the design issues but that the effect of both is similar and highly detrimental to construction process efficiency. *Inadequate* or *insufficient design work being carried out* and *insufficient design coordination* are the design issues that occur most frequently and have the most effect on the construction process. The *design not being achievable within the project budget* is another design issue to impact negatively on the construction process. Documentation issues providing the most concern to contractors include documents lacking *clarity* or *having conflicting* or *incorrect information.*

2.1.2 Importance of design and documentation issues

The designers' perception of the importance of issues relating to aspects of design, the design process and documentation was assessed. The issues addressed are listed below in Table 2.1 and Table 2.2

Table 2.1 Design Quality Attributes – Designers

Design Quality Attributes
a) Consideration of whole life–cycle issues
b) Happy client and public
c) Extent of client involvement in the design process
d) Availability of experienced design personnel
e) Balance in the ratio of junior to senior staff used
f) Quality of the place created
g) Material efficiency – ensuring the efficient use of materials
h) Economy – ensuring design solutions are cost effective
i) Relevancy – ensuring project requirements are met
j) Constructability – incorporating constructability principles
k) Innovation – incorporating innovation in the design solution
l) Expressiveness – provides symbolic expression and feeling
m) Aesthetics – the finished product is visually pleasing
n) Consideration of ecological sustainability issues
o) Functionality – effectively serves the purpose for which it was intended
p) Timelessness and durability – design will gracefully endure the passing of time
q) Site compatibility – effectively uses and makes due allowance for site conditions
r) Competence and experience of the person managing the design process
s) Material selection – ensuring the availability, suitability and compatibility of materials
t) Proper examination of design proposals (to prevent ambiguity, omissions and errors)
u) Provision of in-house and external training to ensure continuing professional development of design staff
v) Design service contracted for, is compatible with the design requirements of the project

Table 2.2 Documentation quality attributes

Documentation Quality Attributes
a) Completeness – drawings and other documents provide all the information required
b) Clarity – drawings and other documents are legible and are easily read and interpreted
c) Accuracy – drawings and other documents are free of errors, conflicts and inconsistencies
d) Final checking – drawings and other documents are properly checked prior to release to the contractor
e) Standardisation – use of standard details and specifications in drawings and other documentation
f) Relevance – trade specifications and details are specific, relevant and appropriate to the project
g) Timeliness – drawings and other documents are supplied when required, to avoid delays
h) Coordination – drawings and other documents are thoroughly coordinated between design disciplines
i) Certainty - drawings and other documents do not require changes or amendments
j) Conformity – drawings and other documents indicate the requirements of performance standards and statutory regulations

According to the responses the most important attributes of design and documentation quality were:

Design Quality Attributes

- Functionality – effectively serves the purpose for which it was intended;
- Relevancy – ensuring project requirements are met;

Documentation Quality Attributes

- Accuracy – drawings and other documents are free of errors, conflicts and inconsistencies
- Clarity – drawings and other documents are legible and are easily read and interpreted

The attributes of design and documentation quality indicated by designers to be the least important, were:

Design Quality Attributes

- Expressiveness – provides symbolic expression and feeling;
- Balance in the ratio of junior to senior staff used;

Documentation Quality Attributes

- Standardisation – use of standard details and specifications in drawings and other documentation
- Certainty - drawings and other documents do not require changes or amendments

Overall, the perception of design attribute importance was very high, averaging just over eight (8.01) out of 10 across all of the attributes. This perception was echoed for the level of importance for documentation quality attributes, averaging almost nine (8.7) out of a possible 10. Documentation issues generally received a higher rating than the design attributes and there was a greater level of agreement among designers for documentation issues. The most common rating given by the designers for the level of importance for either design or documentation attribute overall was ten (10), implying that the majority of respondents perceive all attributes of design and documentation quality as being of extremely high importance in determining overall quality. These results were also reasonably consistent across the different design disciplines.

Has the design quality declined?

Both designers and contractors were asked to consider whether there had been a decline in ***design*** quality over the past 15 years, with the available responses being either:
a) ***Yes***; b) ***No***; or c) ***Unsure***.

Figure 2.1 illustrates that just over half (52%) of the designers agreed that the overall quality of design had declined over the past 15 years. While just over a third (35%) of designers disagreed, only 13% were unsure. When checking the results across design disciplines, it was found that landscape architects overall, disagreed with the other professions, indicating that quality had not declined over the past 15 years. There was however, no statistical difference in the responses for the other individual design disciplines surveyed.

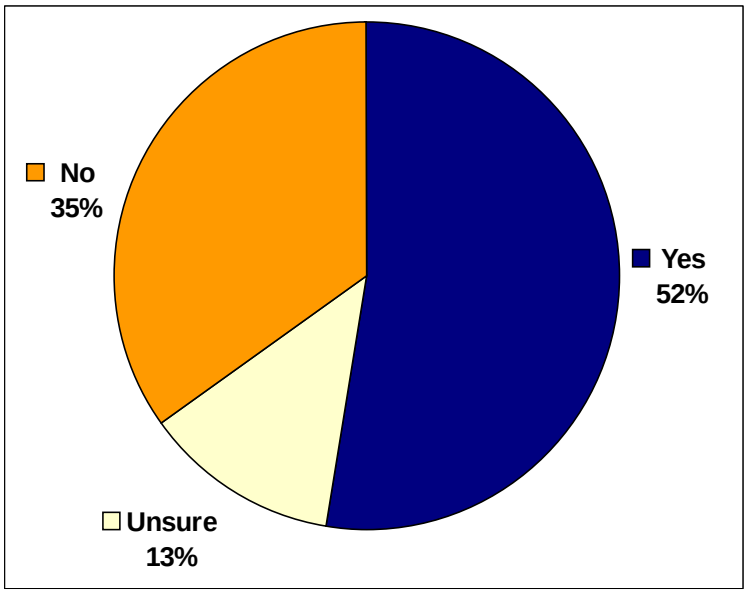

Figure 2.1 Designers response to whether there had been a decline in overall design quality over the past 15 years

Contractors however were more certain that there had been a decline in the overall quality of design as a whole over the past 15 years. As can be seen in Figure 2.2, the response was clearly “Yes”, with 69% of contractors stating quality of design has declined.

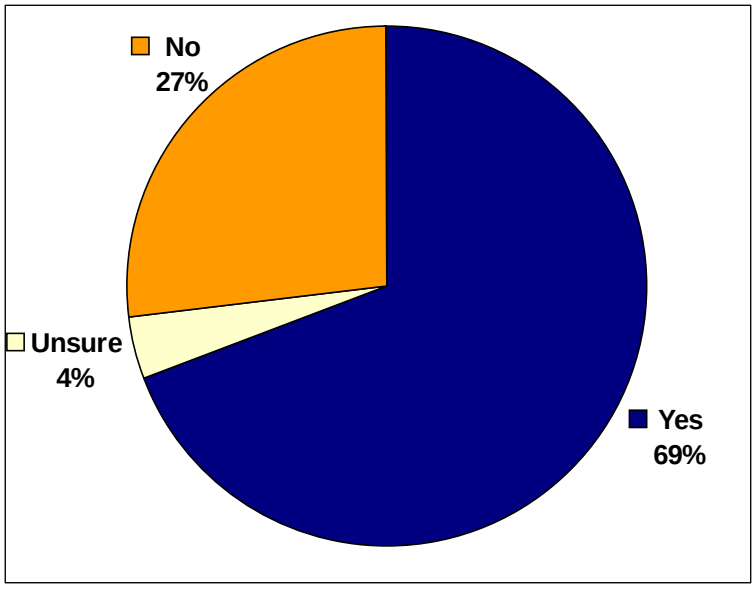

Figure 2.2 Contractors response for whether or not there had been a decline in the quality of design over the past 15 years

Has the documentation quality declined?

Similarly, all respondents were asked to consider whether there had been a decline in ***documentation*** quality over the past 15 years, with the available responses again being either: a) ***Yes***; b) ***No***; or c) ***Unsure***.

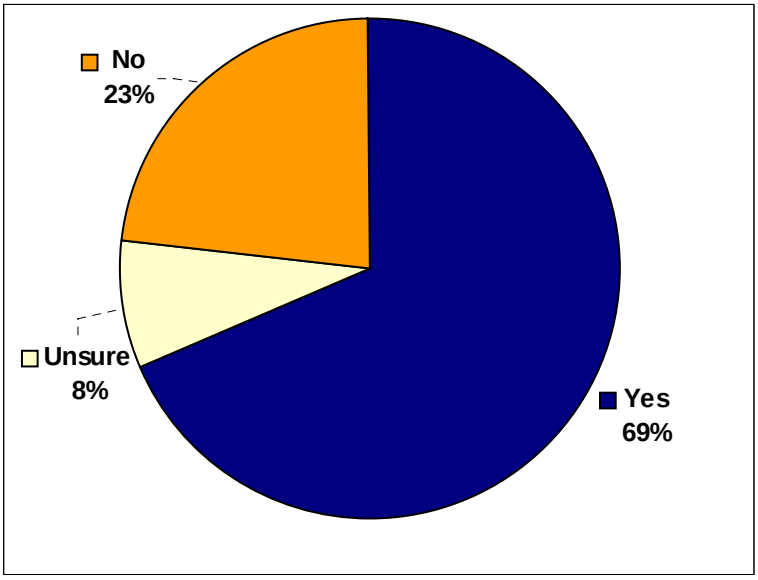

Figure 2.3 Designers response to whether there had been a decline in overall documentation quality over the past 15 years

As can be seen in Figure 2.3, the designers were much more definite in their response to this question compared to the design question, with a large majority (69%) indicating that there had been a decline in the quality of documentation over the past 15 years. When comparing the disciplines, it was found that comparatively more engineers suggested that there had not been a decline in documentation quality, however a greater proportion of quantity surveyors were sure that documentation quality had declined.

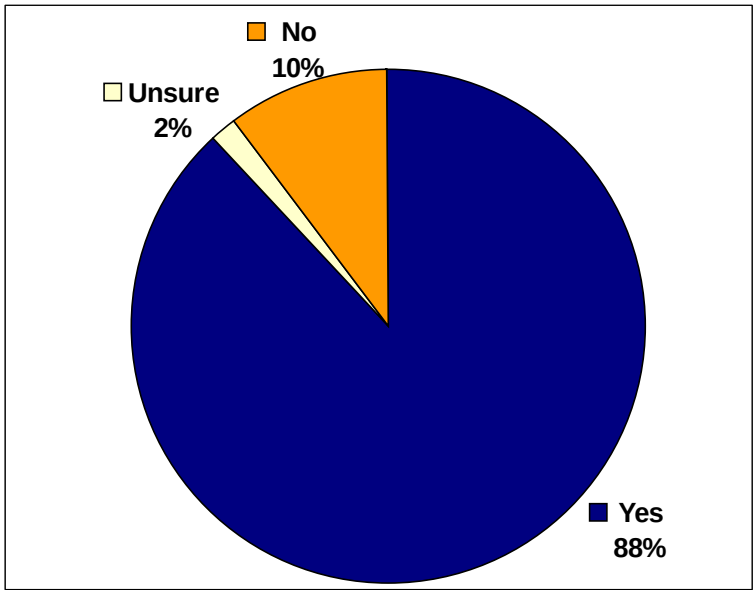

Figure 2.4 Contractors response for whether or not there had been a decline in the quality of documentation over the past 15 years

As is evident in Figure 2.4 the response to this question by contractors was overwhelmingly yes, with 88% of all respondents agreeing that there had been a decline in documentation quality and only 10% disagreeing. This response was uniform across all the industry organisations.

Has the decline in the quality of documentation been more significant than in design?
Those respondents that had previously indicated that the overall quality of both design and documentation had declined were then asked to consider whether they felt that the decline in ***documentation*** quality had been more significant than the decline in the overall quality of design. Again, the available responses were either:
a) ***Yes***; b) ***No***; or c) ***Unsure***.

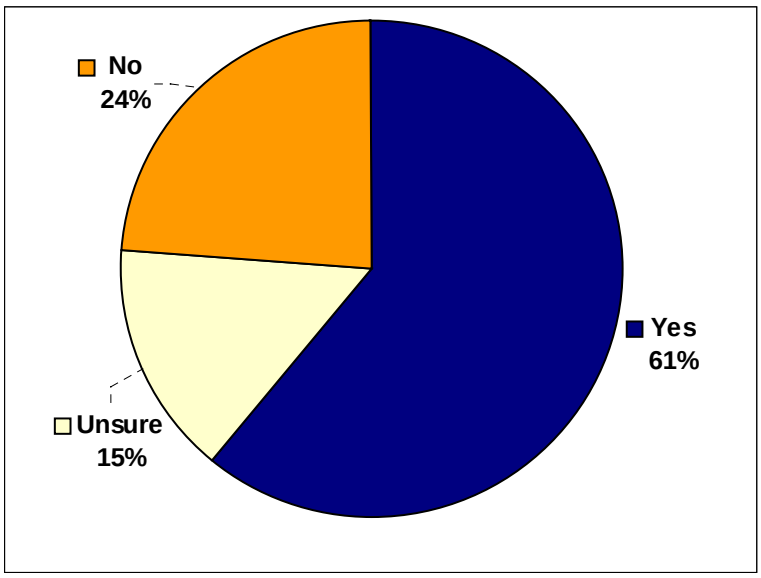

Figure 2.5 Designers response to whether the decline in documentation quality had been more significant than the decline in design quality

As can be seen from the responses shown in Figure 2.5, the majority (61%) of designers believe that the decline in documentation quality has been more significant than in design.

Similarly, Figure 2.6 shows that the majority of contractors also believe that documentation was the area where the decline has been greatest with 82% of the contractor respondents agreeing with the statement, 14% disagreeing and only 4% unsure.

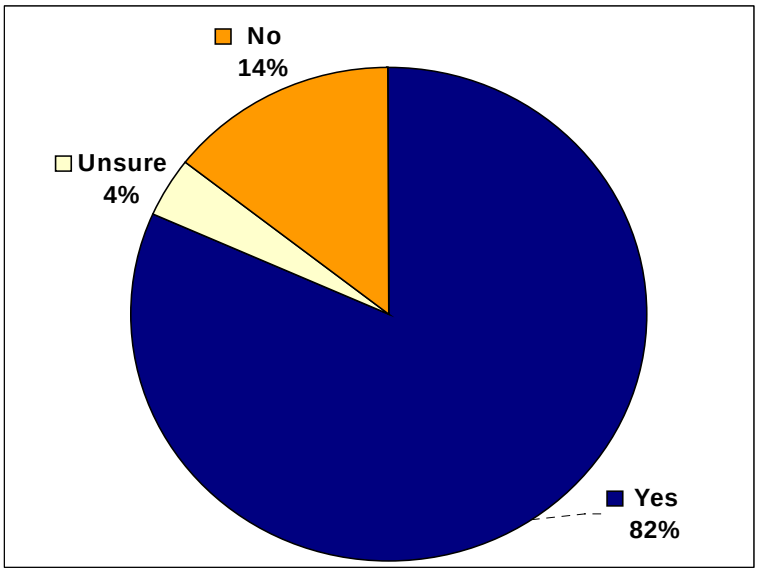

Figure 2.6 Contractors response for whether the decline had been greater in documentation than design

When comparing the responses for the two surveys, the contractors were more definite of their views than the designers and this proved to be the difference between the two groups for this question. When those who were unsure were excluded from the analysis the statistical significance of the difference in the results was marginal. For the other questions, the difference in the responses for the two groups was statistically significant, with contractors having a more negative view of the current level of quality than designers had. Overall, the respondents from both groups have indicated the major area of concern in the design and documentation process is documentation. When combined, 76% of respondents had indicated they believe the quality of design has declined over the past 15 years and 70% of those have indicated the decline has been more significant in documentation. As indicated earlier, designers have identified this area as being slightly more important in determining overall design and documentation quality.

2.1.3 Changes in Design and Documentation Quality

The survey initially dealt with changes in design and documentation quality over the past fifteen years by examining a number of attributes of design and documentation quality and investigating whether there had been any significant changes in their level of incorporation over the past 15 years. As the overall quality of design and documentation is to a large extent determined by the level of incorporation of such attributes, any improvement or decline in their level of incorporation is likely to be a reflection of the overall quality of the design and documentation being produced. As previously mentioned the list of design attributes presented to the contractors differed from that presented to designers. The contractors' list is displayed in Table 2.3 below.

Table 2.3 Design Quality Attributes - Contractors

Design Quality Attributes
a) Consideration of whole life–cycle issues
b) Material efficiency – ensuring the efficient use of materials
c) Economy – ensuring design solutions are cost effective
d) Relevancy – ensuring project requirements are met
e) Constructability – incorporating constructability principles
f) Innovation – incorporating innovation in the design solution
g) Expressiveness – provides symbolic expression and feeling
h) Aesthetics – the finished product is visually pleasing
i) Consideration of ecological sustainability issues
j) Site compatibility – effectively uses and makes due allowance for site conditions
k) Material selection – ensuring the availability, suitability and compatibility of materials
l) Proper examination of design proposals (to prevent ambiguity, omissions and errors)
m) Functionality – effectively serves the purpose for which it was intended

Changes in the level of incorporation of design attributes

The mean rating by designers for the level of incorporation of design quality attributes now with all issues combined was 7.19, excluding the issues that contractors were not surveyed on was the mean rating was 7.37. All disciplines, apart from Quantity Surveyors – who had a more negative view of the levels of incorporation at all time periods – believed the overall quality of design had increased over the past 15 years, up from a mean rating of 6.90 with all issues included. Quantity Surveyors' ratings however, showed no significant changes over time.

The designers' perception was that the greatest increase in level of incorporation of design attributes had been:

- consideration of *ecological sustainability* issues, and
- consideration of *whole life-cycle* issues.

Although consideration of whole life-cycle issues attained the greatest increase in the level of incorporation, it also recorded the lowest level overall.

The greatest decrease in level of incorporation were:

- equitable balance in the *ratio of junior to senior staff used*, and
- ready *availability of experienced design personnel*.

As discussed earlier these issues were not presented to contractors. The perceived decline in the level of incorporation of these issues highlight one of the major concerns of the design sector of the construction industry is staffing. The issue perceived to attain the highest level of incorporation was:

- *relevancy* – ensuring the project requirements are met.

According to the consultants, most other attributes of design quality showed only marginal improvement in their level of incorporation.

The increase in the level of incorporation of attributes of design quality was slightly greater in the period now to 5 – 7 years ago, than 5 – 7 years ago to 12 – 15 years ago, although the difference is only marginal.

Despite this perception of individual attributes of design quality generally increasing in the level of incorporation designers still indicated that they believe the overall quality of design has declined over the past 12 – 15 years, as discussed earlier. A regression analysis was performed on the data in an attempt to extract a trend for the level of incorporation of the design quality attributes. The results indicated that those who believed the level of incorporation was high 12 – 15 years ago generally believe it has declined marginally over time, while those who believed the level of incorporation was low 12 – 15 years ago believe there has been a substantial increase. This has contributed to a perception of an overall improvement in the level incorporation of design quality attributes.

Contractors were also asked for their perception of the level of incorporation for the design quality attributes using the same scale and over the same periods as the designers. The analysis of the attributes also indicated there had been a slight improvement in the level of incorporation overall during the past 15 years according to the contractors as a whole.

The mean rating by contractors for the level of incorporation of design quality attributes now with all issues combined was 5.68, well below the rating perceived by the designers. Through out the analysis the members of the MPA and AMCA provided a slightly more negative view of the level of incorporation.

The contractors' perception was that the greatest increase in level of incorporation of design attributes had been:

- consideration of *ecological sustainability* issues, and
- *material efficiency* – ensuring the efficient use of materials.

This is consistent with the designers' perception that there has been significant improvement in these areas.

The greatest decrease in level of incorporation were:

- *proper examination of design proposals*, and
- *constructability* – incorporating constructability principles .

In contrast, designers had indicated they believed there had been no significant change in the level of incorporation of *proper examination of design proposals* and that there had been a slight improvement in the incorporation of *constructability*.

The issue perceived to have attained the highest level of incorporation overall, was:

- *relevancy* – ensuring the project requirements are met.

While this is also in agreement with designers' perception, the current level of incorporation is in dispute.

Regardless of the time period there had not been any issue that had an average level of incorporation over 6.5 indicating that contractors believe there was significant room for improvement in the design process. Again despite this perception of individual attributes of design quality generally increasing in their level of incorporation, contractors still indicated that they believe the overall quality of design has declined over the past 12 – 15 years.

Comparing the perceptions

As was revealed earlier both designers and contractors believe that the overall quality of design, has declined over the past 12 – 15 years, even though this perception was not supported by the results of the analysis relating to the incorporation of design quality attributes. The analysis presented a view somewhat different to the stated perception as can be seen in Figure 2.7. Due to this apparent discrepancy in the perceptions of the changes to design quality, further analysis was undertaken.

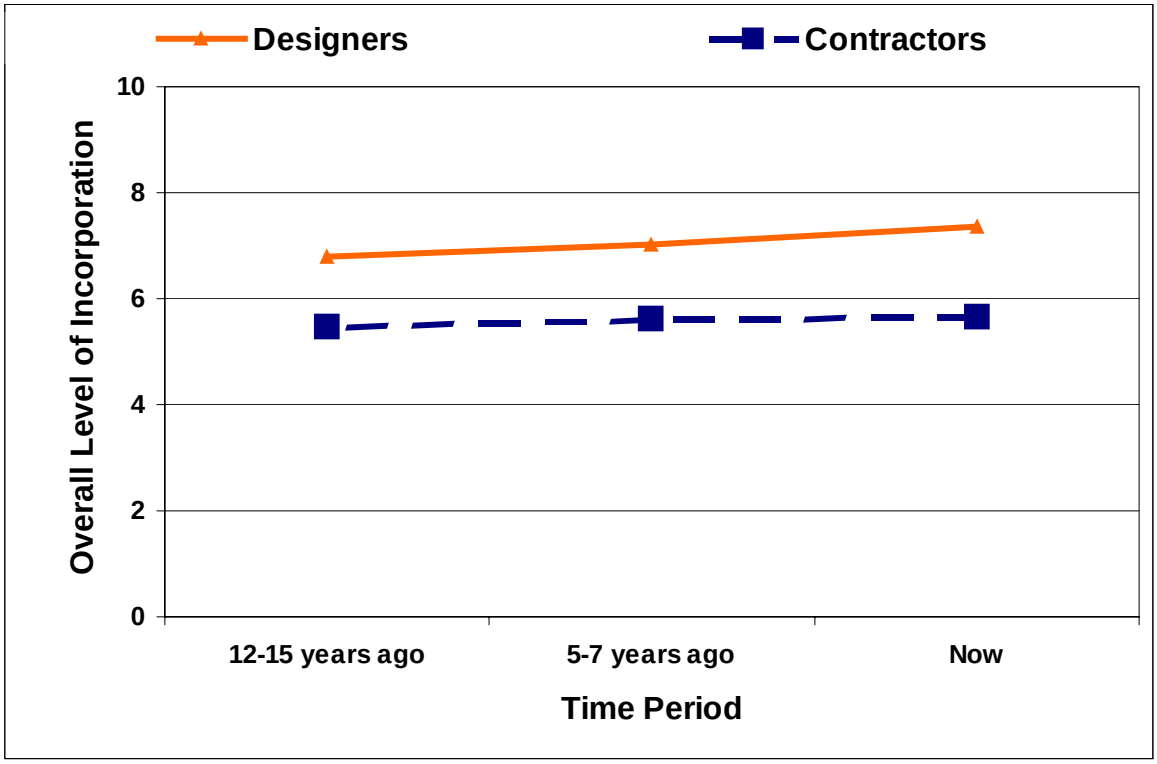

Figure 2.7 Comparison of overall level of incorporation of design issues

An analysis of the designers' responses for the design issues, which compared those respondents that answered "*Yes*" to whether there had been a decline in the overall quality of design over the past 15 years, to those who answered "*No*", revealed that there was a statistically significant difference in the mean responses. Overall, there were 255 designers who believed that the quality of design had declined, 170 who believed the quality had not declined and 61 who were unsure. By comparison, there were 218 contractors who believed that the quality of design had declined, 85 who believed the quality had not declined and 12 who were unsure.

The mean response for those designers who indicated that the quality of design had declined over the past 15 years was approximately 6.9 over all time periods, with all issues pooled, suggesting that any change was only marginal. The mean response for those who indicated there had not been a decline in the quality of design was 7.5 for the current period up from 6.8 for the period 12 – 15 years ago, again with all issues pooled, thereby supporting their assertion that design quality had actually improved.

The mean response for those contractors who indicated that the quality of design had declined over the past 15 years was approximately 5.6 for the period 12 – 15 years ago, declining to approximately 5.2 for the current time period – with all issues pooled – suggesting that the decline was only slight. The mean response for those who indicated there had not been a decline in the quality of design was 6.8 for the current period up from 5.2 for the period 12 –

15 years ago, again with all issues pooled, thereby supporting their assertion that design quality had actually improved. Even for those who were unsure, the mean response again showed an improvement from 5.0, up to 6.0 over the 15 year time frame. This therefore provides an explanation for the apparent discrepancy in the overall perceptions.

Comparing the responses for designers and contractors for the issues individually, both designers and contractors perceived an increase in the level of incorporation of the *consideration of ecological sustainability issues*, but as can be seen in Figure 2.8 the actual level of incorporation is contentious. This was also the case for *site compatability* as is evident in Figure 2.9. While the mean rating from the contractors survey for all issues was below that of the designers for the current time period, the effect size statistic for *constructability* was large. This difference can be seen in Figure 2.10. The greatest difference in mean response between the two groups was for *proper examination of design proposals* (Figure 2.11) with the contractors' perception well below that of the designers. The smallest difference of opinion was for *expressiveness* and *innovation*. *Whole of life-cycle issues* was the only attribute where contractors perceived a higher level of incorporation than designers did at any time. This can be seen in Figure 2.12. While the contractors' responses indicated a lower level of incorporation of most design issues when compared to the designers, the responses generally followed the perceptions of the designers and, similar to the designers, they contained an upward trend over time for many issues.

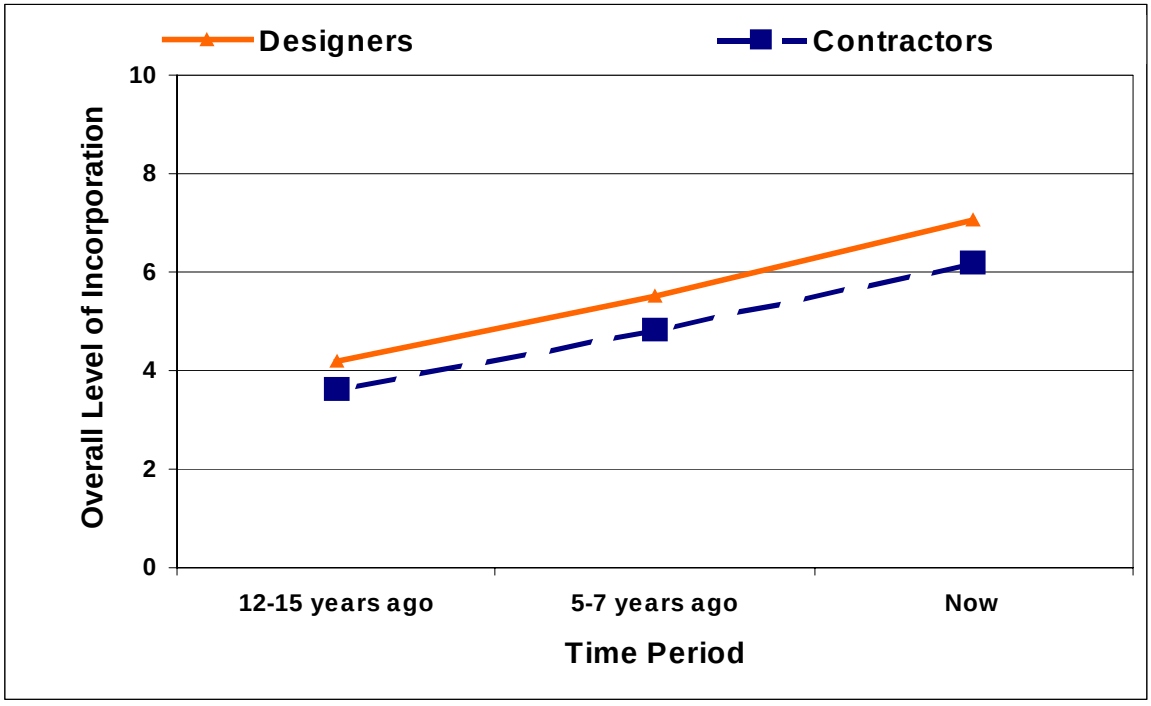

Figure 2.8 Comparison of the responses for *ecological sustainability*

Figure 2.8 shows the perceived extent of improvement in the level of incorporation for *ecological sustainability*. As was pointed out this issue attained the greatest increase in incorporation over time by both groups.

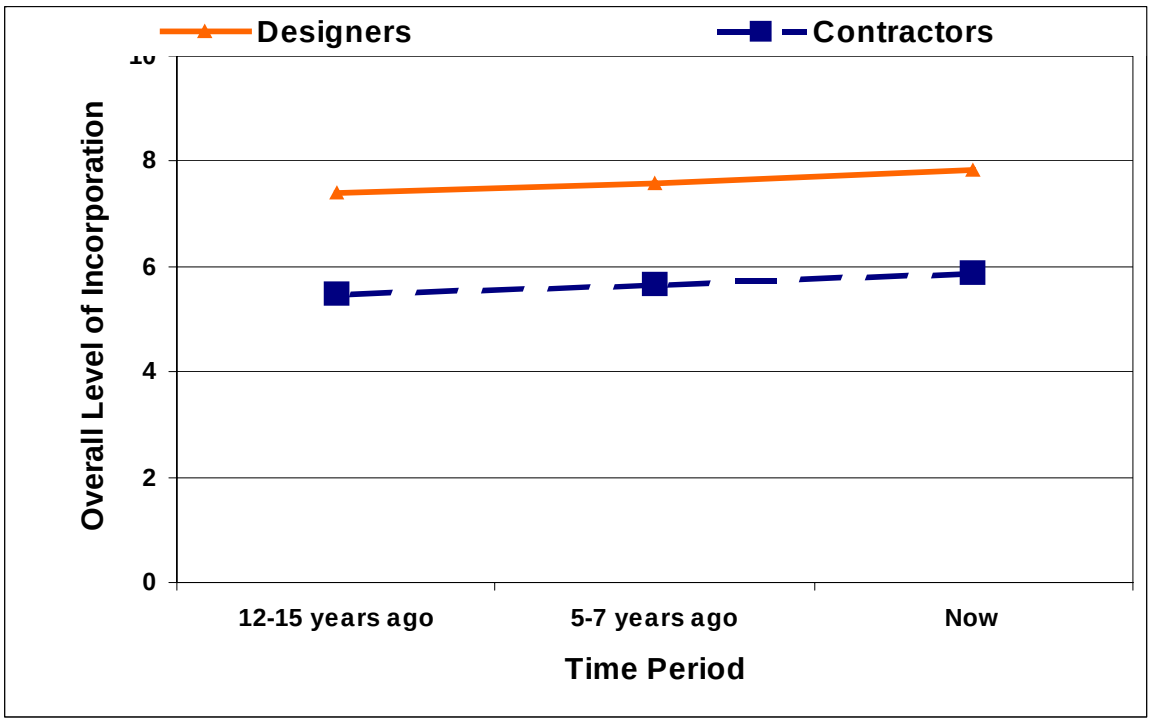

Figure 2.9 Comparison of the responses for *site compatibility*

While *site compatibility* did not increase at the same rate as some issues, Figure 2.9 illustrates that both groups believe there has been an upward trend in the level of incorporation for this issue. This chart also draws attention to the difference of opinion between the two groups as far as the actual level of incorporation. This typifies the results for most design issues.

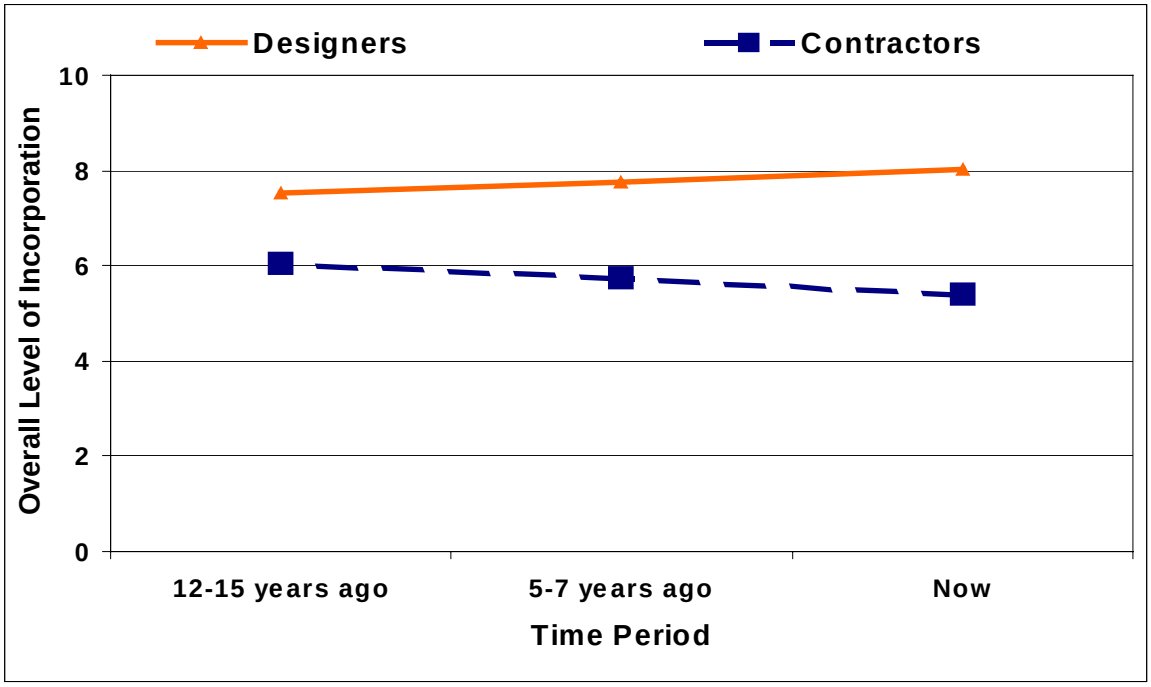

Figure 2.10 Comparison of the responses for *constructability*

Designers and contractors have conflicting views of the trend for the level of incorporation of *constructability*. Figure 2.10 shows that not only do the two groups differ with regard to the level of incorporation of this issue, their perceptions are diverging.

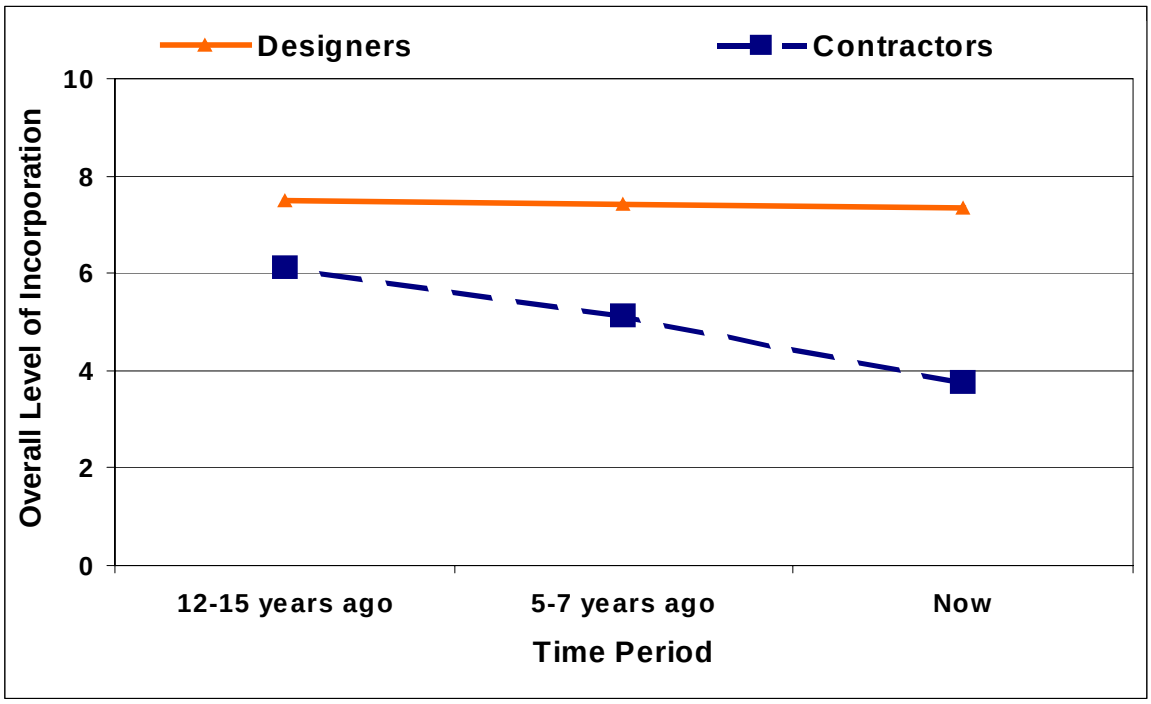

Figure 2.11 Comparison of the responses for *proper examination of design proposals*

Proper examination of design proposals was the issue where the difference in the perceptions of current level of incorporation was the greatest. The Contractors perceived this issue as having the greatest decline in its level of incorporation over the past 12 – 15 years of those issues surveyed. While the designers believe there has been a decline in the level of incorporation, their perception is that it has only been slight.

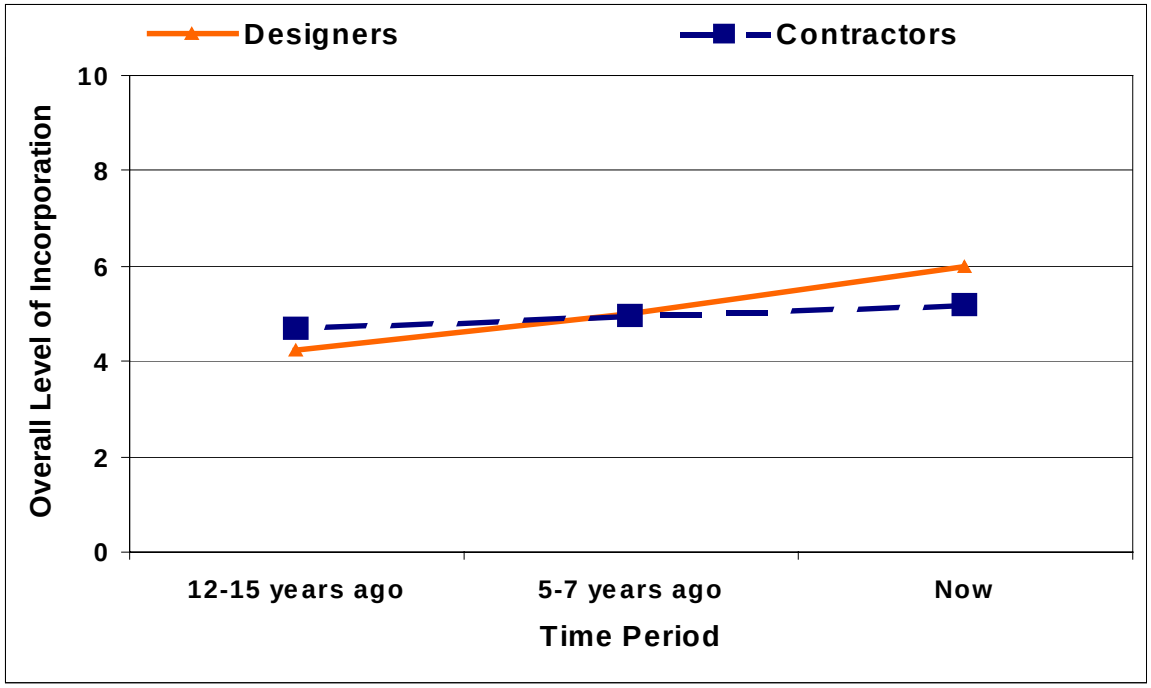

Figure 2.12 Comparison of the responses for *whole of life-cycle issues*

Figure 2.12 again illustrates the difference of opinion between the two groups for some issues. Here we see that the designers perceived a much greater rate of improvement in the level of incorporation for *whole of life-cycle* issues than contractors had. This was the only issue

where the contractors had indicated a higher level of incorporation than the designers had for any period surveyed.

An analysis of variance of the responses for all responses with the issues pooled and the different categories of the respondents coded confirmed the responses between the groups were significantly different for all time periods. The analysis revealed that the responses from the Quantity Surveyors were very similar to the responses for the contractors in general. In fact, comparison tests of the mean responses for the different respondent associations and disciplines showed the Quantity Surveyors views were most closely aligned with those of the AMCA and ECA. By using the effect statistic, we can assess the relative size of the difference of opinion between the two groups. For this comparison the statistic was 0.73, a moderate to large effect confirming the contractors' view is that the level of incorporation of design quality issues is considerably lower than the designers perceive.

An investigation into the correlation structure between the variables revealed that many of the variables were highly correlated. This correlation between the variables prompted further investigation into the underlying structure of the data using a statistical procedure called factor analysis. Factor analysis seeks to represent the interrelationships among a set of variables by a number of underlying linearly independent factors, only those variables common to both groups could be used in this analysis. The factor analysis carried out exposed three underlying factors; these factors – set out in Table 2.4 below – explain 70% of the total variation in the responses.

The same procedure was applied to both the contractors' and designers' responses and to the responses for the period 5 – 7 years ago and 12 – 15 years ago with corresponding results. The alignment of issues into similar factors and the high final communality estimates from the factor analysis highlights the consistency between the two groups and within the groups with regards to the issues. The closeness of the factor coefficients and the issue grouping into the extracted factors provides substantial evidence of the similarity of views with regards to specific issues between the groups. The extractions of the same factors from all of the replicated analysis also provide confirmation of the factors.

The factor/variable grouping is such that appropriate factor names can be assigned. Factor 1 groups the *practical construction* issues, factor 2 combines the *conceptual-creative* issues, while factor 3 brings together issues concerned with *future resource utilisation*. By applying the factor pattern to the data using the scoring coefficients, we are able to determine relative ratings for the factors.

Table 2.4 Factor patterns for design issues

Factor patterns for design issues

	Factor 1	Factor 2	Factor 3
Consideration of whole life–cycle issues			*
Material efficiency – ensuring the efficient use of materials	*		
Economy – ensuring design solutions are cost effective	*		
Relevancy – ensuring project requirements are met	*		
Constructability – incorporating constructability principles	*		
Innovation – incorporating innovation in the design solution		*	
Expressiveness – provides symbolic expression and feeling		*	
Aesthetics – the finished product is visually pleasing		*	
Consideration of ecological sustainability issues			*
Functionality – effectively serves the purpose for which it was intended	*		
Site compatibility – effectively uses and makes due allowance for site conditions	*		
Material selection – ensuring the availability, suitability and compatibility of materials	*		
Proper examination of design proposals (to prevent ambiguity, omissions and errors)	*		

The mean result for the factors were determined to allow comparison over time and with each other, the results are presented in Figure 2.13, Figure 2.14 and Figure 2.15 below.

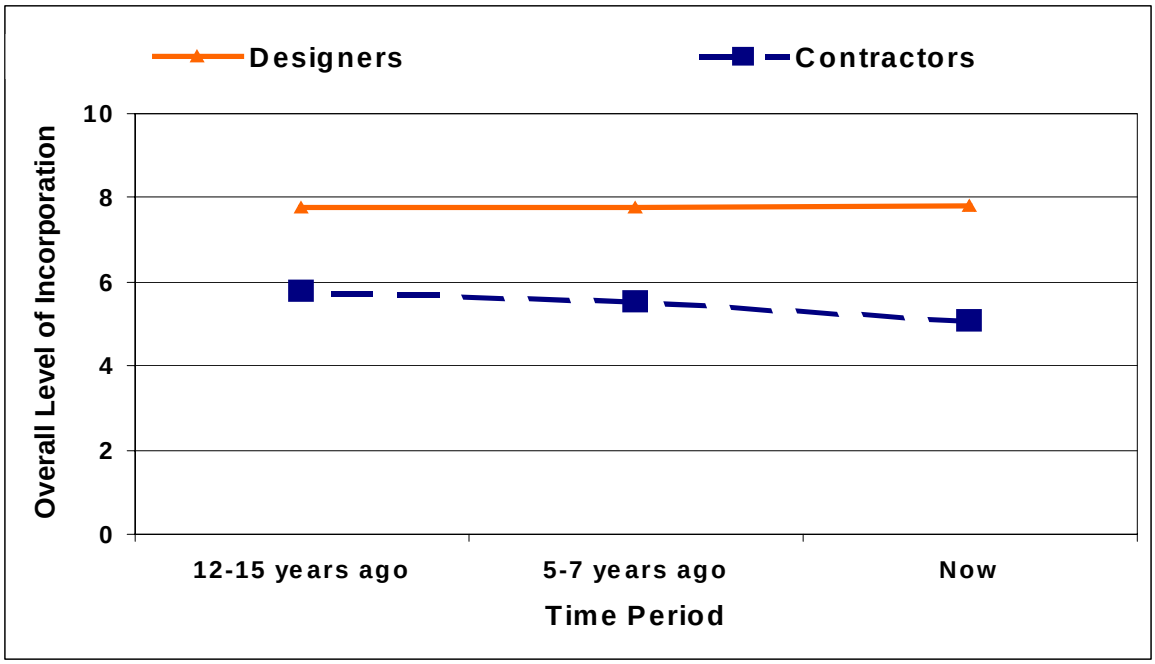

Figure 2.13 Change in level of incorporation of *practical construction* issues over time

It is clear from Figure 2.13 above that designers believe the level of incorporation of practical design issues has remained constant at a high level of incorporation over the past 15 years. Contractors have indicated the level of incorporation has been well below the designers'

perception and has decreased over time, with the rate of decline increasing during the most recent time period.

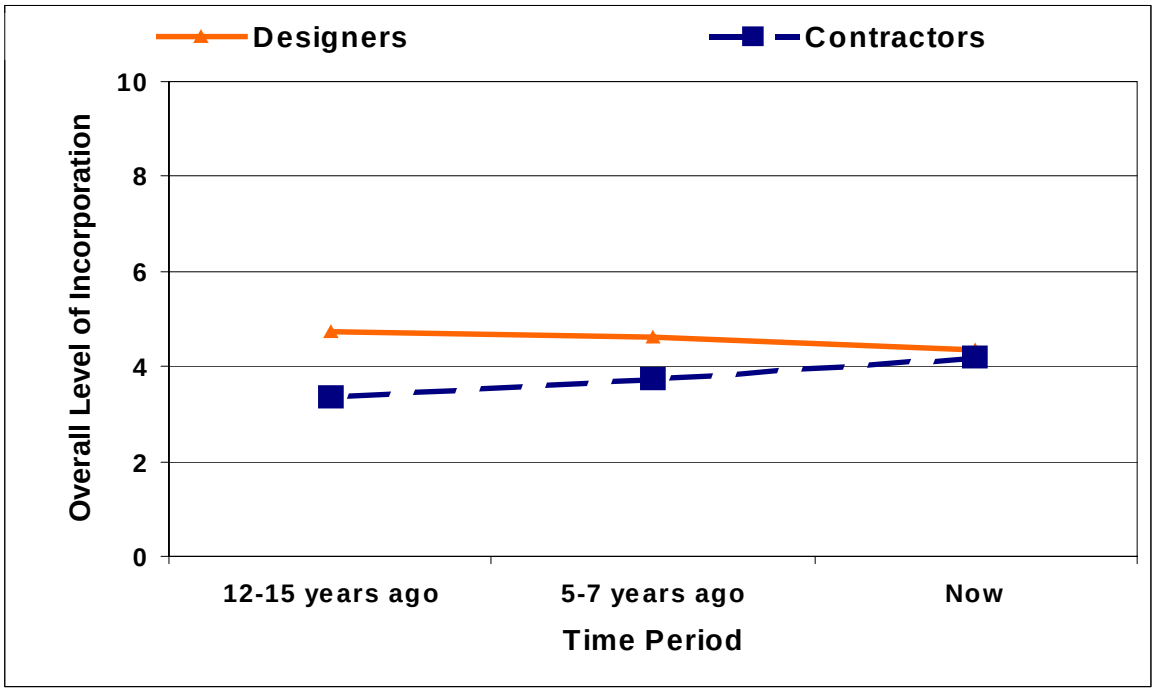

Figure 2.14 Change in the level of incorporation of *conceptual and creative* issues over time

In Figure 2.14 we can see that both groups agree on the current level of incorporation of this factor although there is a dispute as to the level of incorporation 12 – 15 years ago. Designers believe there has been a significant decline in incorporation over time while conversely contractors believe there has been a significant improvement.

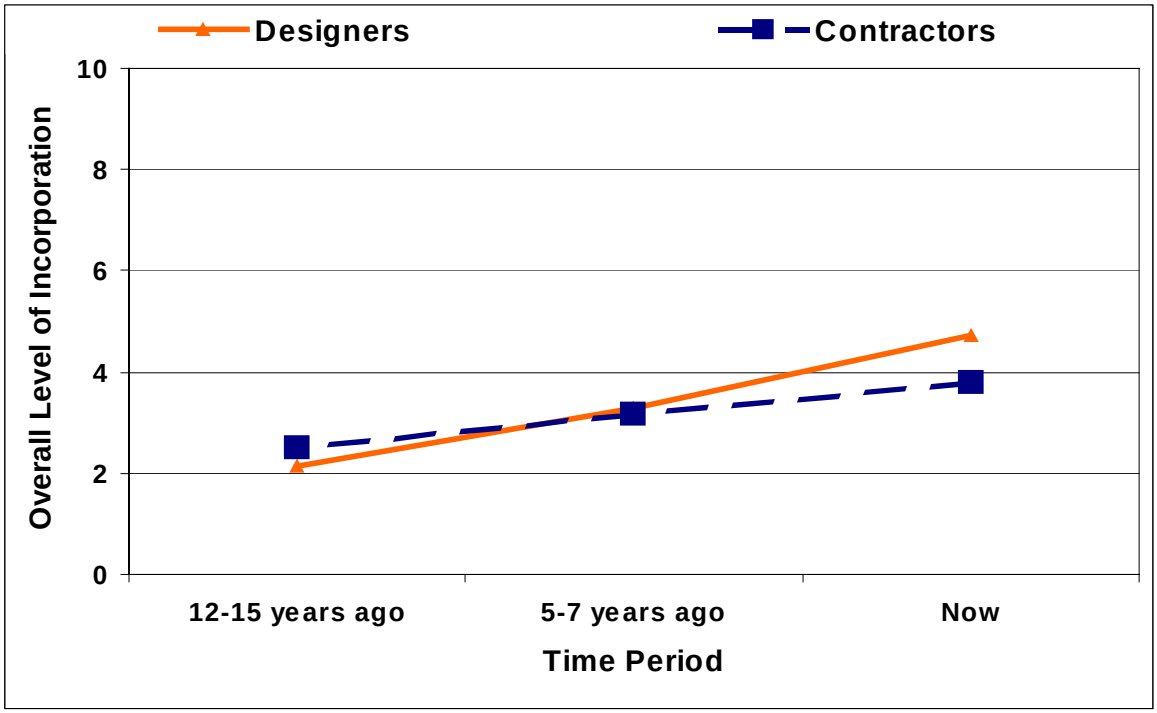

Figure 2.15 Change in the level of incorporation of *future resource utilisation* issues over time

Both designers and contractors agree that the level of incorporation of factor 3 has improved over time, with designers believing that the level of incorporation has improved at a greater rate than contractors have. It should be pointed out that the ratings given for the overall level of incorporation are still below 5, indicating that significant improvements in these areas can still be made.

The factors help focus on the areas where there has been significant change and provide a clearer view of the difference in the perceptions of the two groups. Overall, excluding the designers' perception of practical issues, all respondents have agreed the level of incorporation of design quality attributes is low.

Changes in the level of incorporation of documentation attributes

The issues surveyed for this question were those listed in Table 2.2 and were the same for both groups. The mean rating by designers for the level of incorporation of documentation quality attributes now with all issues combined was 7.26 out of a possible 10. This result is significantly lower than the 7.43 mean response for the period 12 – 15 years ago indicating a perceived decline over time. The views of the different disciplines as to the levels of incorporation for the current time period were inconsistent, with Architects rating the level of incorporation overall at 7.64, Engineers 7.05, Landscape Architects 6.83, Surveyors at 6.47 and Quantity Surveyors indicating the worst overall level of incorporation, at 4.61. The responses for the period 12 – 15 years ago were much more consistent.

Considering individual documentation attributes, most either maintained their level of incorporation or declined according to designers. The exceptions to this were the following, which showed a slight increase in their level of incorporation:

- *standardisation* – use of standard details and specifications in drawings and other documentation; and
- *conformity* – documents indicate the requirements of standards and statutory regulations.

As was the case for designers, contractors indicated the level of incorporation of s*tandardisation* improved over time, receiving a higher average rating now than was the case 12 to 15 years ago. While the level of incorporation for this issue has improved over time the mean rating for the current period is still only 5.70 out of a possible 10. The rating for all other issues reveal a considerable decline in the level of incorporation, overall the rating for the level of incorporation declined from 6.06 down to 3.86. The concern is the types of issues with the greatest decline in level of incorporation, which are:

- *accuracy* – drawings and other documents are free of errors, conflicts and inconsistencies,
- *final checking* – drawings and other documents are properly checked prior to release to the contractor, and
- *completeness* – drawings and other documents provide all the information required.

This suggests that contractors generally believe they cannot be confident in the detail of the documentation.

Comparing the perceptions

Both designers and contractors agree there has been a decline in the quality of documentation produced over the past 15 years. This belief is supported by an analysis of the specific issues addressed by the respondents. The issues raised in the survey form were considered the primary issues that determine the quality of documentation according to their level of incorporation. As was the case for design issues, the responses from the contractors indicated a much lower level of incorporation for all issues than did designers. Further analysis using

both analysis of variance and median tests revealed that, all contractor associations provided significantly lower responses than any of the designer professions indicated other than Quantity Surveyors. This was the case for both the current period and for the period 5 – 7 years ago. A comparison between the contractors and designers perception of the overall level of incorporation of documentation attributes with all attributes pooled is displayed in Figure 2.16.

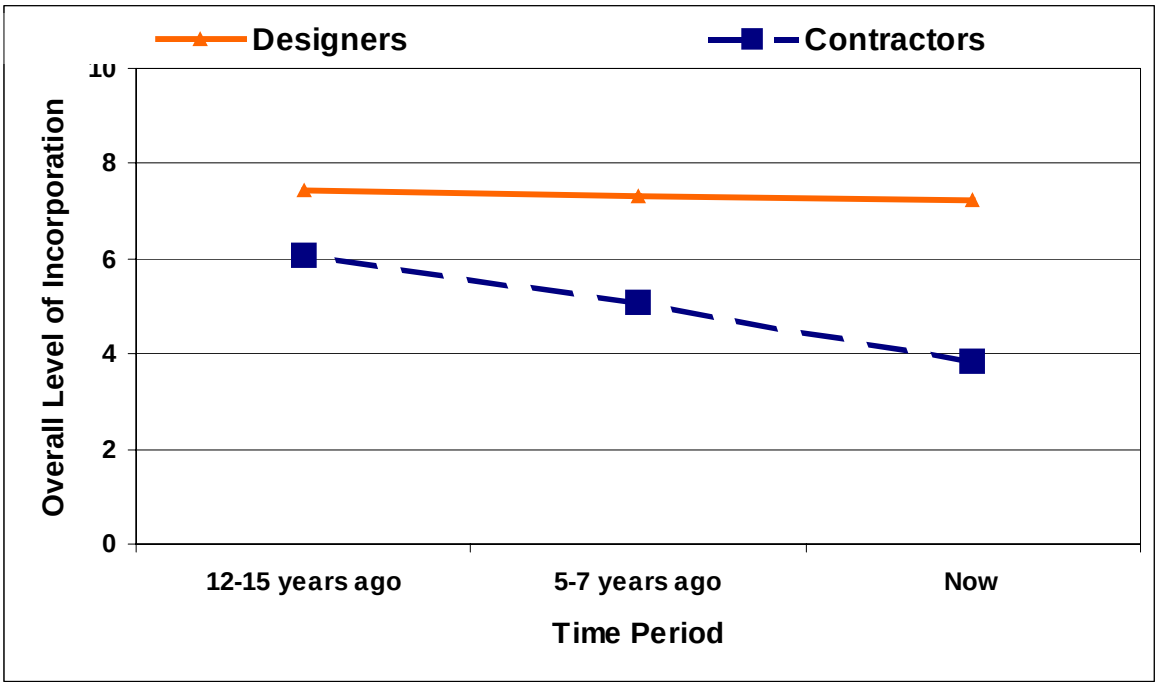

Figure 2.16 Comparison of overall level of incorporation of documentation issues

It is evident from Figure 2.16 that the two groups have very different perceptions of the level of incorporation at the current period. For the period 12 – 15 years ago, some of the designer professions and contractor associations had similar mean responses especially for the level of incorporation of *standardisation* and *relevance*. However, the overall mean responses with all of the contractor associations pooled, were still below that of the designers as a whole.

The only documentation issue to show a significant improvement in the level of incorporation over time was *standardisation*. As can be seen in Figure 2.17, this issue was determined to have improved at a steady rate over the past 15 years, according to designers. Contractors indicated that while there was a significant improvement between the periods 12 – 15 years ago and 5 – 7 years ago, since then there has only been slight improvement. Interestingly, designers rated this issue as the least important of the documentation quality attributes.

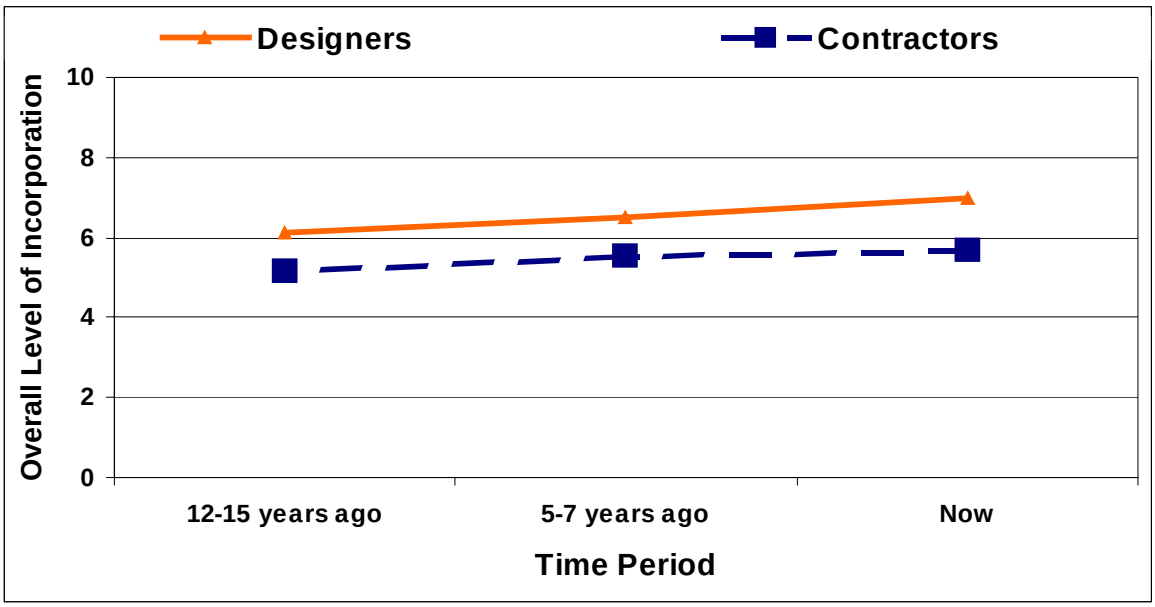

Figure 2.17 Comparison of the responses for *standardisation*

Figure 2.18 however, illustrates the different opinions between the groups in relation to the level of incorporation for *conformity*. The chart shows that the designers perceived a slight increase in the incorporation of this attribute in the period 12 – 15 years ago until the period 5 – 7 years ago and then significant improvement since this period. Conversely, the contractors believe the level of incorporation had declined slightly and then the rate of decline had accelerated. This pattern was similar for *timeliness* and *relevance*.

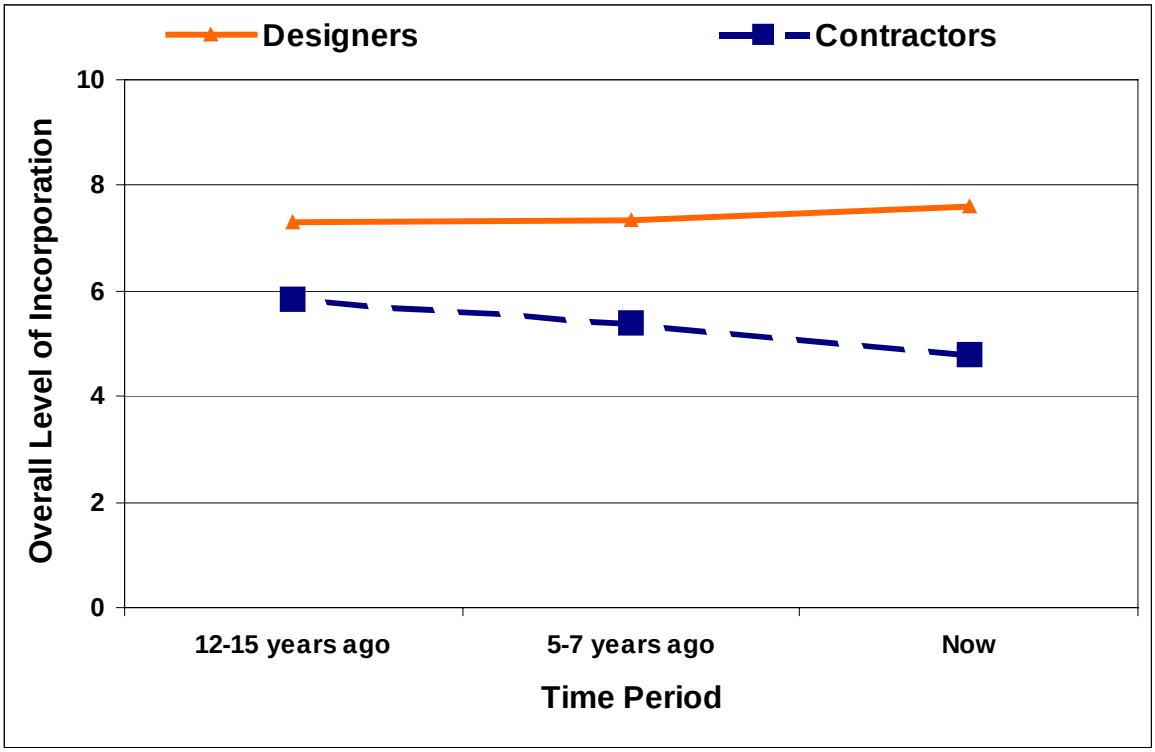

Figure 2.18 Comparison of the responses for *conformity*

Although designers indicated that *final checking* of documentation and *completeness* of documentation were of a high level of importance in determining overall documentation quality, they are two of the issues that were identified as having significantly declined.

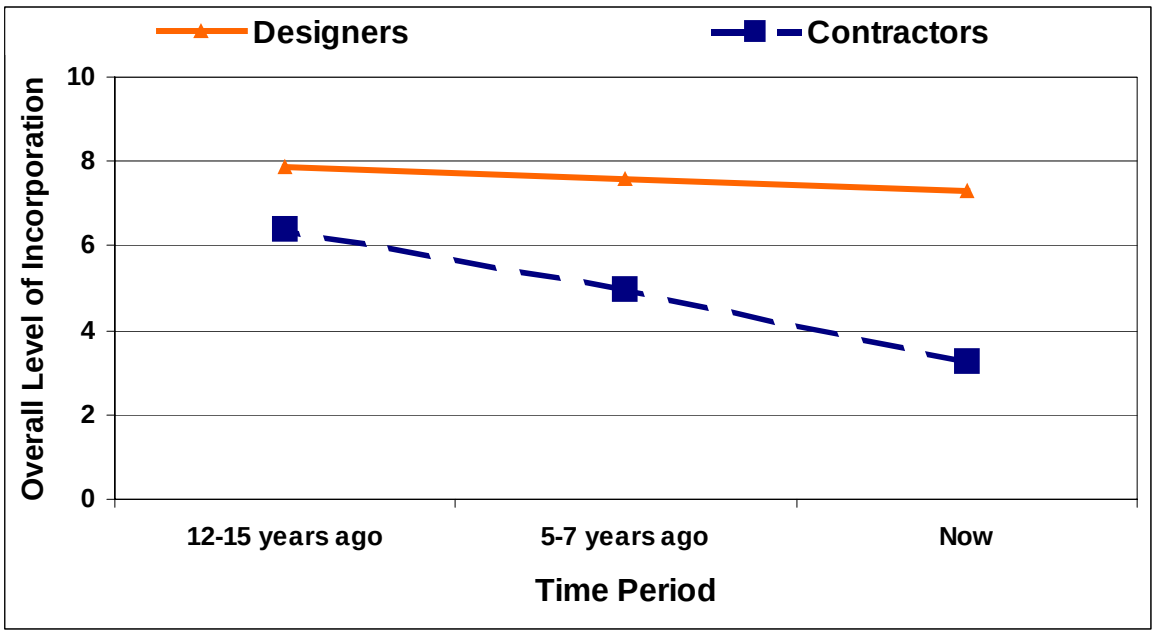

Figure 2.19 Comparison of the responses for *final checking*

Figure 2.19 shows the perceived decline in the level of incorporation for *final checking*. Here we see that designers and contractors agree that there has been a decline however the rate of decline and the current level of incorporation are in debate. This chart also reflects the overall perception, as illustrated in Figure 2.16. The responses for *coordination*, *certainty*, *clarity*, *completeness* and *accuracy* were all similar to those shown in Figure 2.19

Again, as was the case for design issues, an exploratory factor analysis was carried out on the data. The first attempt grouped all variables together under one factor but left *standardisation* as the major component of a second factor. In an attempt to increase the total variance explained by the extracted factors, the analysis was repeated leaving *standardisation* as a separate variable. The procedure extracted one factor that could successfully explain 69% of the variation in the responses for the included variables. In all, the ten documentation issues could successfully be reduced to two variables, one *standardisation* and the other a factor comprising of a linear combination of the other nine issues. As was the case for design issues the factor analysis was repeated for both groups and at each time period and all of the results supported the factor extraction.

The rating for the level of incorporation of documentation quality attributes can be adequately represented by the factor depicted in Figure 2.20 and as can be seen, is similar to the overall perceptions displayed in Figure 2.16. This chart illustrates that both the rating for the level of incorporation and the rate of decline for the factor differs between the two groups however both designers and contractors agree that there has been a decline over time. For both the documentation factor and *standardisation*, the contractors' perception of the level of incorporation is well below that of designers.

The contractors perception that documentation issues other than *standardisation* have declined, some by up to 50%, with most of the decline occurring in the past 5 years, is reflected in Figure 2.20. The designers' belief however, was that some of the issues were declining but that this decline has been arrested in the past 5 years. The *effect* size of the difference of opinion between the two groups is 1.35, which is a large to extra large *effect*. So, in the area of documentation, while there is a high level of correlation between the designers and contractors with regards to the ranking of specific issues (r = 0.94) the degree of the problem is in debate, as is the current trend for the specific issues.

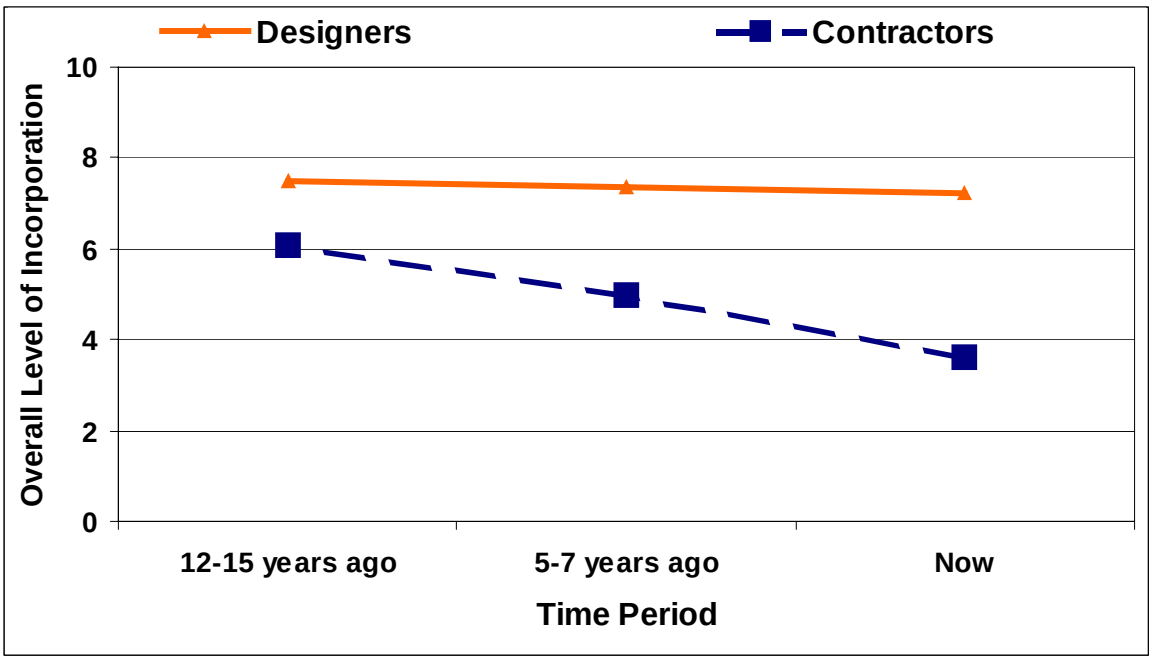

Figure 2.20 Comparison of the factor for documentation attributes.

In an attempt to describe the trend illustrated in Figure 2.20 a regression analysis of the responses was carried out. The results of the analysis showed there is a strong linear relationship in the designers responses over time. The results indicated that the level of incorporation of documentation attributes overall had declined by 6% over the total period surveyed according to designers. Designers believe a greater proportion of the decline took place in the earlier period and has been arrested some what in recent times. The results of a similar analysis using the contractors responses showed a very different result. There was a perceived decline of up to 40% in the level of incorporation for documentation issues over time and this rate of decline has been increasing.

2.1.4 Comparison of design and documentation issues.

Comparing design issues and documentation issues over time, clearly those issues relating to documentation have been the major concern for respondents. The survey documents specifically asked respondents if they considered there has been a decline in the quality of both design and documentation over the past 15 years, both designers and contractors agree the quality has declined. They were also asked if the decline in quality of documentation has been greater then the decline in quality for design. 82% of contractors and 63% of designers responded "*Yes*" to this question. The net result is that the current perception of the design and documentation quality in the Australian construction industry is that it is below the standard achieved 12 – 15 years ago. Both designers and contractors agree the level of decline in the quality of documentation has been greater than the decline of design. When comparing the perceptions of the level of incorporation of design and documentation issues with the level of importance of the issues as defined by the designers we can see the design issues deemed most important, *functionality* and *relevance* are perceived to have remained static. However, the documentation issues deemed most important, *accuracy* and *clarity* have declined significantly. Some of the contractor associations indicated that the accuracy of the documentation has shown the most significant decline of all of the attributes.

The contractors were asked to differentiate between the private sector and the public sector with regards to the quality of design and documentation. The overall response for this question was that private sector documentation is perceived to be as good if not better than public sector documentation by 41% of respondents. 36% believe the quality of

documentation has been better on public sector projects than on private sector projects, which is in line with the response for design quality and 23% were unsure. The responses by industry organisation were comparable to the responses for design quality.

2.1.5 Issues Affecting Design and Documentation Quality

This section was presented to designers and looks at a number of issues previously identified at a recent industry workshop as being detrimental to design and documentation quality. It was designed to not only determine the frequency with which these issues occur, but also the level of effect that they had on quality, when they occurred. The frequency of occurrence was measured on a five-point scale, from '*Not at All*' to '*Always*', while the level of effect was rated on a scale from 0 (*no detrimental effect*) to 10 (*highly detrimental effect*). A list of the problem issues that were rated are shown in Table 2.5 below:

Table 2.5 Problems issues impacting on design and documentation quality

Problems issues impacting on design and documentation quality
a) Low fee structures
b) Insufficient overall design time
c) Inadequate or moving client brief
d) Requests for unpaid design submissions
e) Uncertainty of design brief at bid stage
f) Improper implementation of CAD
g) High cost of 'Expression of Interest' (EOI) and D & C submissions
h) Unrealistic expectations by clients – in relation to fees, service, timing, etc.
i) Inadequate or insufficient project estimates or budgets
j) Builder-employed design managers instigating design changes
k) Insufficient profits being generated to enable the training of staff
l) No one person or office being responsible for design coordination
m) Difficulty in finding good staff (eg. Spec. writers and construction detailers)
n) Additional work necessary to meet 'Quality Assurance' (QA) requirements
o) Clients requesting design changes, without being prepared to pay for them
p) High volume of builder-initiated design changes (under D & C system)
q) Architectural consultants being engaged on a 'design only' basis
r) Proliferation of 'backyard' operators prepared to work for minimal fees
s) Lack of understanding by the client of the value of Bills of Quantities
t) Difficulty in interfacing between varying contractual relationships
u) Fellow consultants not clearly defining exactly what is required
v) Difficulty in convincing clients of the value of comprehensive and clear documentation
w) Fellow consultants having reduced service – incompatible with overall project team requirements

The issues identified by designers as occurring most frequently (and there modal rating), were:

- unrealistic expectations by clients - in relation to fees, service, timing etc. (Often);
- low fee structures (Often); and
- insufficient profits being generated to enable the training of staff (Often).

However, the issues that they believed occurred the least were:

- improper implementation of CAD (Rarely);
- no one person or office being responsible for design coordination (Rarely); and
- difficulty in interfacing between varying contractual relationships (Occasionally).

The issues indicated by designers as having the greatest effect on design and documentation quality and their mean response were:

- proliferation of 'backyard' operators prepared to work for minimal fees (7.5);
- low fee structures (7.5);
- insufficient overall design time (7.4);
- inadequate or moving client brief (7.4); and
- unrealistic expectations by clients – in relation to fees, service, timing, etc. (7.3).

As can be seen, all five of these issues had an average rating between 7.3 and 7.5 and were perceived by the designers as having a significantly greater effect on design and documentation quality than the other issues.

Those issues perceived to effect design and documentation quality the least and their mean response were:

- improper implementation of CAD (4.6);
- additional work necessary to meet 'Quality Assurance' (QA) requirements (4.8); and
- difficulty in interfacing between varying contractual relationships (4.9).

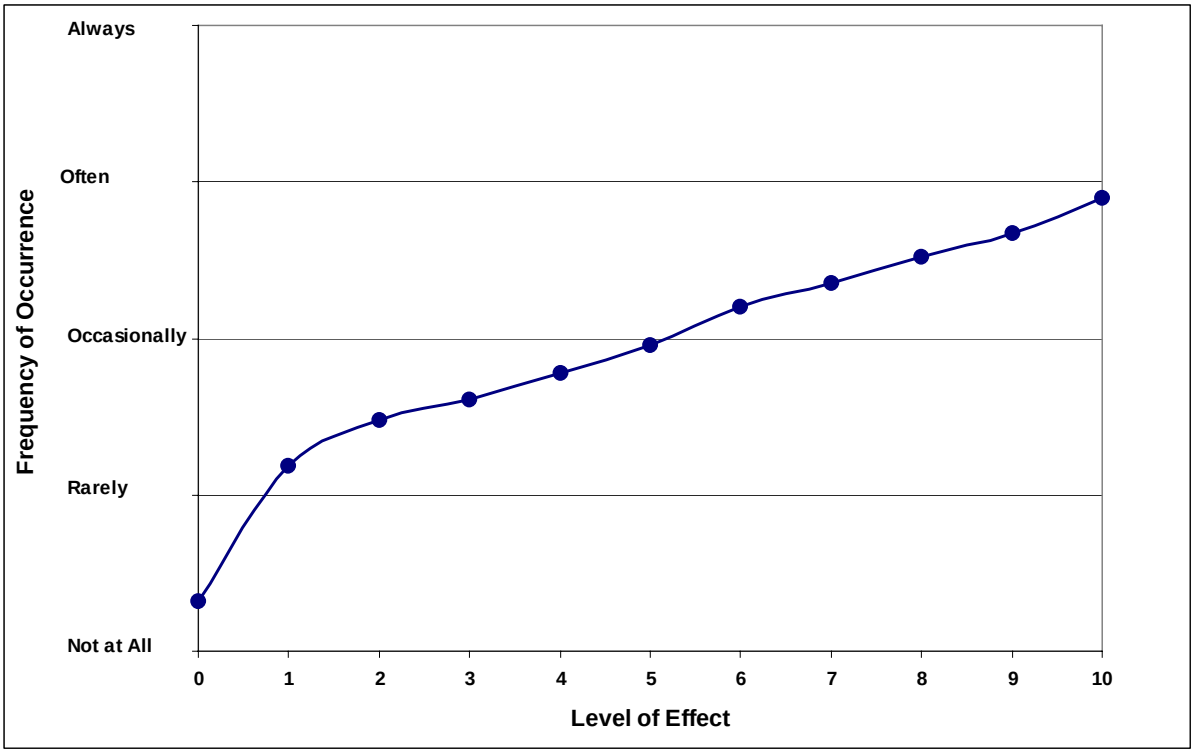

Figure 2.21 Correlation of *frequency* with *effect*

To try to determine the strength of the relationship between frequency and effect, a correlation test was done. The results of this test showed a correlation coefficient of 0.57, which indicates that there was a positive correlation between frequency and effect. Figure 2.21 shows graphically how the level of effect becomes increasingly detrimental, as the frequency of occurrence of the issues effecting design and documentation quality increase.

2.1.6 Areas of Design and Documentation Deficiency

This section of the contractors survey looked at a number of issues identified at the contractor's workshop as being detrimental to construction process efficiency. The issues are listed below in Table 2.6 and Table 2.7. This part of the questionnaire was designed to determine the frequency with which these issues occur, and the level of effect that they have had on quality, when they occurred. Contractors were required to rate the frequency of occurrence of the issues, 'Not at all', 'Rarely', 'Occasionally', 'Often' or 'Always' and then indicate their perception of the level of effect each issue had on the construction process efficiency when it occurred. The scale for the level of effect ranged from 1 – no detrimental effect to 9 – highly detrimental effect. They were also asked to rate the quality of design and documentation that was produced under the different procurement methods – Traditional, Design and construct and Management.

Design problems identified

The contractors point out, through their responses, that approximately half the issues raised occur with high frequency. Given that these issues were identified as contributing to a reduction of construction process efficiency, this result is alarming.

Table 2.6 Design problems identified

Identified Design Problems
a) Inadequate or insufficient design work carried out
b) Design not being achievable with in the project budget
c) Insufficient clearances (from statutory bodies) prior to commencement on site
d) Designers with a lack of understanding of the project delivery process
e) Designers with a lack of knowledge of local by–laws or BCA requirements
f) Fast–track design not keeping pace with construction activities
g) Insufficient design coordination causing clashes between building elements
h) Insufficient design coordination causing clashes between services elements
i) Impractical construction methodologies and detailing
j) Site constraints not being adequately checked prior to starting on site
k) Materials or products specified contrary to manufacturers' recommendations
l) Limits being placed on the number or type of suppliers allowed
m) Lack of innovation in design solutions provided
n) Design changes causing disruption to critical construction activities

According to contractors, issues that occur most frequently (and there modal rating) with regards to design problems were:

- inadequate or insufficient design work carried out (Often);
- design not being achievable within the project budget (Often);
- insufficient design coordination causing clashes between building elements (Often); and
- insufficient design coordination causing clashes between services elements (Often).

The issues that occur least frequently were:

- limits being placed on the number or type of suppliers allowed (Rare to Occasional); and

- materials or products specified contrary to manufacturer's recommendations (Rare to Occasional).

When considering the effect of these design problems the contractor's assessment was that the occurrence of any of the problems had a detrimental effect on construction process efficiency.

Design problems that have had the most effect on construction process efficiency and their mean response were:

- inadequate or insufficient design work carried out (6.7);
- design not being achievable within the project budget (6.8);
- fast–track design not keeping pace with construction activities (6.9);
- insufficient design coordination causing clashes between building elements (7.0);
- insufficient design coordination causing clashes between services elements (7.0); and
- design changes causing disruption to critical construction activities (7.5).

Limits being placed on the number or type of suppliers allowed has had the least effect (4.6) but still occurs with reasonable frequency and has a detrimental effect on construction process efficiency.

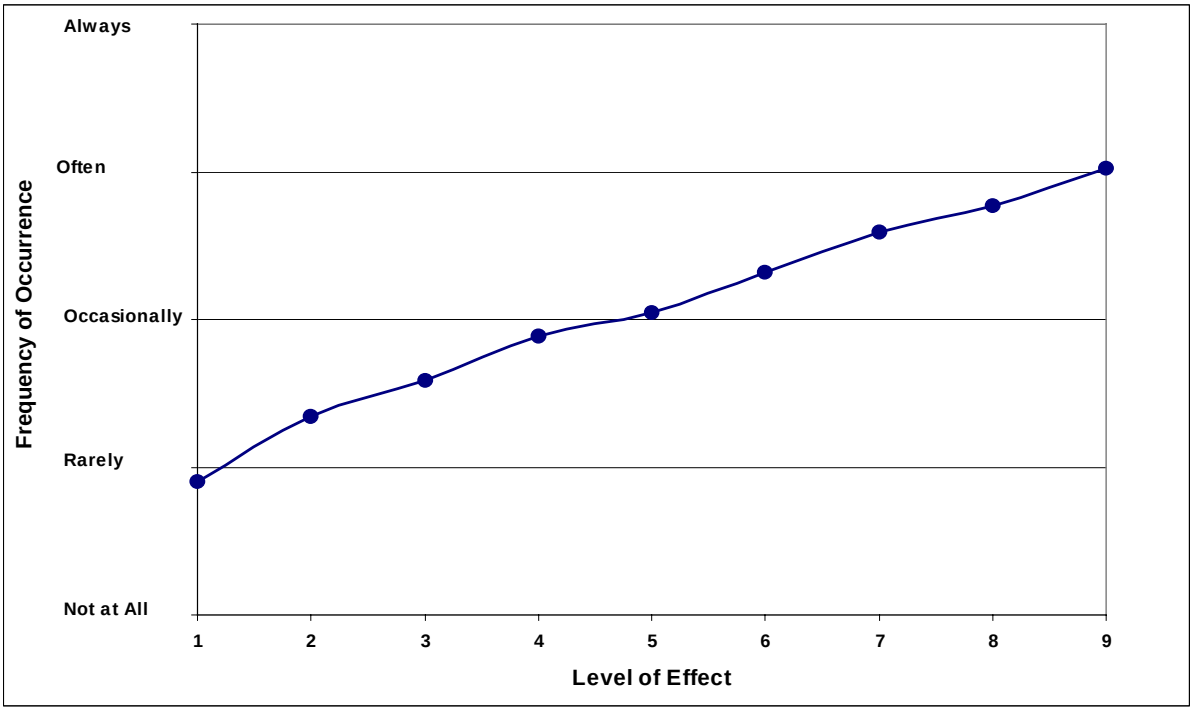

Figure 2.22 Correlation of frequency with effect for design deficiency issues

As can be seen in Figure 2.22, the issues that those which occur most often are also the issues that have the most detrimental effect on construction process efficiency. The correlation statistic between frequency and effect is 0.56, which is a moderate positive relationship.

Contractors were asked to indicate whether they believed there been an increase in the overall frequency of occurrence of the identified design problems as a whole? The "*Yes*" response was expected for this question based on their responses to the changes in levels of design quality, but not to the degree indicated. As shown in Figure 2.23, 85% of contractors agree there had been an increase in the frequency of occurrence of the identified design problems as a whole. All of the respondents from the AMCA agree and members of the MBA were the least sure but still 77% claim there had been an increase.

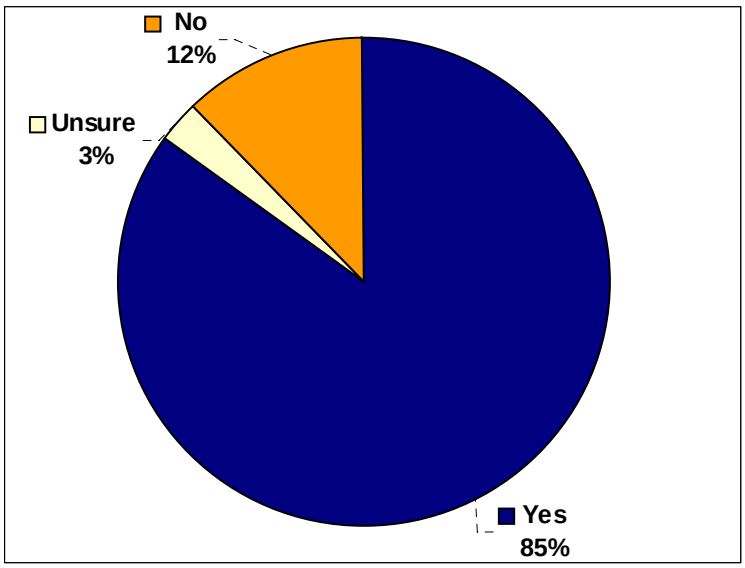

Figure 2.23 Response for whether there had been an increase in design problems

Documentation problems identified

According to contractors, the frequency of occurrence for every issue was excessive, with the greatest frequency of occurrence pertaining to documentation detail, clarity and accuracy.

Table 2.7 Documentation problems identified

Identified Documentation Problems
a) Documents issued with conflicting information
b) Documents lacking clarity and forcing contractors to interpret requirements
c) Late production of colour and finishes schedules
d) Documents issued with incorrect or inaccurate information
e) Critical explanatory notes hidden in general notes
f) Simple projects being unnecessarily over documented
g) Lack of definition and clarity in scope of works
h) Documents lacking standard details (reinventing the wheel)
i) Documents issued with insufficient details or dimensions
j) Inaccurate or non-standard or poorly prepared Bills of Quantities
k) Mixing of prescriptive and performance specification clauses
l) Issue of unamended standard specifications (Natspec/other projects)
m) Documents considered questionable in relation to project requirements
n) Reliance of specification notes, in areas where drawings are required
o) Documents calling up out–of–date or inappropriate standards/specifications
p) Specifications not designed to be split up into trade packages
q) Lack of programming to indicate the issue of critical design information
r) Use of catch all type clauses, requiring the contractor to make allowance for items not designed or specified

Again, the problems that respondents believe occur most often, have also been rated as having the greatest effect on construction process efficiency.

The problems that are perceived to occur most frequently and have the most effect (Frequency, Effect) are:

- documents issued with conflicting information (Often, 6.4);
- documents lacking clarity and forcing contractors to interpret requirements (Often, 6.7);
- documents issued with incorrect or inaccurate information (Often, 6.6);
- reliance on specification notes in areas where drawings are required (Often, 6.3); and
- use of ***catch all*** type clauses, requiring the contractor to make allowance for items not designed or specified (Often to Always, 7.4).

The issue to occur least frequently, although still far too regularly (Occasionally to Often), was *Simple projects being unnecessarily over documented*. The result was similar to the result for design problems but more severe.

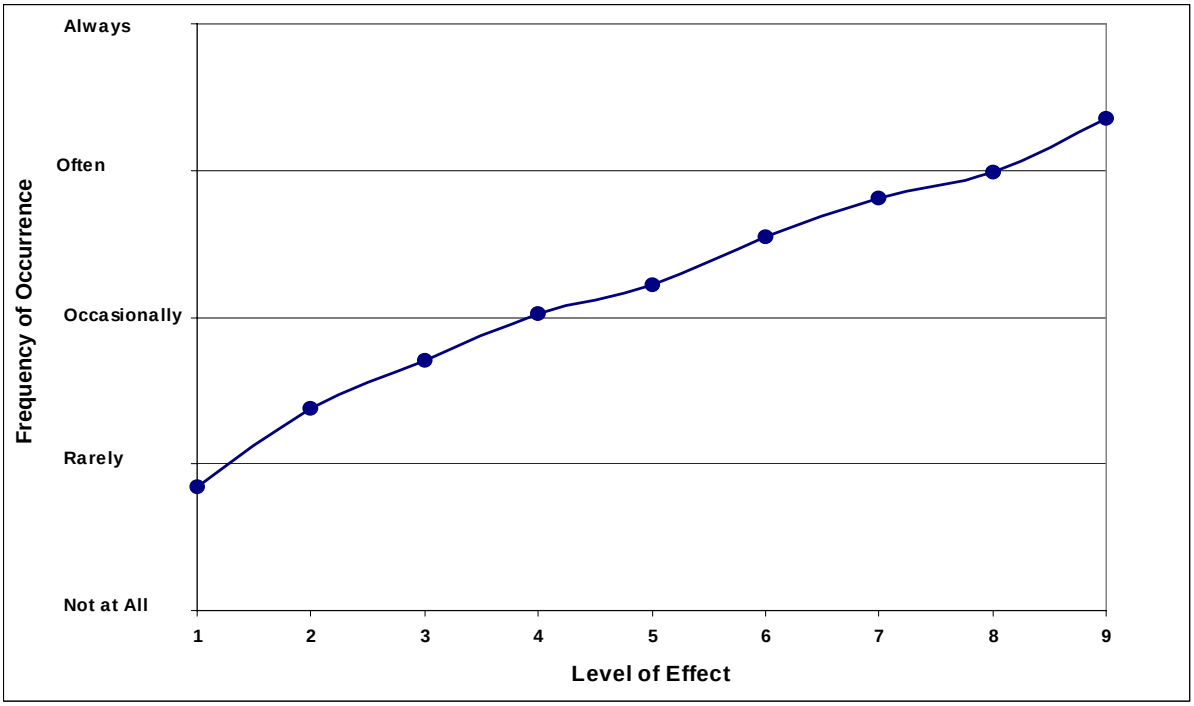

Figure 2.24 Correlation of frequency with effect for documentation deficiency issues

Again, as was the case for design issues, Figure 2.24 illustrates as the frequency increased the effect increased. The correlation statistic between frequency and effect for documentation deficiency is 0.62, which is a moderate to strong relationship.

As was the case for design problems, contractors were asked to indicate whether they believed there been an increase in the overall frequency of occurrence of the identified documentation problems as a whole.

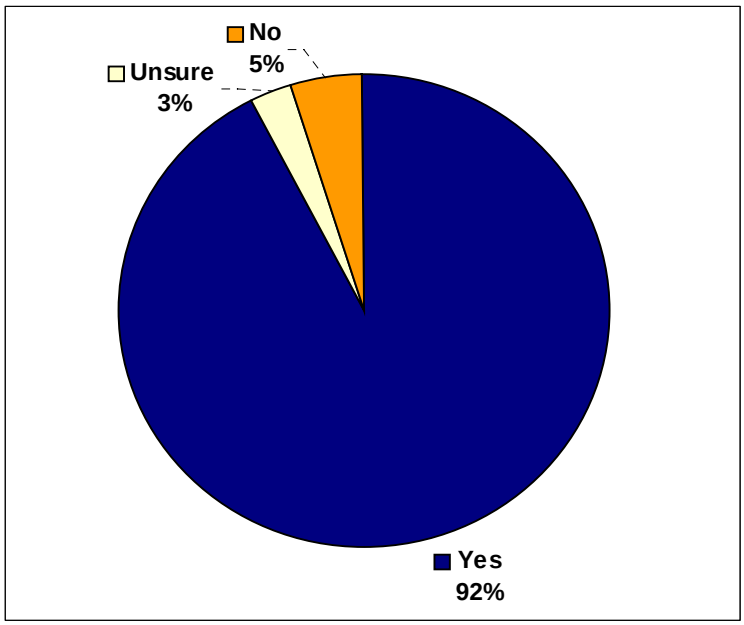

Figure 2.25 Response for whether there had been an increase in documentation problems

As can be seen in Figure 2.25, 92% of contractors believe there had been an increase in documentation problems over time, with all organisations in strong agreement. This result should be a major concern for all parties of the building industry. It shows that contractors are beginning projects with the belief that there will be problems with much of the project documentation and these problems will lead to a reduction in construction process efficiencies. The net result will be a higher cost of construction.

When comparing the responses for frequency of occurrence and effects of design problems and documentation problems, the contractors consider the documentation problems occur more frequent than the design problems but the effect of both design and documentation problems is highly detrimental to construction process efficiency

2.2 Procurement Methods

2.2.1 Overview

Here the respondents' perception of various issues concerning the procurement of design and documentation services was assessed. Consultants were asked to consider a number of statements relating to the clients understanding of the value of the design function and then indicate their level of agreement to each statement. They were also asked to consider issues in relation to obtaining work and rate their perception of the importance each issue has in obtaining work. For these questions, designers were asked to provide a response for both public and private sector clients to enable comparisons between each client group. Then designers were asked to consider the actual availability of time to ensure the production of quality design and documentation. Contractors were asked for their perception of whether the quality of design or documentation had been greater on public sector projects than on private sector projects.

Together with the issues mentioned above, the surveys presented questions in an effort to determine whether the type of procurement method used has an impact on the level of design and documentation quality likely to be attained. Designers were asked to indicate the percentage of work carried out under three different procurement methodologies – *traditional*, *design and construct* and *management* procurement methods – at three different time periods – *Now*, *5 – 7 Years Ago* and *12 – 15 Years Ago* – and then to rate the quality of design and documentation being produced for the systems at those time periods. Contractors were also asked to rate the overall quality of design and quality of documentation being produced at each time period for each of the three procurement methods. In addition, the designers were asked to rate both the adequacy of the time available to carry out the design function and the level of service requested by the clients, for each procurement method and each time period. By including the different time periods into the questions, it was possible to determine trends in not only the usage of the different procurement methodologies, but also the changes in design and documentation quality, time availability and service requested.

It was the opinion of designers that the main selection criteria for obtaining design work from either client group, was the level of design fees submitted, with issues such as experience, qualifications and quality assurance being only of secondary consideration. When asked to consider issues relating to the availability of actual time to carry out the design function, there was a general consensus that there was insufficient time being allowed for designers to not only produce high quality design and documentation, but also to adequately incorporate innovation and life cycle considerations.

There was a perception by designers that *private* sector client's expect them to be able to interpret and expand on inadequate design briefs more so than *public* sector clients. Also that designers believed that clients from both sectors did not understand there are high litigation costs involved in selecting designers based on minimum cost. With regard to clients understanding that an increase in project costs can be due to cut backs in the initial time allowed for design, surveyors and architects indicated that in their opinion, ***private*** sector clients were distinctly worse than their ***public*** sector counterparts. Overall however, neither client group was perceived to be good in relation to this issue. Designers disagree with the statement indicating that clients did not understand the impact that a changing design brief has on the efficiency of the design team. These results show there was a strong perception by designers that the majority clients – be they ***public*** or ***private*** sector clients – did not appear to possess an understanding of the impact that the level of fees and the time available has on the quality of the design and documentation produced.

Overall, the results indicated that the *traditional* procurement method was – by quite a large margin – still the most widely used method, but that its usage has steadily declined over the past fifteen years. Although both the *design and construct* and *management* procurement methods have seen an increase in their usage over the same period, there was a slightly greater increase in the *management* procurement system.

When considering the impact of the various procurement methodologies on design and documentation quality, the results show that designers overall consider quality to be greater under the *traditional* procurement method than either *design and construct* or *management.* However, the results also indicate that under all three procurement methods, design and documentation quality has declined over the past 15 years and that the greatest decline has been under the *traditional* method. Contractors agree that there has been decline in quality under all three methodologies, however they believe that design and documentation currently being produced under both *design and construct* and *management* methods, is of a marginally higher standard than that produced under the *traditional* method. Contractors perceived the current rating for documentation quality was below the rating for design quality for each procurement method indicating the decline in documentation quality had been the more severe.

In relation to the adequacy of time available for the design and documentation function, designers felt that it was greater under the *traditional* procurement method, than under either the *design and construct* or *management* procurement methods over all time periods. However, under all three procurement methods, the adequacy of time available for the design and documentation function has significantly declined over the past 15 years, with the greatest decline occurring under the *traditional* method.

The level of design and documentation service requested by clients was also perceived by designers to be greater under the *traditional* procurement method, than under either the *design and construct* or *management* procurement methods. Although there had also been a decline in the levels of service being requested over the past fifteen years, the extent of this decline was less than that shown for design and documentation quality, or for the adequacy of time available for the design and documentation function.

2.2.2 Aspects of client's understanding of the value of the design function

The designers were asked to consider a number of statements relating to the client's understanding of the value of various aspects of the design function and indicate their level of agreement to each statement. The respondent's level of agreement was measured on a five-point scale, from '*Strongly Disagree*' to '*Strongly Agree*'.

The format of the question also specifically allowed designers the ability to compare the performance of both *public* and *private* sector clients in relation to each issue. A list of the statements relating to the clients understanding of the value of the design function surveyed are shown in Table 2.8.

Table 2.8 Aspects of client's understanding of the value of the design function

Aspects of client's understanding of the value of the design function
a) Clients expect designers to be able to interpret and expand on inadequate briefs
b) Clients possess realistic expectations of fees, services and timing
c) Clients understand there are high litigation risks involved in selecting designers based on the minimum cost
d) Clients understand that the provision of an adequate service is attainable at a sensible fee
e) Clients understand that an increase in project costs can be due to cut backs in the initial time allowed for design
f) Clients understand the time and money saving value of comprehensive and clear documentation
g) Clients understand the importance of design services being compatible with project requirements
h) Clients are generally willing to work with designers to ensure the correct interpretation of the brief
i) Clients understand the impact that a changing design brief has on the efficiency of the design team
j) Clients understand the importance of the compatibility of the design firms and their ability to work together cooperatively
k) Clients understand that the quality of design and documentation is determined by the level of fees provided and the time available
l) Clients understand that money spent early, properly defining project requirements, saves money later in the design and documentation process
m) Clients understand the importance of a clear and concise brief to assist the efficiency of the design and documentation process
n) Clients understand that poor quality design and documentation leads to variations, delays and rework in the construction process, which causes increases in construction costs

The results are based on the overall frequency of the responses for each of the specific issues raised. Based on the responses provided, the top five concerns of designers overall were that:

- clients expected them to be able to interpret and expand on inadequate briefs;
- clients did not seem to understand that there are high litigation risks involved in selecting designers based on the minimum cost;
- clients did not seem to understand that an increase in project costs can be due to cut backs in the initial time allowed for design;
- clients did not seem to possess realistic expectations of fees, services and timing; and
- clients did not seem to understand that the quality of design and documentation is determined by the level of fees provided and the time available.

When considering these results as a whole, the overall perception provided by designers was that clients in general – both *private* and *public* – did not appear to understand the true value of the design function, in relation to overall project outcomes. However, when comparing the differences between the two different client types, the results show that overall, there was an perception by designers that *private* sector client's had less understanding than did *public* sector clients. Relating these responses to the responses for issues affecting design and documentation quality, it may be reasonable to conclude that the designer's perception of clients having unrealistic expectations of the design team and an inability to provide comprehensive and consistent project briefs could be grounds for their assertions that clients have a lack of understanding of the design process.

Contractors were asked whether they considered that the overall quality of design over the past 15 years has been greater on public sector projects than on private sector projects. In

Figure 2.26 it can be seen that overall 46% of respondents agree the quality of design has been at least as good if not greater on private sector projects than on public sector projects. 38% believe the quality of design has been greater on public sector projects and 16% were unsure.

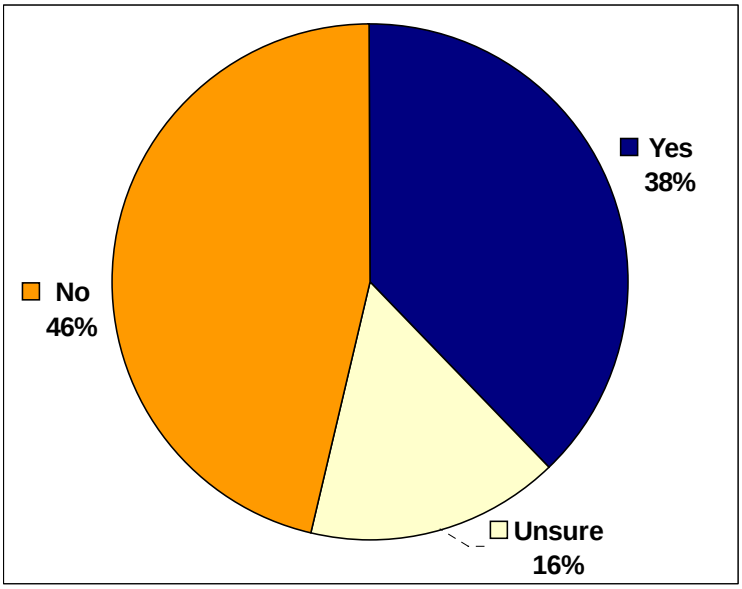

Figure 2.26 Overall response for whether the quality of design had been greater in the public sector.

Similarly for documentation quality, contractors were asked whether they considered that the overall quality of documentation over the past 15 years has been greater on public sector projects than on private sector projects?

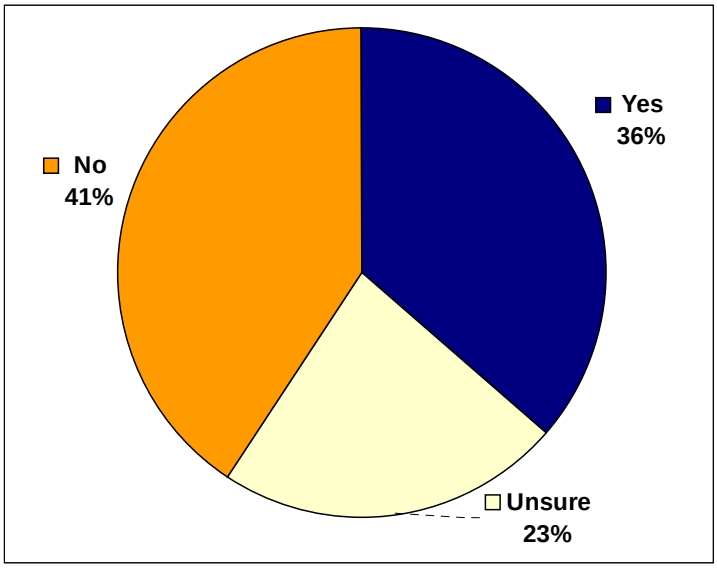

Figure 2.27 Overall response for whether the quality of documentation had been greater in the public sector

The overall response for this question was that private sector documentation is perceived to be as good if not better than public sector documentation by 41% of respondents. 36% believe the quality of documentation has been better on public sector projects than on private sector projects as is evident in Figure 2.27 and 23% were unsure. This result is in line with the response for design quality.

2.2.3 Importance of Designer Selection Criteria

In the designers survey document, the designers were asked to consider a number of issues in relation to obtaining work from clients and to provide their perceptions of the relative importance clients appear to place on those issues. The respondent's level of importance was measured on a five-point scale, from '*Very Low*' to '*Very High*'.

Again, the format of the question specifically allowed designers to compare both *public* and *private* sector clients in relation to each issue. The selection criteria issues surveyed are shown in Table 2.9.

Table 2.9 Client criteria for the selection of design services

Client criteria for the selection of design services
a) Design firm's reputation, capabilities, experience and qualifications
b) Level of design fees submitted for the project
c) Level of design and documentation quality required
d) Level of contractual risk accepted by the designer
e) Quality Assurance accreditation of the design firm
f) Stability of design firm's recent financial history
g) Current workload of design firm
h) Acceptance of contractual arrangements that are incompatible with project requirements

When considering the all the various selection criteria, it was the *"level of design fees submitted for the project"* that designers believed to be the most important factor in obtaining work, for both *public* and *private* sector clients. It is also interesting to note that both Architects and Engineers – the bulk of the respondents – consider the level of design fees was of relatively more importance to clients from the *public* sector than from the *private* sector.

Designers believed a *"design firm's reputation, capabilities, experience and qualifications"* as a factor in obtaining work was perceived by clients – both *public* and *private* sector – to be the next most important issue. The figures show however, that designers perceive this issue to be of more significance to *private* sector clients than it was to *public* sector clients.

An issue that has had a large impact on design firms over the past 10 years or so - the *"quality assurance accreditation of the design firm"* – was not considered all that important as a factor in obtaining work. Designers did however indicate that this factor was seen as being of much more importance to *public* sector clients than to *private* sector clients, even though its overall level of importance was only a little above average. Interestingly, further analysis showed that those firms who either did not have quality assurance, or were in the process of becoming quality assured, believe it was of more important than those who had already achieved certification, especially in relation to *public* sector clients.

It is also interesting to note that an issue one would generally consider to of relatively high importance – the *"stability of design firm's recent financial history"* – was actually considered by designer's to be the least important issue in a client's selection process.

2.2.4 Availability of Time to Carry out the Design Function

The designers were asked to consider a number of statements relating to the availability of actual time to ensure the production of quality design and documentation and to provide their

level of agreement to each statement. The respondent's level of agreement was measured on a five-point scale, from '*Strongly Disagree*' to '*Strongly Agree*'. A list of the statements relating to time availability which were surveyed, are shown in Table 2.10.

Table 2.10 Statements relating to the availability of design time

Statements relating to the availability of design time	
a)	The time spent with clients, establishing project requirements, is sufficient to ensure understanding
b)	Time available for each key phase of the design process is sufficient to ensure high quality
c)	There is sufficient time to compare and discuss project details with other design disciplines
d)	Sufficient time is provided early in the design stage to consider whole life-cycle issues
e)	There is an adequate amount of time to properly check drawings and specifications
f)	If more time was made available for design and documentation, the level of quality would be higher
g)	There is adequate time available to promptly and accurately respond to contractor RFIs
h)	Time available is adequate to allow basic training for junior staff to be provided
i)	There is adequate time available to investigate innovative approaches to better meet the specific requirements of the project
j)	The amount of time necessary to complete the design and documentation process, is adequately accounted for within the fee structure

As is shown in Figure 2.28, the greatest level of agreement overall, was achieved by the following two (2) statements:

- *if more time was made available for design and documentation, the level of quality would be higher* – with 45% of respondents agreeing and a further 32% strongly agreeing; and
- *the time spent with clients, establishing project requirements is sufficient to ensure understanding* – with 58% of respondents agreeing with this statement.

The following three (3) statements however, achieved the greatest level of disagreement:

- *the amount of time necessary to complete the design and documentation process, is adequately accounted for within the fee structure* – had 39% of respondents disagreeing and a further 24% strongly disagreeing;
- *there is adequate time available to investigate innovative approaches to better meet the specific requirements of the project* – had a total of 64% disagreeing; and
- *sufficient time is provided early in the design stage to consider whole life-cycle issues* – had 62% of respondents disagreeing.

For all three (3) statements there was reasonable consistency between the majority of the disciplines with regard to their level of disagreement, however in all instances, the Quantity Surveyors were significantly more negative.

Further analysis indicated there was also a high level of consistency of agreement between the disciplines with regard to the need for extra time to ensure higher quality. Overall therefore, these results would appear to indicate that designers believe that there is insufficient time being allowed to enable the production of high quality design and documentation and to adequately incorporate innovation and life cycle considerations.

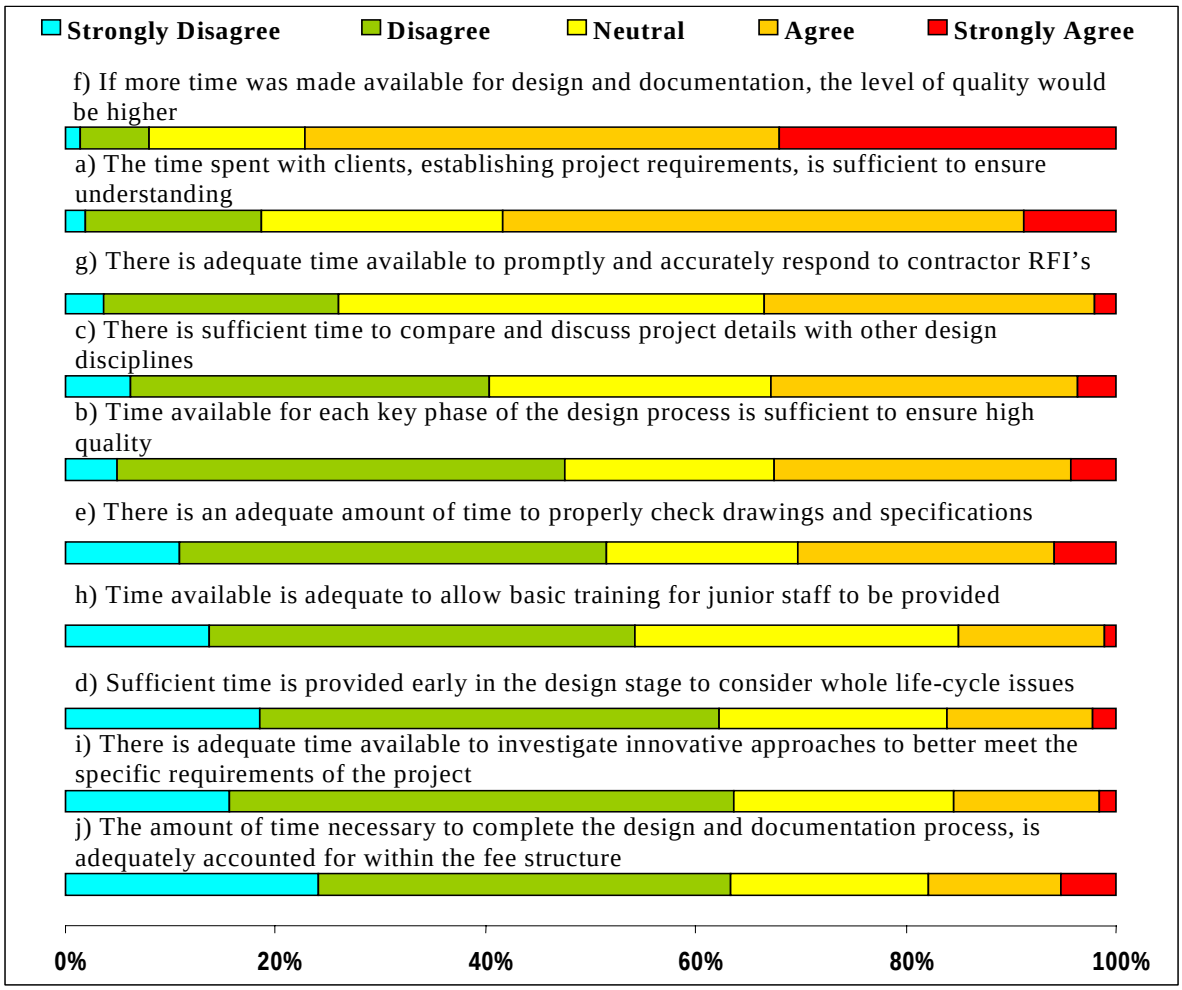

Figure 2.28 Overall level of agreement for availability of time issues

2.2.5 Effect of Procurement Methods on Design and Documentation Quality

In Figure 2.29, the chart clearly shows that the *traditional* procurement system was – by quite a large margin – the most widely used method of procurement over the past fifteen years, but that its usage has steadily declined over that time frame, with the extent of that decline being just over 24%. To counteract this decline, there have been significant increases in the use of both the *design and construct* method (176%) and the *management* procurement method (303%).

When considering the impact of the various procurement methodologies on design and documentation quality, the results show that designers overall consider quality to be greater under the *Traditional* procurement method than either *Design and Construct* or *Management.* However, the results also indicate that under all three procurement methods, design and documentation quality has declined over the past 15 years and that the greatest decline has been under the *Traditional* method.

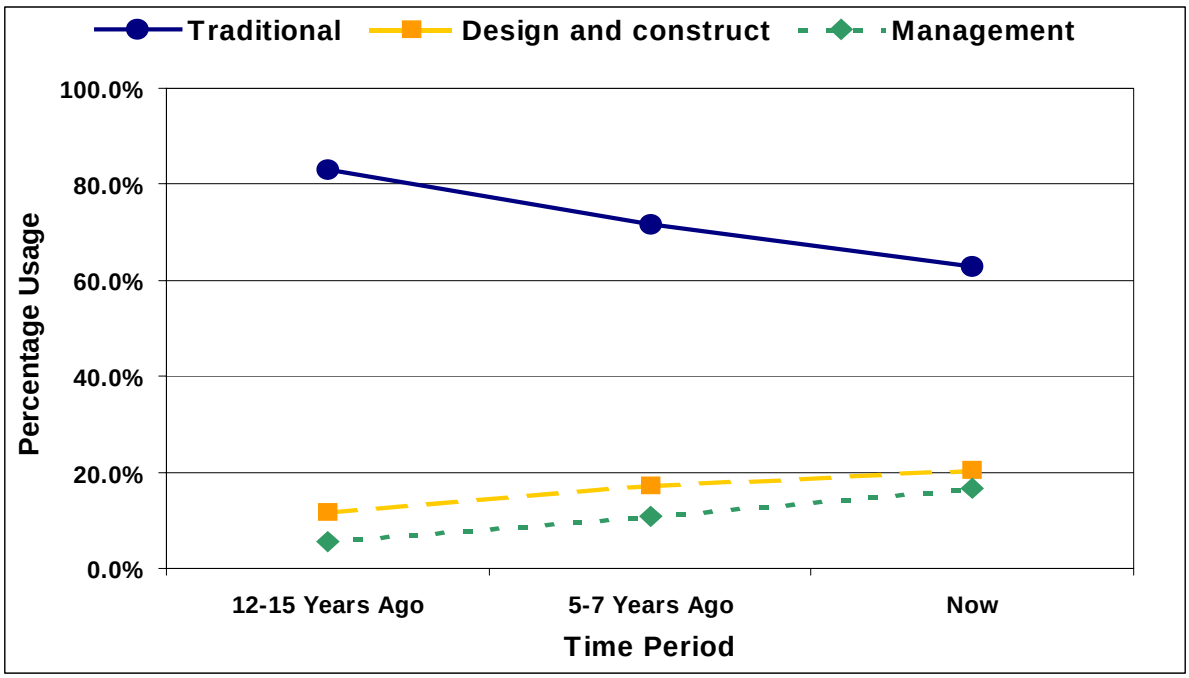

Figure 2.29 Extent of use of each procurement method

The designers perception of the overall *quality* of design and documentation produced under each of the three different procurement methodologies and at each of the three different time periods is depicted in Figure 2.30. The level of quality was measured on a nine-point scale, from 1 (*Very Poor*) to 9 (*Excellent*). As can be seen, the responses to this question graphically display the changes in overall design and documentation quality for each procurement method over the past 15 years.

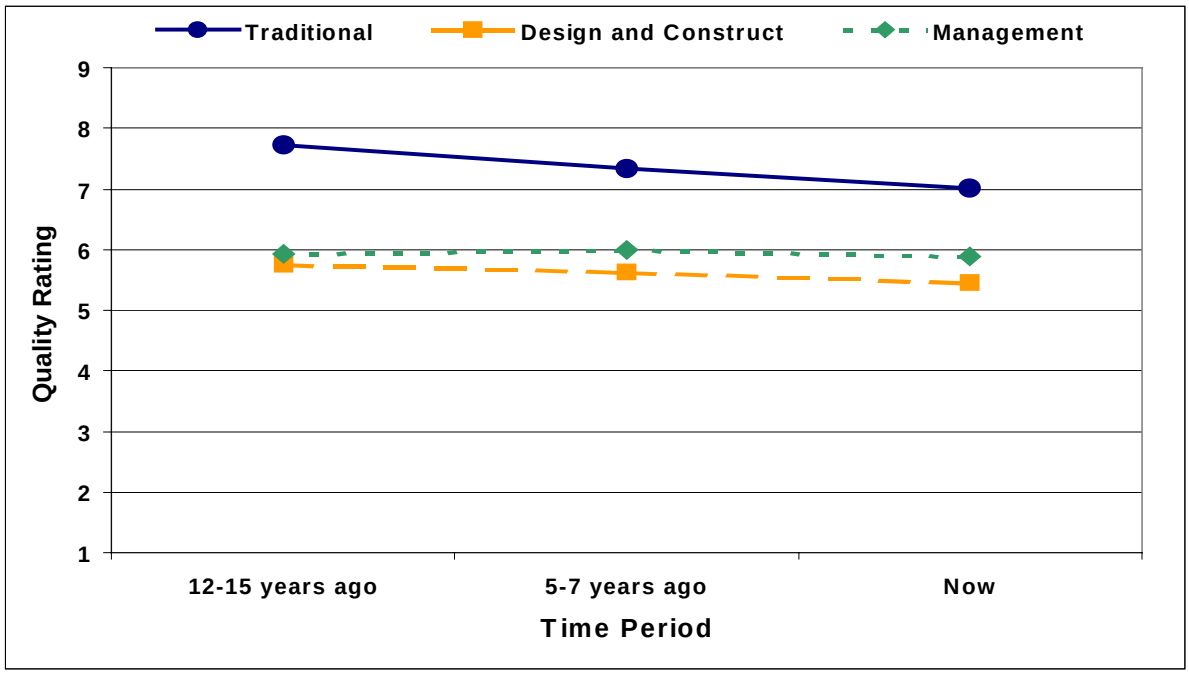

Figure 2.30 Rating of design and documentation quality for each procurement method

Although the graph shows that the *traditional* procurement method was perceived to provide the highest quality standards of the three procurement methods over the past 15 years, it also showed the greatest decline over that period, with the extent of that decline (nearly 10%) being statistically significant. Design and documentation quality under the *management*

procurement method was next best and showed virtually no change over time according to the designers as a whole. The respondents however saw the *design and construct* procurement method as providing the lowest levels of design and documentation quality and indicated that quality levels had also declined over time, but only by a small amount.

The contractors' responses for the overall quality of design being produced at the specified time periods for each procurement system, is illustrated in Figure 2.31 below.

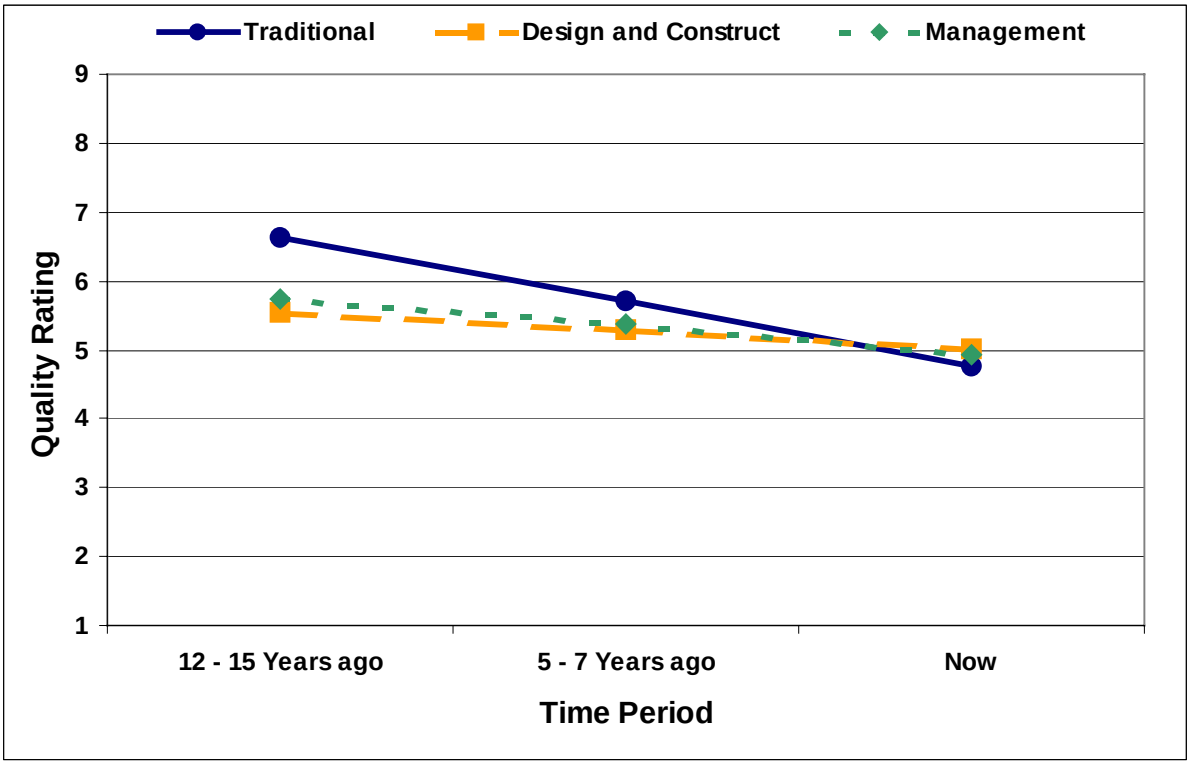

Figure 2.31 The perceived decline in quality of design over time by method of procurement

This chart highlights the perceived decline in the quality of design, particularly for the *traditional* procurement method. Like the designers, the contractors perceive the quality under the *traditional* procurement method as starting at a much higher rating 12 – 15 years ago, although unlike the designers, the contractors rating for design quality has now dropped below the standard of the other two procurement methods. Contractors and designers agree that both the *design and construct* and the *management* procurement method have declined slightly and were not significantly different to each other at any time period. This response underlines the contractors' perception as stated earlier that the overall quality of design has declined, particularly with regards to the traditional system.

When considering the overall quality of documentation being produced at the specified time periods for each procurement system, the contractors responses were similar to their perception for the design quality although they perceived a much greater decline overall as can be seen in Figure 2.32 below.

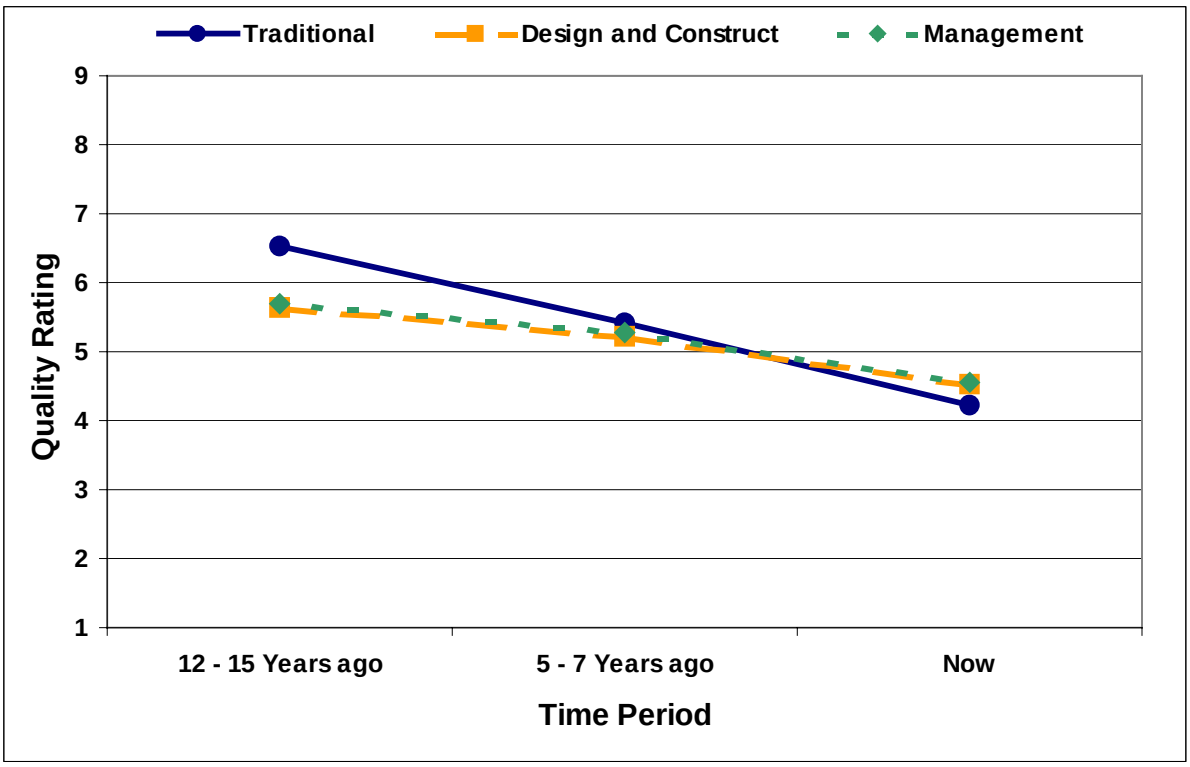

Figure 2.32 The decline in quality of documentation over time by method of procurement

Again, starting at a much higher rating 12 – 15 years ago, the contractors rating for documentation quality for the *traditional* procurement method has now dropped below the standard of the other two procurement methods. Both the *design and construct* and the *management* procurement method have also declined and were not significantly different from each other at any time period.

Although the contractors rating for both design quality and documentation quality had declined between the period 12 – 15 years ago to 5 – 7 years ago the level of decline for the two areas was nearly the same, with each procurement method having corresponding ratings for both design and documentation. The rating now for documentation quality was below the rating for design quality for each procurement method indicating the decline in documentation quality had been more severe in the past 5 – 7 years. This supports the respondent's perception that the decline in documentation has been greater than the decline in design.

In relation to the adequacy of time available for the design and documentation function, the designers were asked to rate their perception of the overall *adequacy* of time available to carry out the design and documentation function under each of the three different procurement methodologies and at each of the three different time periods. The adequacy of time was also measured on a nine-point scale, from 1 (*Totally Inadequate*) to 9 (*More than Adequate*). Figure 2.33 below, displays the responses to this question and graphically shows the perceived changes in the overall adequacy of design time for each procurement method over the past 15 years.

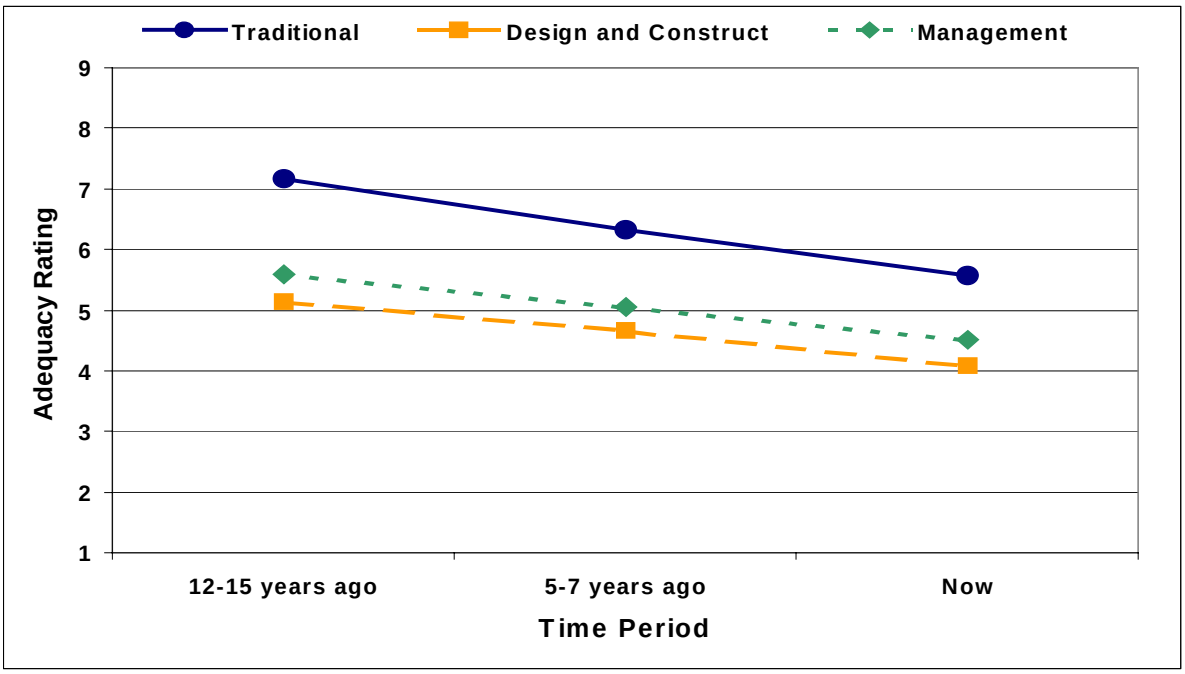

Figure 2.33 Adequacy of time available to carry out design and documentation function for each procurement method

This chart shows that the adequacy of time available for the design and documentation function was greater under the *traditional* procurement method, than under either the *management* or *design and construct* procurement methods at all time periods. However, the graph also shows that the designers considered that there had been a significant decline in the availability of time to carry out the design and documentation function over the past fifteen years. This level of decline was consistent – at around 20% – for all three procurement methods.

The designers were asked to rate their perception of the overall level or extent of the design and documentation service requested by clients, under each of the three different procurement methodologies and at each of the three different time periods. The extent of service was measured on a nine-point scale, from 1 (*Minimal Service*) to 9 (*Complete Service*). Figure 2.34 below, displays the responses to this question and graphically shows the perceived changes in the overall extent of the design and documentation service requested for each procurement method over the past 15 years.

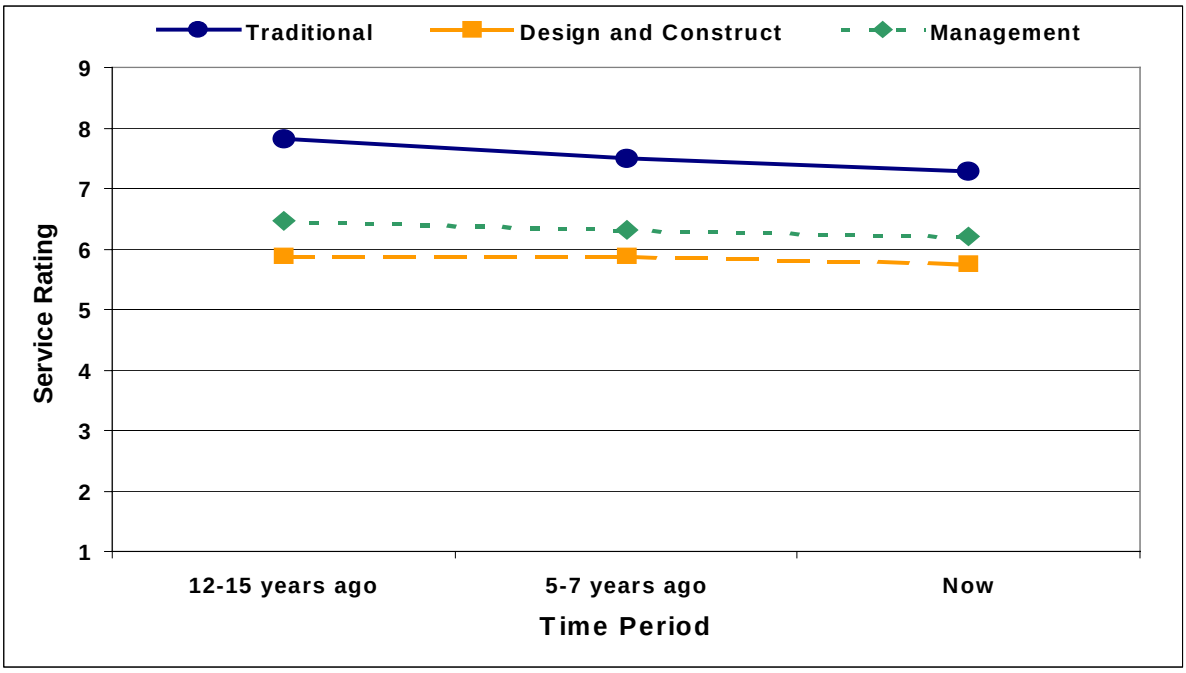

Figure 2.34 Level of design and documentation service requested by clients

The chart shows that the level of design and documentation service requested by clients was perceived by designers to be greater under the *traditional* procurement method, than under either the *management* or *design and construct* procurement methods. The graph also shows that for all three procurement methods, the designers consider that there had been a slight decline in the levels of service being requested over the past fifteen years but only the decline for the traditional method – at around 7% – was considered statistically significant.

When comparing the results for this section it is apparent that the time available to carry out the level of service required has declined significantly over the past fifteen years, while the level of service required has itself, only declined slightly by comparison. It is this disparity that the authors believe may well be a major contributing factor in the perceived decline in the quality of design and documentation. From this, it is reasonable to deduce that the main reason why the quality of design and documentation produced under the *traditional* procurement method is perceived to be greater than that produced under the other methods, is directly related to the extra time available to carry out the design and documentation function.

Further analysis showed almost perfect correlation between the decline in both the adequacy of time and in design and documentation quality, therefore if quality is to be improved, more time (person hours) or greater efficiency is required in the design and documentation process.

2.3 Changes in Levels of Design Fees

2.3.1 Overview

The changes in the level of project design fees over the past 15 years was addressed in the designers survey, with the designers asked to nominate the level of fees they considered necessary to provide a quality service, produce quality design and documentation and make a reasonable profit. Supplementary to this, they were also indicate the level of fees they believed were required to be submitted to clients to actually obtain the work.

To ensure that the results were truly representative, the designers were asked to provide their responses for projects of differing complexity levels and budget ranges. In addition to this, designers were asked to indicate whether the level of fees able to be obtained on projects, differed between public and private sector clients and if so, by what percentage.

Designers were asked what they perceive the impact that a reduction in overall design fees has on the quality of design and documentation produced. To determine the areas affected most, designers were asked to rate the level of effect that reduced design fees had on the listed attributes of design and documentation quality. They were also asked to consider various aspects of design service and to rate the extent to which each aspect had been fulfilled during each of the three specific time periods.

The overall results indicated that over the past 15 years, the overall fee levels *required* by a designer to provide a proper service, produce quality work and make a reasonable profit, remained fairly consistent, with an average decline of just 2.6%. However, when considering the fee levels required to be *submitted* to actually obtain the work, the results show that there has been a significant decline over the past fifteen years, averaging around 26.4%. These results were also fairly consistent across the different project budget ranges and levels of complexity, although it was noted that as projects became smaller and simpler, the decline in fee levels and difference between *required* fee levels and *submitted* fee levels, became greater.

When considering the differences in fee levels between *public* and *private* sector clients, a greater proportion of respondents considered that the level of fees able to be obtained from *public* sector clients was generally lower than those able to be obtained from *private* sector clients. Of those who considered that fee levels from the *public* sector were lower than from the *private* sector, the most common response given for the extent to which the fee levels differed was 20% lower, with the overall average being 15.85% lower.

According to designers reduced design fee levels has had a significantly detrimental effect on all of the design quality attributes, with the mean responses for all the issues above the midpoint. The attributes shown to be most affected were *innovation*; *provision of in-house and external training*; and *proper examination of design proposals*. Those with the lowest mean response and therefore considered to be least affected were *the extent of client involvement in the design process*; *functionality*; and site *compatibility*.

When considering the effects on *documentation* quality, again the mean responses for all the issues lie above the midpoint, indicating that designers perceive reduced design fee levels as having a significantly detrimental effect on all of the documentation quality attributes. The attributes affected most by reduced design fees were noted as being *completeness*, *certainty* and *final checking*, while *standardisation*, *relevance* and *timeliness* were considered to be the least affected. When comparing the results for both design and documentation it is evident

consultants believe reduced design fees had affected documentation attributes slightly more than design attributes.

When assessing the responses for the changes in levels of design service provided, the majority of the design service issues showed a decline over the past 15 years, although the overall mean result actually showed an increase in the extent of design services. This overall result was however clearly influenced by the results for the design service issues relating to *using CAD for the production of drawings* and *using information technology to improve project communications*, both of which have shown dramatic increases due to the rapid growth of computerisation and information technology (IT) during this period.

If these two issues were excluded from the analysis, the overall change in level of service provided shows a statistically significant decline over time. Apart from the two IT related issues, the design service issue relating to *obtaining of clearances from statutory bodies, prior to commencement on site*, showed the greatest improvement over time. Showing the greatest decline however was the design service issue relating to *providing complete and accurate documentation and design detailing*, which is consistent with the results shown in other sections of the survey.

2.3.2 Fee Levels

This section of the designers survey was designed to look specifically at the changes to the levels of project design fees over the past 15 years. Designers were asked to nominate not only the level of fees they considered necessary to provide a quality service, produce quality design and documentation and make a reasonable profit, but also indicate the level of fees they believed were required to be submitted to clients to actually obtain the work. This question required respondents to provide an estimate of project fee levels (expressed as a percentage of project costs) for a range of project budget levels (from *$0-1M* to *$100+*) and complexity levels (*simple*, *conventional* and *complex*), at three time periods over the past 15 years. The analysis of this data would not only enable the differences between *required* and *submitted* fees to be assessed for each budget and complexity level at each time period, but also to identify any trends that had occurred over the past 15 years. In addition, the analysis would also determine what impact the project's level of complexity had on influencing the level of fees obtained.

The following chart (Figure 2.35) looks at the overall responses to the question and summarises the differences between the design fee levels *required* to provide the level of design service needed and the fee levels which are *submitted* to obtain the work.

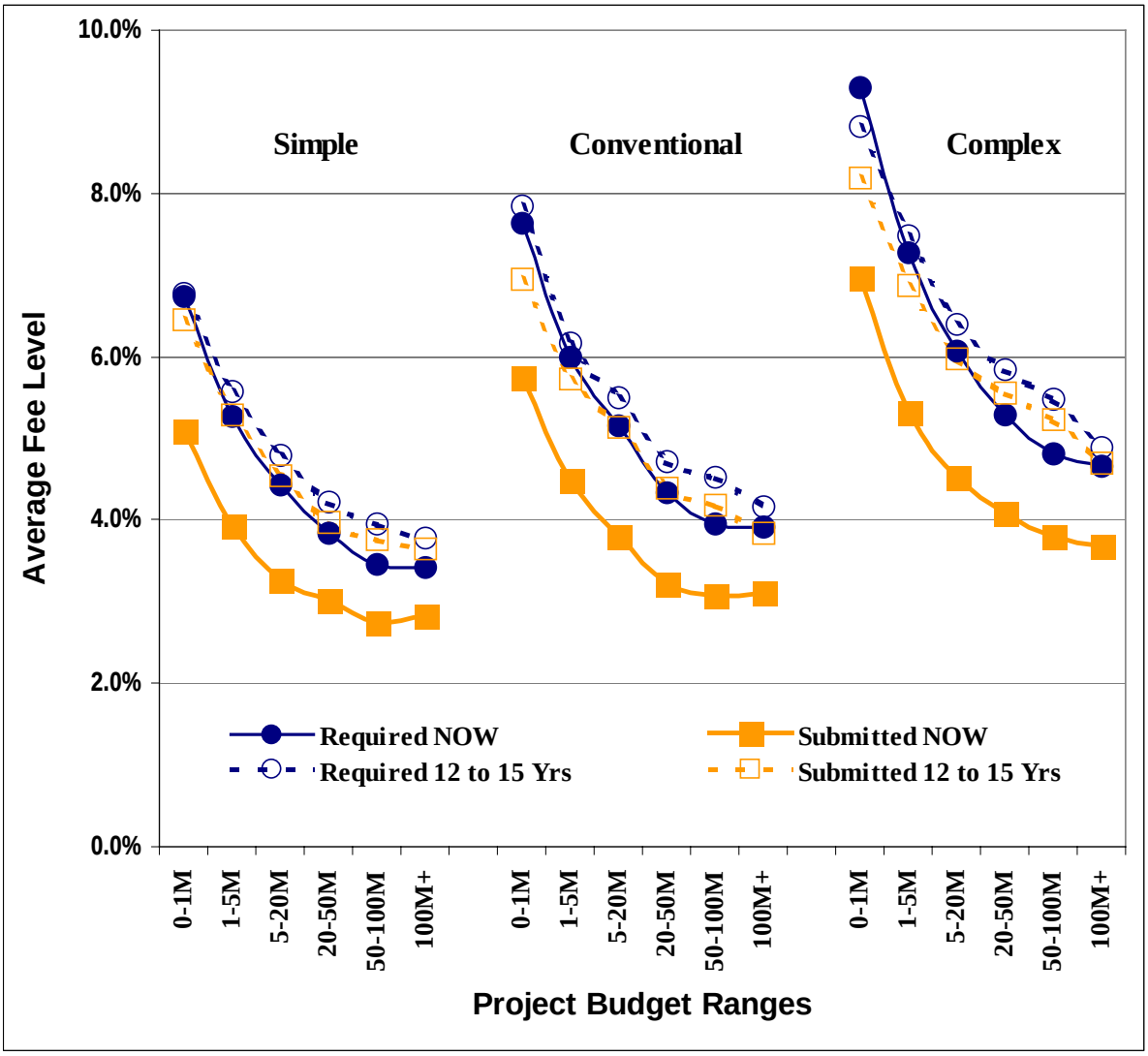

Figure 2.35 Difference in level of design fees required to be submitted

As can be seen in Figure 2.35, the *required* and *submitted* percentage fee levels decay exponentially, depending on the budgeted project value, to an overall minimum rate. The chart also shows that as the projects become more complex, the percentage rates for corresponding project budget ranges also increase. However, for each of the different project complexity levels, the rates of decay are similar.

Overall, the results indicate that while the *required* percentage fee levels have only declined marginally between each time period and for each level of project complexity, the percentage fee levels *submitted* to obtain the work have significantly declined over the past fifteen years – for all project budget ranges and levels of complexity. While the decline in the *required* fee levels may be due in part to the increased use of technology, which would compliment other areas of improved efficiency, increased competition and client fee bidding practices would appear to be influencing the decline in *submitted* fee levels.

When considering the current time frame, simple and conventional project types with project values ranging from $5M to $20M showed the greatest disparity between *required* fee levels and *submitted* fee levels. On average however, the fee levels currently being *submitted* are over 32% (32.32%) below the fee levels considered necessary by designers, to provide a quality service.

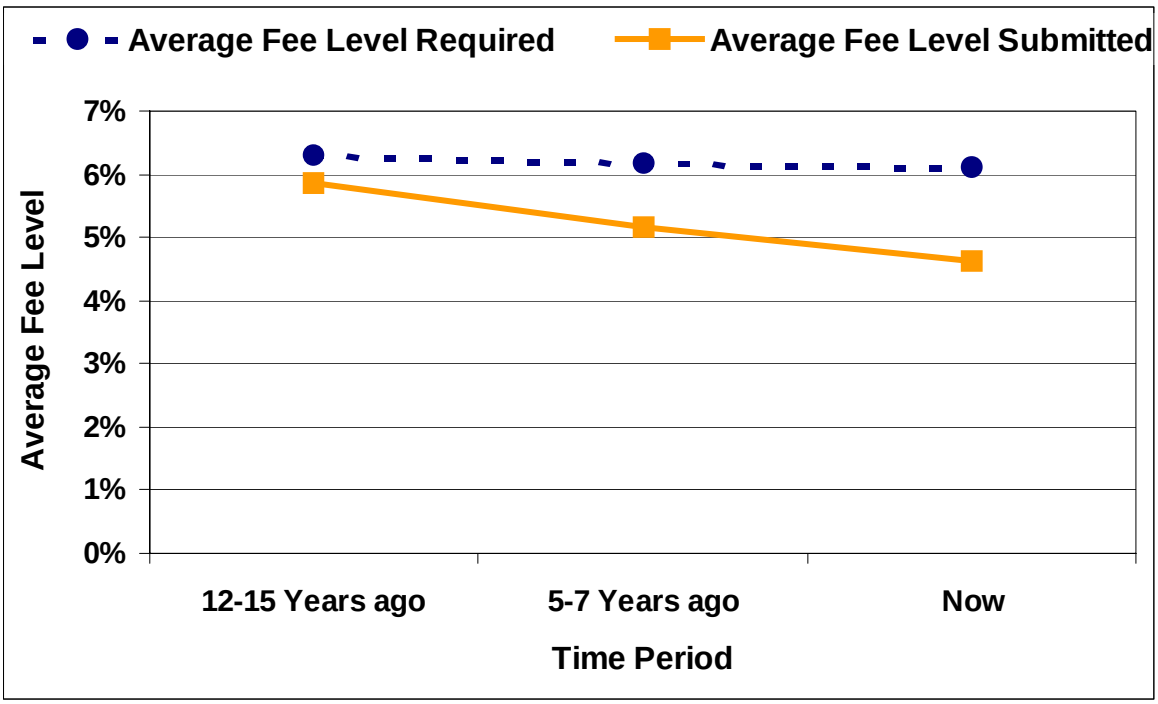

Figure 2.36 Overall decline in design fee level

The overall results indicated that over the past 15 years, the overall fee levels *required* by a designer to provide a proper service, produce quality work and make a reasonable profit, remained fairly consistent, with an average decline of just 2.6%. However, when considering the fee levels required to be *submitted* to actually obtain the work, the results show that there has been a significant decline over the past fifteen years, averaging around 26.4%. These results were also fairly consistent across the different project budget ranges and levels of complexity, although it was noted that as projects became smaller and simpler, the decline in fee levels and difference between *required* fee levels and *submitted* fee levels, became greater.

By performing a regression analysis of the fee level submitted, we can determine if there has been a linear relationship in the fee level submitted 12 – 15 years ago and the current level of fees. The result supports the statement above that the average decline in fee level submitted has been 26.4% and revealed that the decline was marginally greater in the period 12 – 15 years to 5 – 7 years ago.

2.3.3 Comparison of Designer Fee Levels Between Public and Private Sector Clients

Respondents were also asked to consider whether or not the level of fees able to be obtained from *public* sector clients were generally higher, lower or the same as those able to be obtained from *private* sector clients. Those respondents who indicated either *higher* or *lower* were asked to consider to what extent (expressed as a percentage) the level of fees able to be obtained from *public* sector clients were *higher* or *lower* than those able to be obtained from *private* sector clients.

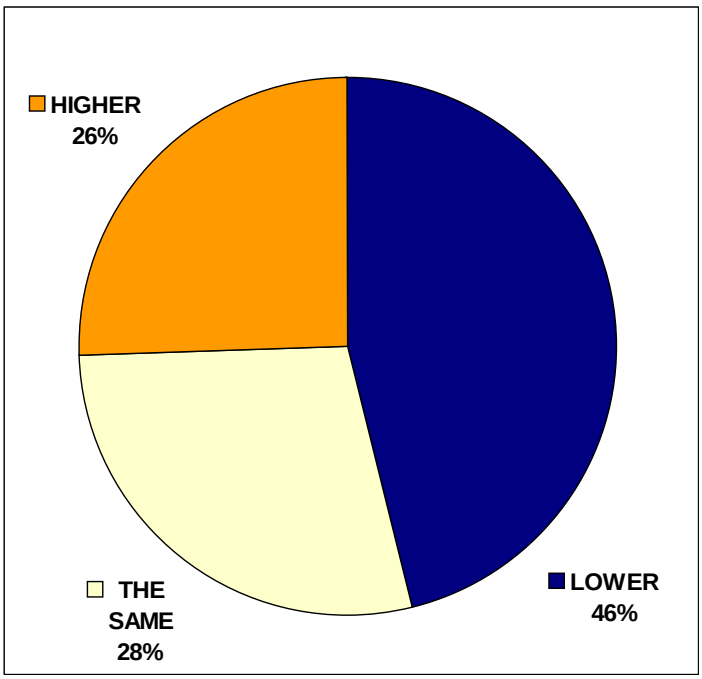

Figure 2.37 Level of fees obtained from public versus private sector clients

Figure 2.37 shows that overall, a greater proportion of designers (46%) consider that the level of fees able to be obtained from *public* sector clients was generally lower than for *private* sector clients. While there was a large variation between the responses given, the most common response from those respondents who indicated that the fee levels from *public* sector clients were *higher* than those available from the *private* sector was 20% - with the overall average coming to just under 13% (12.97%). For those respondents who indicated that the fee levels from *public* sector clients were *lower* than those available from the *private* sector, the most common response was again 20% - with the overall average coming to just under 16% (15.85%). When all responses are assessed together, the results indicate that the fee levels from *public* sector clients were – on average – *lower* than those available from the *private* sector, by just under 6% (5.80%).

2.3.4 Effect of Reduced Fees on Attributes of Design and Documentation

Additionally to determining the changes in the levels of design fees, the survey assessed the perceived effects that a reduction in overall design fees has on the quality of design and documentation produced. To determine the areas affected most, designers were asked to rate the level of effect that reduced design fees had on a number of attributes of design and documentation quality – the same as those listed in Table 2.1 and Table 2.3. The rating scale used for this question ranged from 0 (*no detrimental effect*) to 10 (*highly detrimental effect*).

When considering the effects on *design* quality, the mean responses for all the issues lie above the midpoint, indicating that designers perceive reduced design fee levels as having a significantly detrimental effect on all of the design quality attributes. However, the results show that the attributes of design quality affected most by reduced design fee levels, were:

- *innovation*;
- *provision of in-house and external training*; and
- *proper examination of design proposals*.

The results also show that the attributes of design quality affected least, were:

- *extent of client involvement in the design process*;
- *functionality*; and

- *site compatibility*.

These results also provide much concern for the future, in so far as where innovation is stifled and training does not occur, there is a potential for the design professions to stagnate due to a lack of growth and development. When considering the effects on *documentation* quality, the results show that the attributes of documentation quality affected most by reduced design fee levels, were:

- *completeness*;
- *certainty*; and
- *coordination*.

The results also show that the attributes of documentation quality affected least, were:

- *standardisation*;
- *relevance*; and
- *timeliness*.

Again all the results lie above the midpoint, depicting reduced design fees as having a highly detrimental effect on all documentation quality attributes. When comparing the results for design and documentation it is evident that reduced design fees had affected documentation quality attributes slightly more than design quality attributes.

2.3.5 Changes in Levels of Service Provided

Designers were asked consider various aspects of design service and to rate the extent to which each aspect had been fulfilled during each of the three specific time periods. This section surveyed issues listed in Table 2.11. The rating scale for this question ranged from 0 (*Not done at all*) to 10 (*Carried out completely*). Apart from being able to identify problem areas relating to specific design service issues, it also provided an opportunity to compare the overall design service results with those provided in their response to the level of design and documentation service requested by clients as disclosed earlier.

Table 2.11 Design service attributes

Design Service Attributes
a) Coordinating design details from various other consultants
b) Investigating alternative designs and comparative cost analyses
c) Providing practical design detailing and construction methods
d) Providing complete and accurate documentation and design detailing
e) Being involved in the production and development of the design brief
f) Checking that dimensions are correct and appropriate
g) Ensuring that trade specifications are both appropriate and up-to-date
h) Ensuring the availability and compatibility of proposed building materials
i) Maintaining a thorough knowledge of local by-laws and BCA requirements
j) Maintaining a thorough knowledge and understanding of the latest construction methods
k) Using CAD for the production of drawings
l) Using information technology to improve project communications and assist with document transfer
m) Obtaining of clearances from statutory bodies, prior to commencement on site.
n) Other (specify):

The majority of the design service issues showed a decline in the extent to which they were fulfilled, over the past 15 years. However, despite this the overall mean result for all issues, actually showed an increase in the extent of design services. This apparent anomaly was due to the dramatic increases in the following two design service issues:

- *using CAD for the production of drawings*; and
- *using information technology to improve project communications*.

The tremendous growth in both of these issues has obviously been influenced by the rapid growth of computerisation and information technology (IT) during this period. However, if these two issues are excluded from the analysis, the overall change in level of design services provided shows a statistically significant decline over time, which is more consistent with the results shown earlier.

Apart from the two IT related issues, the only other design service showing any significant improvement over the past 15 years, was:

- *obtaining of clearances from statutory bodies, prior to commencement on site*.

The design service issues showing the greatest level of decline over the past 15 years however, were:

- *providing complete and accurate documentation and design detailing*;
- *checking that dimensions are correct and appropriate*; and
- *coordinating design details from various other consultants*.

These results are consistent with the results shown in other sections of the survey and indicate that there is a growing problem with the documentation being produced for construction projects.

2.4 Construction Process Efficiency

2.4.1 Overview

In an effort to try to quantify the extent to which design and documentation deficiency affects the efficiency of the construction process a number of questions were presented to the contractors. The questions were formulated to determine the impact that different levels of design and documentation quality have on project time and cost estimates, at tender stage.

Having determined this, the respondents are then asked to consider a number of undesirable elements of construction and determine:

- what proportion are as a direct result of design and documentation deficiencies;
- to what extent have their occurrences changed over the past 15 years; and
- to what extent has the administrative time and cost required to deal with them, changed over the past 15 years.

Designers were also asked to consider a number of issues that have been proposed as being indicators of design and documentation quality and indicate whether there had been an increase in the occurrence of each of these issues over the past fifteen years.

The nature and extent of the impact of design and documentation deficiencies on construction process efficiency indicators are clear – additional project cost and time. The results indicate that almost all contractors add an additional percentage margin to both the tender price submitted for a project and the time allowed to complete a project, to compensate for poor quality design and documentation. The extent of this additional allowance is generally determined by the perceived standard of design and documentation provided – the worse the quality standard, the greater the additional allowance. Based on the current average standard of design and documentation being rated between "*average*" and "*poor*", the respondents have indicated that an average additional allowance of between 2.5% and 7.2% is being added to both the submitted tender price and the time to complete for new projects.

When asked to consider a number of undesirable elements of construction on work currently being carried out, the respondents indicated that design and documentation deficiency was considered to be directly responsible for a high proportion of these problems. Requests for information (RFIs) and variations were particularly of note, but all areas identified contributed. When asked to consider how the extent of occurrence of these undesirable elements of construction had changed over the past 15 years, the contractors indicated an overall average increase of around 50% within that time period.

The designers had perceived an increase in the occurrence of the indicators of design and documentation quality. A majority of designers indicated there had been an increase in all indicators presented, with *drawing revisions* and *variations* heading the list. From the designer's responses and based on the premise that an increase in the occurrence of these issues represents a decline in quality standards, there is agreement that quality standards have declined over the past 15 years.

Contractors also indicated that the managerial time and cost expended on these problem areas has also increased over the same time period. When asked to consider both the managerial and/or administrative time and cost expended on each problem area, the contractor's responses indicated an increase of more than 100% in both time and cost to look after these issues over the past 15 years.

2.4.2 The Nature and Extent of the Impact of Design and Documentation Deficiency

Contractors were asked to indicate whether the quality of design and documentation supplied has an influence on the tender price submitted. As can be seen in Figure 2.38 below nearly all contractors (93%) have indicated that the standard of design and documentation has an influence on the price submitted. There was strong agreement across all associations.

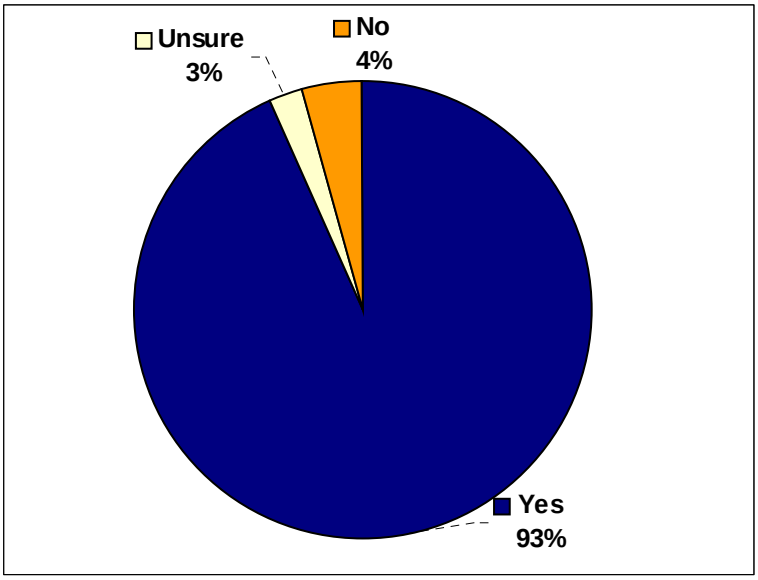

Figure 2.38 Response for whether the quality of design and documentation influenced the tender price

Further, contractors were then asked to indicate to what degree the quality of design and documentation supplied influences the price submitted. The question provided contractors with five design and documentation standards ranging from very poor through to excellent. They were asked to indicate the percentage reduction or increase on the project tender price for specific standard.

Figure 2.39 illustrates that there was a considerable amount extra included in the tender price for a project dependent on the standard of design and documentation. Further analysis indicated that the quality of design and documentation had a greater impact on the tender prices submitted by trade contractors than by head contractors. Overall, *poor* quality design and documentation was costing clients and developers an average of 7% on the estimated project cost. Even when the standard of design and documentation was *good* an average of 0.3% was added to the tender price. This reflected a strong negative relationship between the standard of design and documentation and the price submitted for a project. As the quality of design and documentation declined the tender price increased. The correlation statistic was –0.76.

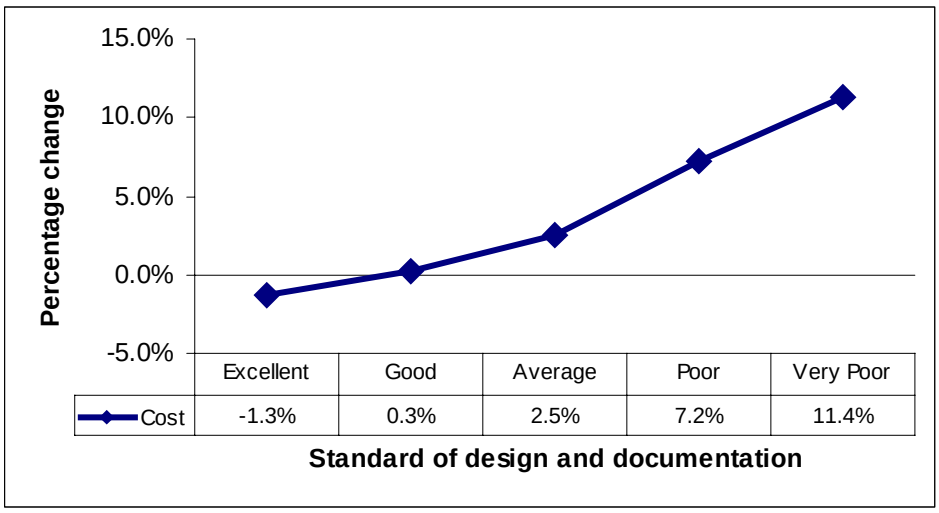

Figure 2.39 Change in tender price relative to the standard of design and documentation

Similarly, contractors were asked to indicate whether the quality of design and documentation supplied has an influence on the time allowed. Overall, 75% of respondents stated the quality of design and documentation influenced the time allowed to complete the project. When considering the individual organisations, 66% of the head contractors indicated they allowed extra time for the project based on the standard of design and documentation compared with 87% of subcontractors. This may indicate subcontractors feel the delays in the project due to design and documentation quality issues, may be of more consequence than the head contractors do.

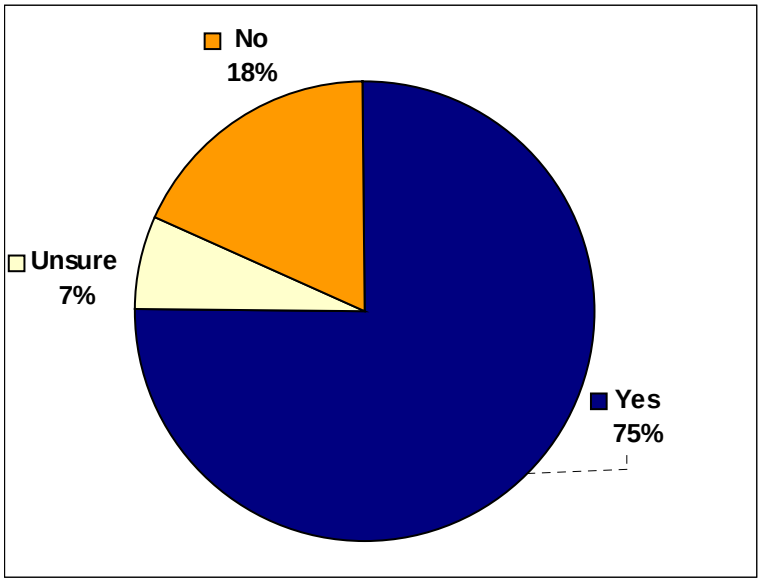

Figure 2.40 Response for whether the quality of design and documentation influenced the project time allowed

As with the issue of project cost, contractors were asked to indicate to what degree the quality of design and documentation supplied influenced the time allowed. The question provided contractors with five design and documentation standards as before and asks them to indicate the percentage reduction or increase on the project time for specific standard.

There were respondents that indicated the standard of design and documentation did not influence the time allocated to complete the project therefore the results for this question are

based on a smaller number of respondents than was the case for the project tender price. There were however still 229 respondents. The results here are equally valid and are similar to the results for the previous question.

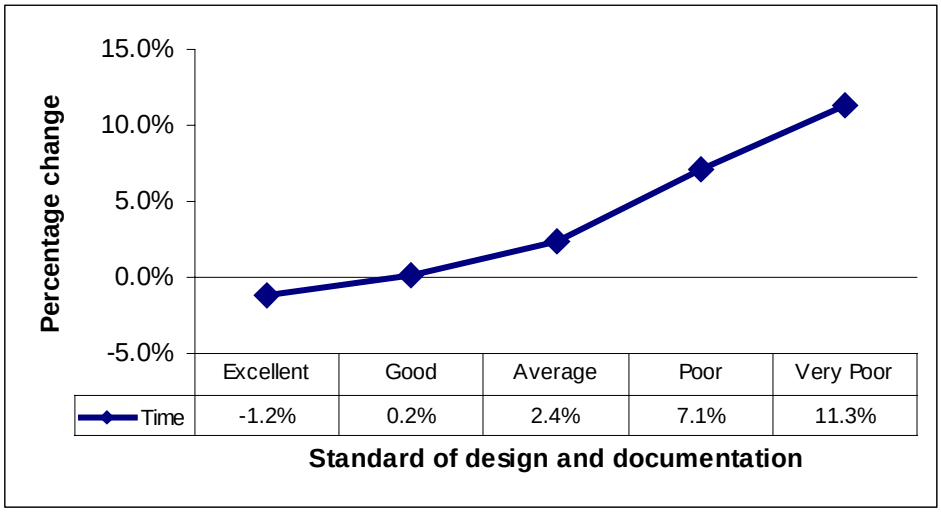

Figure 2.41 Change in project time allowed relative to the standard of design and documentation

As was the case for the tender price, the project duration is affected by the quality of design and documentation. Figure 2.41 is almost identical to Figure 2.39 displaying a strong negative relationship between the standard of design and documentation and the time allowed for a project. As the standard of design and documentation declined the time allowed for a project increased. The correlation statistic here was – 0.73. Given that a higher proportion of trade contractors indicated they added extra time to the project duration based on the quality of design and documentation, further analysis was carried out. Again, it showed that the quality of design and documentation has a greater impact on the project time allowances included by trade contractors than by head contractors.

A correlation analysis of the percentage change in the price submitted and the time allowed for a project given the standard of design and documentation re enforced the strong relationship apparent in Figure 2.39 and Figure 2.41. The correlation statistic is 0.87, which is a strong positive relationship.

2.4.3 Indicators of Design and Documentation Quality and Construction Process Efficiency

A number of issues that have previously been proposed as being indicators of design and documentation quality were listed in the designers' survey document. The premise for these questions was that the occurrence of these issues highlight a deficiency in the design and documentation produced and that an increase in these issues over time, represents a decline in quality standards over that same period. A list of the proposed indicators is shown in Table 2.12.

Table 2.12 Indicators of design and documentation quality

Indicators of Design and Documentation Quality
a) Number of additional (new) drawings required during a project
b) Number of drawing revisions
c) Extent of contractual claims
d) Number of contract variations
e) Number of contractor RFIs requesting design clarifications
f) The extent of rework caused by design and documentation deficiencies
g) The extent of building component clashes, due to insufficient coordination

Similarly, a number of issues that have previously been proposed as being indicators of construction process efficiency were listed in the contractors survey document. The contractors were asked if there had been an increase in the occurrence of what were termed *non-desirable elements of construction*. They were also asked to indicate what proportion of the occurrences were due to poor design and documentation quality and to indicate the impact on managerial cost and time of these issues. A list of the indicators is shown in Table 2.13.

Table 2.13 Non-desirable elements of construction

Non-desirable Elements of Construction
a) Rework
b) Programme delays
c) Extensions of time
d) Cost overruns
e) Variations
f) Contractual disputes
g) Requests for information (RFIs)

As mentioned, contractors were asked to indicate the level of occurrence for the issues listed in Table 2.13 for specific time periods. The rating scale for this question was 0 indicating no occurrence through to 10 denoting extremely excessive occurrence of design and documentation deficiency issues effecting construction process efficiency.

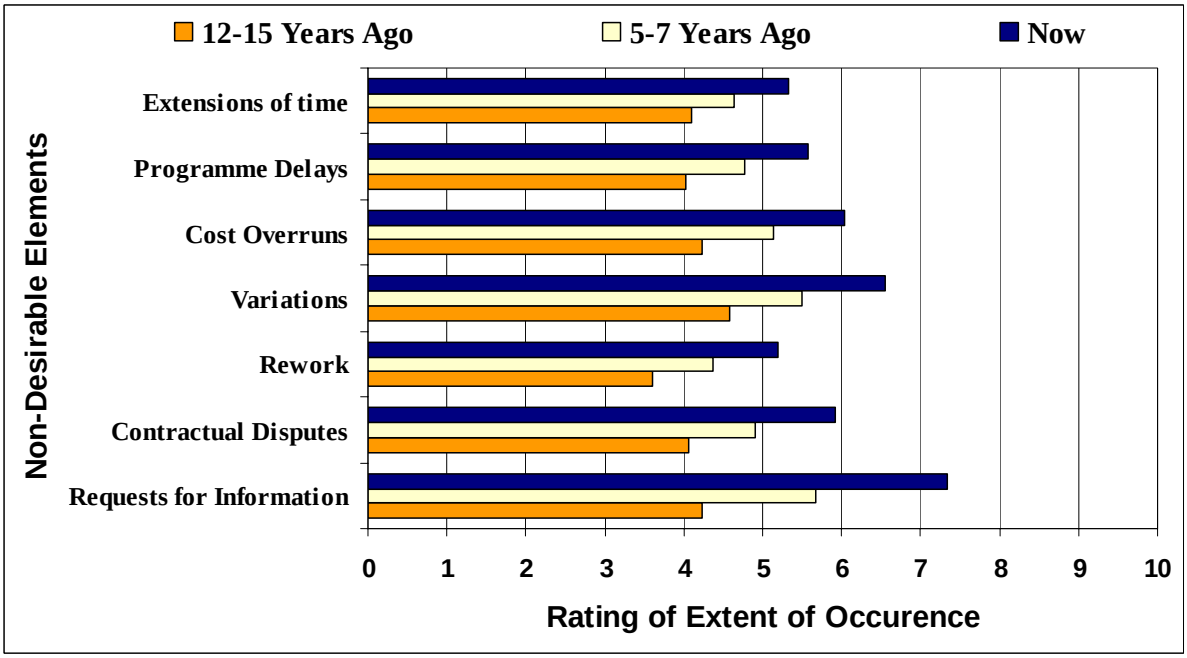

Figure 2.42 Changes in the extent of occurrence of *non-desirable elements of construction* over the past 15 years

As is evident in Figure 2.42 above, contractors believe that the extent of occurrence of each of the non-desirable elements listed, has increased substantially over the past 15 years. The percentage increases in the extent of occurrences, range from 30.4% (*extensions of time*) to 73.7% (*requests for information*) over this period, with *requests for information* also currently rating the highest level of occurrence overall at 7.3 – a rating that contractors consider to be very excessive. Whilst the extent of these non-desirable elements may have been reasonably controllable 15 years ago, the substantial and continuing increase in their extent of occurrence must surely be impacting heavily on the efficiency of the construction process on a majority of new projects, across the industry.

Designers were asked to indicate whether in their experience, there had been an increase in the occurrence of each of the issues listed in Table 2.12 over the past fifteen years. As can be seen in Figure 2.43 below, the majority of designers (between 55% and 67%) believe that there has been an increase in each of the indicators representing deficiencies in design and documentation quality, over the past 15 years. However, while 22% to 32% of respondents indicated there had not been an increase in the occurrence of the various issues, between 9% and 18% of respondents were unsure.

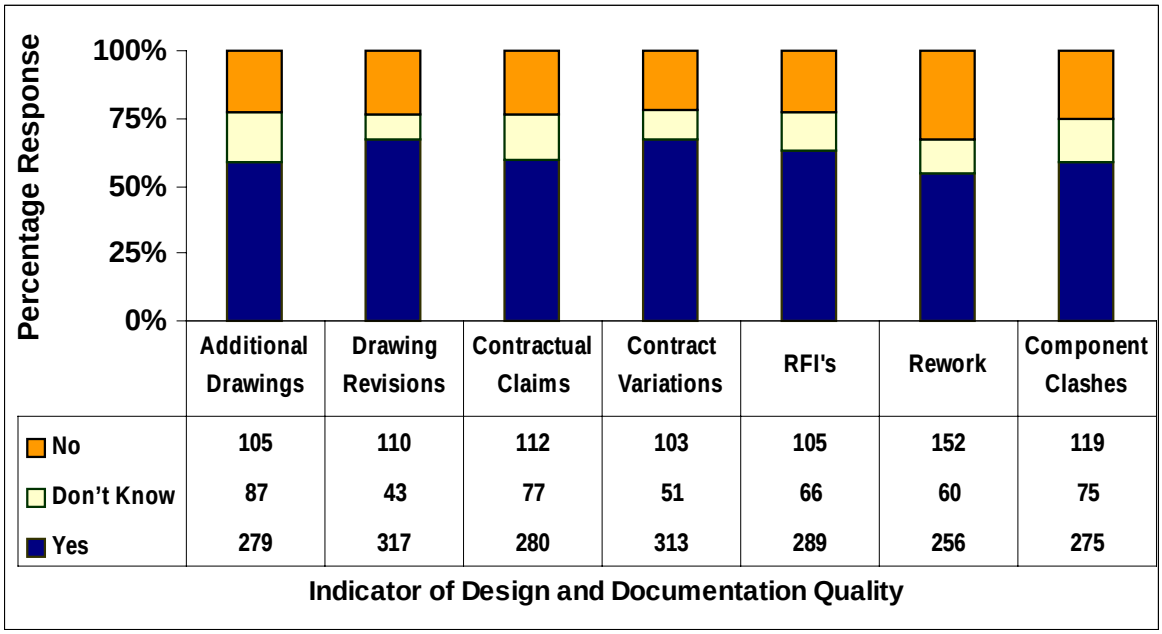

Figure 2.43 Changes in the occurrence of indicators of design and documentation quality

The responses indicate that there have been significant increases in the extent of occurrence of these issues in the past 15 years. These increases point to a deficiency in the design and documentation produced suggesting a decline in quality standards over that same period. Comparing the responses we can see that both designers and contractors agree there has been an increase in the extent of rework and the number of RFIs and variations in the past 15 years.

Supplimenting this information, contractors were required to state what proportion of the total amount / value of the specified construction inefficiency indicators generally achieved on a project is considered to be as a direct result from design and documentation deficiencies.

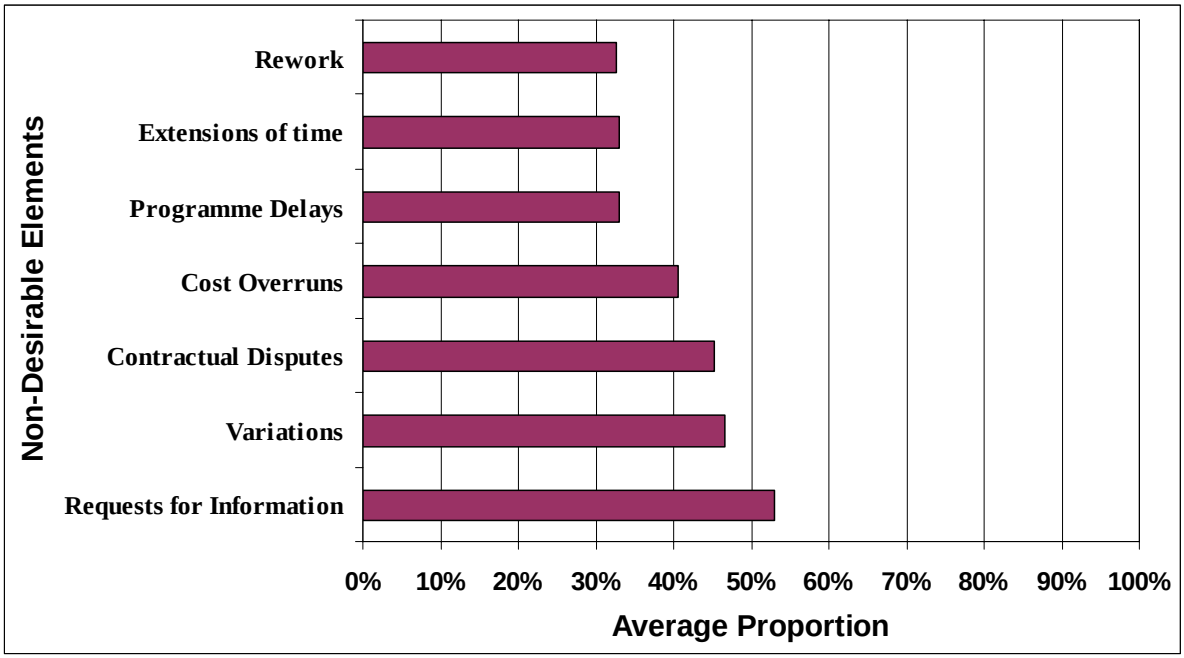

Figure 2.44 The average proportion of *non-desirable elements of construction* resulting from design and documentation deficiency.

The question specified the construction efficiency indicators listed in Table 2.13. In Figure 2.44 the mean response from the contractors for each issue is displayed. As can be seen when there is a request for information, variation, cost over run or contract dispute contractors believed it was due to design and documentation deficiencies more than 40% of the time, with *RFI's* approaching 50%. According to contractors, other issues were due to design and documentation deficiency just under 40% of the time. From these results, it would seem that design and documentation deficiency is causing a high proportion of the now considerable problems.

Contractors were asked to consider how the extent of the managerial or administrative time and cost needed to manage these non-desirable elements of construction, has changed over the past 12 to 15 years. To measure this change, contractors were asked to select the percentage range – from *0 - 1%* to *+20%* – that represents the estimated amount of both administrative time and cost expended at three different time periods, managing each of the non-desirable elements listed.

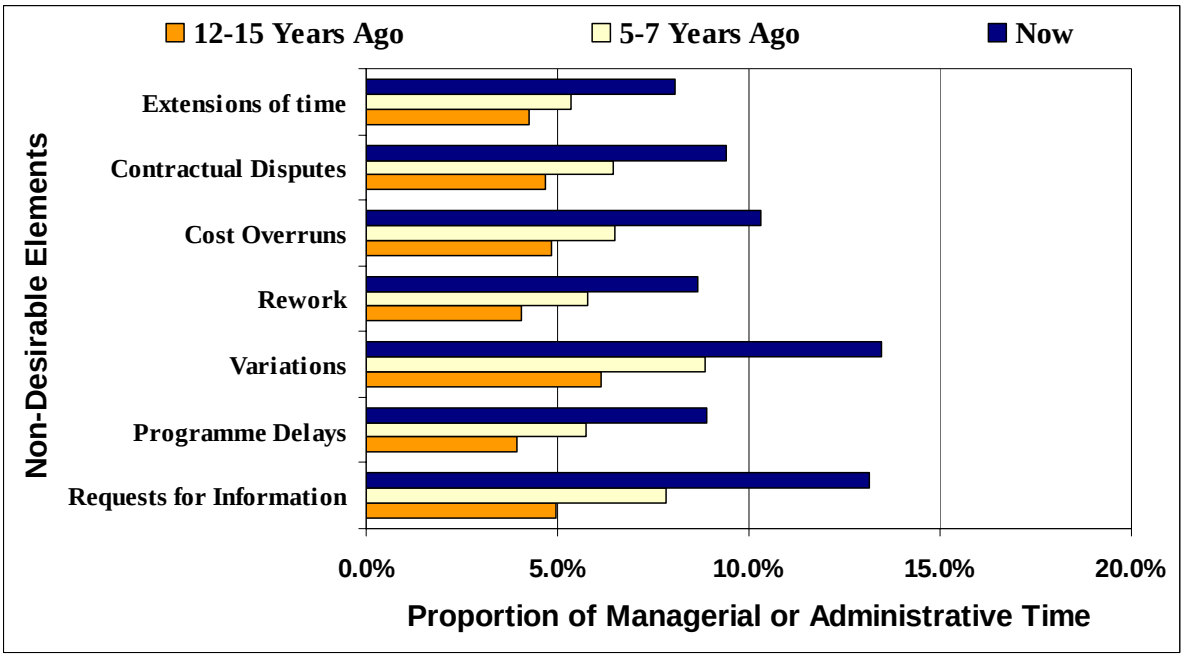

Figure 2.45 Percentage of managerial/administrative time consumed by *non-desirable elements of construction*.

As can clearly be seen in Figure 2.45, the total amount of managerial or administrative time spent on each of the non-desirable elements, has increased dramatically over the past 12 to 15 years. Based on the contractors' responses, the time spent looking after *extensions of time* has increased by an average of 89.3%, while the time spent on *requests for information* has increased by an average of 164.5%. Although *requests for information* have shown the greatest increase over the time period, *variations* now take up the most time, using up 13.5% of all managerial or administrative time allowed on a project.

When all the elements listed are considered together, the results indicate that the amount of time needed to effectively look after them all, 12 to 15 years ago, added to only approximately one third (32.9%) of the total amount of managerial or administrative time allowed on a project. Now however, the contractors have indicated that the time required to look after the same elements, requires over two thirds (72.0%) of all managerial or administrative time – an increase of 119.1%.

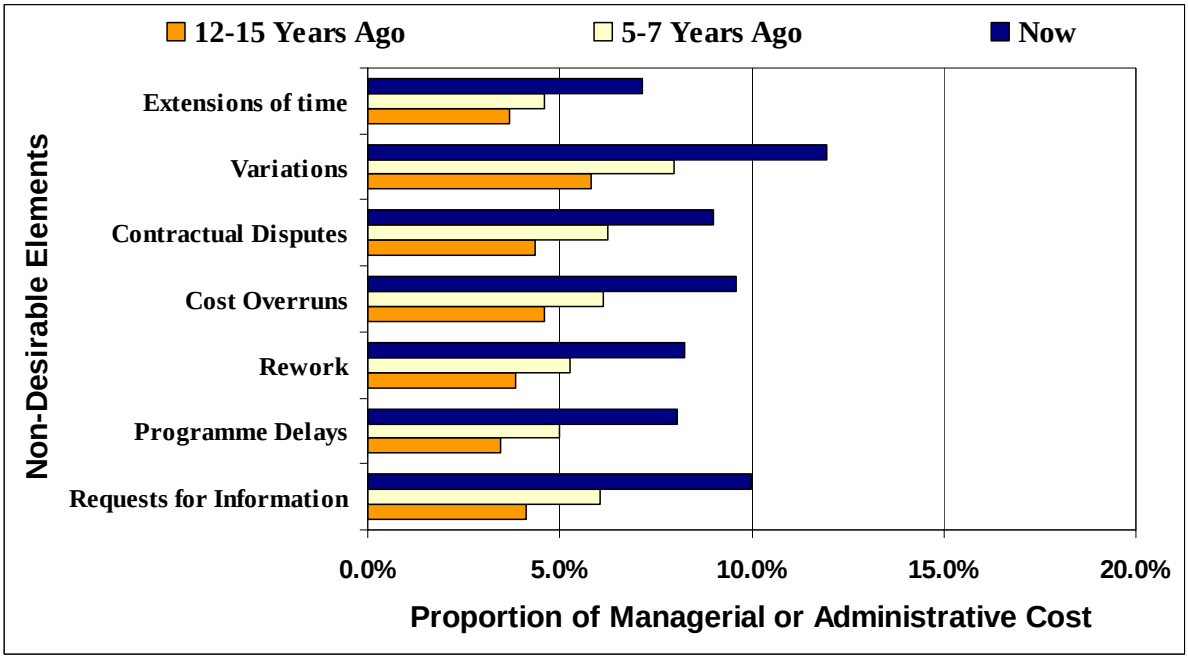

Figure 2.46 Percentage of managerial/administrative cost consumed by *non-desirable elements of construction*.

Figure 2.46 shows a similar trend as Figure 2.45 in that it shows a dramatic increase in the managerial or administrative *cost* expended in managing the non-desirable elements of construction listed. While the results indicated that *extensions of time* showed the least *cost* increase, the extent of that increase was still 93.0% over the 12 to 15 year time period. As was the case in relation to *time, requests for information* have also shown the greatest increase in cost (143.0%), over the time period. Similarly, *variations* now also consume the greatest proportion of managerial or administrative cost, using up an average of 11.9% of the project allowance.

Once again, when all the elements listed are considered together, the results show an overall increase of 114.0% in managerial or administrative cost expended on these elements, from their levels 12 – 15 years ago. From a previous overall average of 29.9%, the proportion of total managerial or administrative cost required to look after these elements has now increased to a total of 63.9% of the total project allowance.

Looking at the relationship between the proportions of both managerial time and cost allowed, it is clear from Figure 2.45 and Figure 2.46, that the correlation is high. The correlation statistic between both time and cost for each of the specific time periods, came to 0.80, which represents a very strong positive relationship. The correlation statistic between the responses for a specific time period and the responses for the previous time period, is also high for both time and cost issues, with a correlation statistic of approximately 0.75 for each period. This indicates the increases have been consistent for all elements across each time period.

In Figure 2.47, a comparison between the total change in managerial or administrative time and cost due to all the non-desirable elements of construction listed is shown. This chart clearly shows that the rate of increase over the last period has been significantly greater than it was over the first period, for both issues. Due to the continuing increase in the proportion of managerial or administrative time and cost required to manage these non-desirable elements of construction, it is expected that contractors will need to look seriously at increasing their allowances, to ensure that all the elements are managed effectively. As is to be expected, these additional costs will be passed on to the clients by way of increased tender bids.

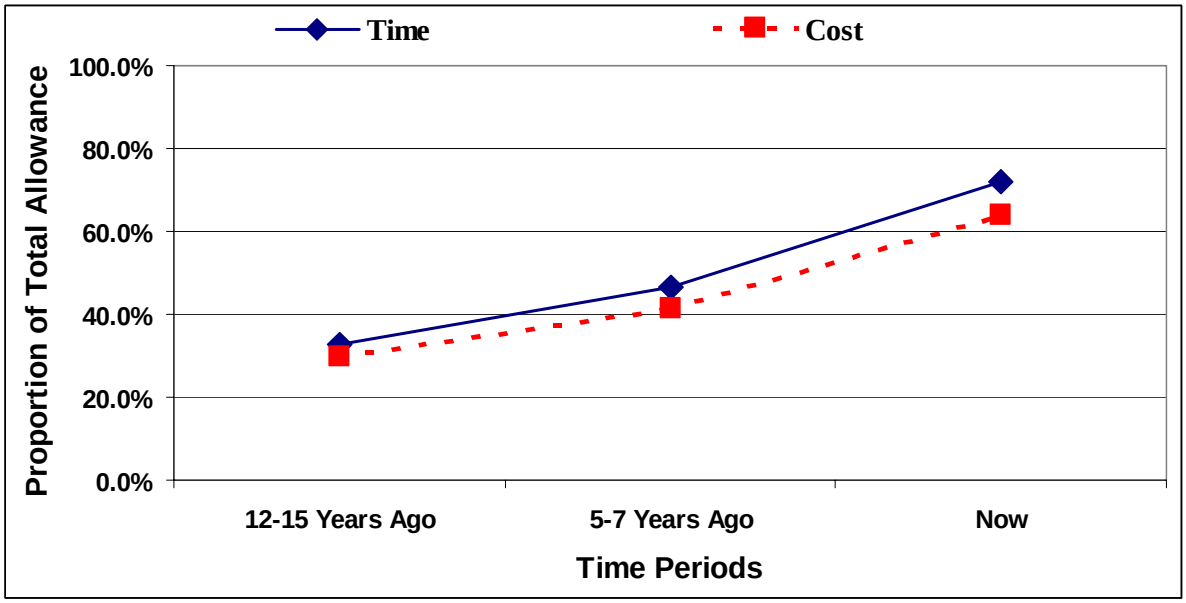

Figure 2.47 Comparison of the changes in the proportion of managerial or administrative *time* and *cost* used in managing *non-desirable elements of construction.*

2.5 Other Changes in the Past 15 Years

2.5.1 Overview

The designers were asked to consider a number of statements relating to changes to the construction industry over the past 15 years and to provide an indication of how those industry changes may have affected design and documentation quality. Respondents were asked to provide both their level of agreement in relation to each statement and their perception as to the level of effect that those changes have had on the quality of design and documentation produced.

From the responses received, the statements receiving the greatest overall level of agreement included; that *clients tend to 'shop around' more for design services*, *economic conditions have tightened* and that *there has been an increase in the likelihood of legal action*. However, when considering the statements in relation to their affect on the design and documentation process, the issues having the greatest detrimental effect on quality included; *the design function has been down-graded/de-valued from a client perspective*, *economic conditions have tightened* and that *clients tend to 'shop around' more for design services*. As can be seen, there is a strong correlation between the issues receiving the highest level of agreement and those having the greatest detrimental effect on design and documentation quality.

Although the only statement to which the majority of designers actually disagreed with as a whole, was that; *quality assurance requirements have helped improve the efficiency of those firms that have adopted it*, when considering its impact on design and documentation quality, designers did indicate that quality assurance did have a slightly beneficial effect. While there was not total agreement among designers with regard to the technological issues, consultants generally agreed that the advances in computer and information technology, have had a beneficial effect on design and documentation quality.

2.5.2 Other Changes in the Past 15 Years

The designers were asked to consider a number of statements relating to changes that had previously been identified as having occurred in the construction industry over the past 15 years and to provide an indication of how those industry changes may have affected design and documentation quality. Respondents were asked to provide not only their level of agreement in relation to each statement relating to those changes, but also to determine the level of effect that those changes have had on the quality of design and documentation produced. The level of agreement was rated on a five point scale, ranging from strongly disagree to strongly agree while the level of effect was also measured on a five point scale, ranging from highly detrimental effect to highly beneficial effect. The issues raised are those listed in Table 2.14 below.

Table 2.14 Issues pertaining to other changes in the past 15 years

Statements Relating to Industry Changes Over the Past 15 Years
a) There has been an increase in the likelihood of legal action
b) Clients 'shop around' more for design services
c) Economic conditions have tightened
d) Quantity Surveying standards have declined
e) There has been a change in the attitude to 'copyright'
f) More practices have become nationally focused
g) Professional relationships and trust have come under threat
h) Interstate and international competition has increased
i) Stricter trade practice requirements have been implemented
j) There has been a decline in the level of 'in-house' training within design firms
k) Changes to the state purchasing policy have affected the way business is obtained
l) There has been a increased difficulty in getting paid by clients
m) The design function has been de-valued from a clients perspective
n) Advances in computer software have helped improve the level of service able to be provided
o) The introduction of CAD has improved the efficiency of the design and documentation process
p) Quality Assurance requirements have helped improve the efficiency of those firms that have adopted it
q) Implementation of Information Technology has improved communication within the industry

Based on the responses received, the industry changes receiving the greatest level of agreement, were:

- clients tend to *shop around* more for design services;
- economic conditions have tightened; and
- there has been an increase in the likelihood of legal action.

The industry changes receiving the least level of agreement, were:

- quality Assurance requirements have helped improve the efficiency of those firms that have adopted it;
- quantity Surveying standards have declined; and
- the introduction of CAD has improved the efficiency of the design and documentation process.

The industry changes causing the greatest level of detriment to design and documentation quality according to designers were:

- the design function has been down-graded/de-valued from a clients perspective;
- economic conditions have tightened; and
- there has been a decline in the level of in-house training within design firms.

The industry changes providing the greatest level of benefit to design and documentation quality, were:

- advances in computer software have helped improve the level of service able to be provided;
- the implementation of Information Technology has improved communication within the industry; and
- the introduction of CAD has improved the efficiency of the design and documentation process.

As is evident from the results, there is a strong positive correlation between both the level of *agreement* and the level of *effect* and that when the level of *effect* is at the extremes the level of *agreement* is quite strong and visas versa

2.6 Organisational Profile

2.6.1 Overview

Both surveys specifically included the 'Organisational Profile' section to try to obtain some additional data relative to the organisations in which the respondents work. This data is expected to be valuable in trying to determine additional trends in relation to the previous sections.

Of the design firms who responded to the survey, over 65% have been in business for more than eleven years while the most common size of firms were those employing only between two to five people (approximately 33%), with more than half employing over five people. When considering the extent of fees obtained under the different procurement systems, although almost all respondents indicated that they carry out some work under the *traditional* procurement method, just over half indicated they carried out work using *design and construct*, while just under half were involved in projects using some form of *management* procurement methodology.

While 60% of the contractor firms who replied to the survey have been in business in their state for over 15 years, with just 7% having only been in operation for 5 years or less. As for the contractor respondents themselves, nearly 90% have worked in the construction industry for 15 years or more ensuring the validity of the data obtained. Based on *staffing levels*, it can be seen that medium to large size companies figure prominently in the contractor organisations, with 38.1% having between in 16 and 50 employees and a further 31.1% having more than 50 employees.

In looking at *company turnover*, the contractor questionnaire also investigated the proportions shared by the different project delivery methods – *Traditional, Design and Construct* and *Management*. In all 89.0% of contractor respondent companies carry out work under the *traditional* method, 76.5% in *design and construct* and only 58.7% have projects using one of the *management* project delivery methods. The proportion of the contractors total turnover attributed to the *traditional* method (44.5%) is significantly greater than that produced under either the *design and construct* (30.5%) or the *management* (25.0%) project delivery methods.

Comparing the various market areas, the *government, heavy industrial* and *commercial* sectors, represent by far the most predominant areas of work for contractors, while the *residential* and *recreational* sectors were the least common work areas. The *traditional* method was the dominant project delivery method in all areas excluding *heavy industrial*, where *design and construct* had the highest proportion of turnover.

While all of the diverse market segments of the construction industry listed were adequately represented, *civil engineering, government* and *commercial* projects represented the greatest proportion of the designer income – although the greatest proportion of designers were involved in the *residential* sector. When considering the different payment options, the results indicated that just over half of design fee income was derived by lump sum fees, with nearly 30% based on a percentage of the construction value and the remainder mostly coming from hourly rates.

When asked to consider the level of quality assurance (QA) implementation by design firms, approximately 45% have or were implementing QA to ISO 9000 standards, approximately 20% did not utilise any form of QA, while around 33% of firms utilised their own in-house quality system. Correspondingly, approximately 63% of contractors either have a fully

implemented QA system or are in the process of attaining ISO 9000 accreditation. A further 29.7% of contractors utilise an "In House" QA system.

2.6.2 Years of Operation in Each State

Respondents were asked to indicate how long (in years) their organisations had been in operation in their state. As can be seen in Figure 2.48, over 65% of the designers organisations have been in business for at least eleven years, while just over 30% have been operating for less than ten years.

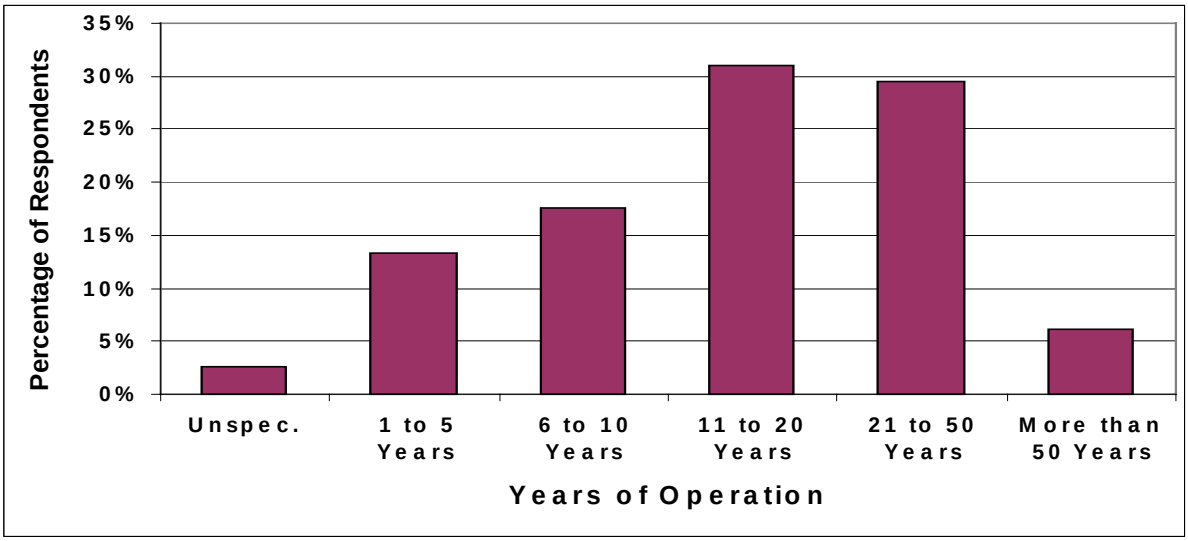

Figure 2.48 Number of years each organisation has been in operation – designers

Similarly, Figure 2.49 below shows that 59.9% of contractor organisations have been in business in their state for over 15 years, indicating that the majority of companies have been in operation over the time frame being investigated. This corresponds favourably with the profile of the contractor respondents themselves, of which 89.6% have worked in the construction industry for 15 years or more, further ensuring the validity of the data obtained in relation to the time based questions. Those contractor organisations that have been in operation for just 5 years or less represent only 7.3% of the respondent companies, whilst the proportion of companies that have been in operation for more than 50 years is just slightly higher at 8.5%.

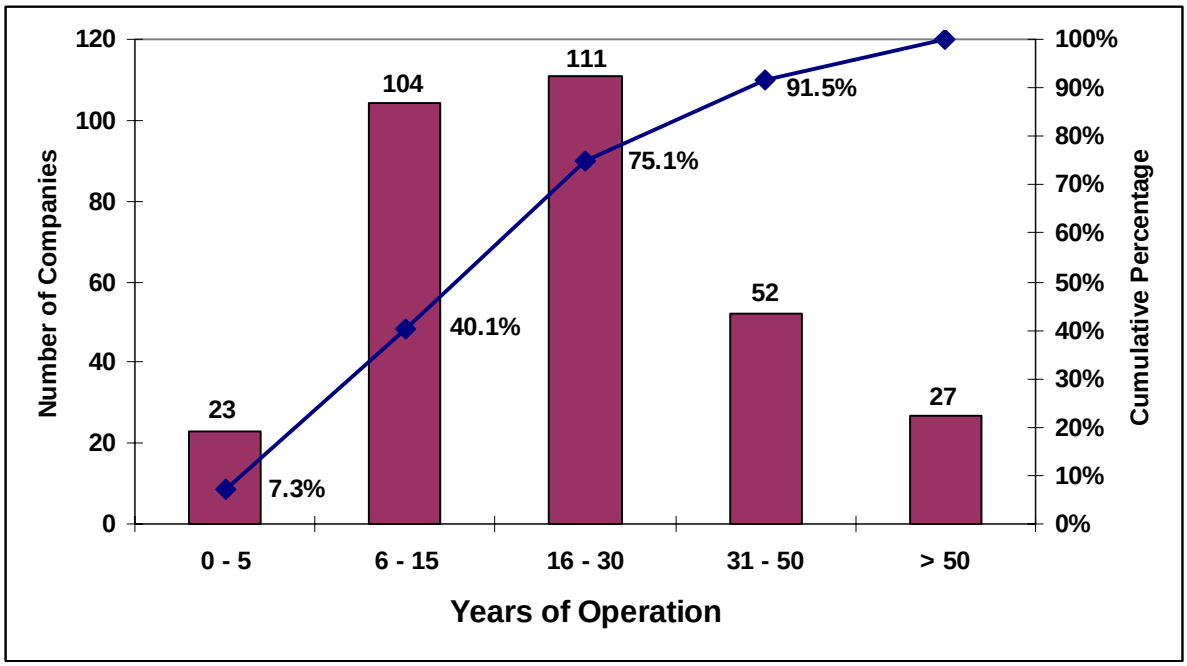

Figure 2.49 Number of years the respondents' organisations have been in operation – contractors

2.6.3 Number of Employees in Each State

Respondents were asked to indicate how many people their organisations employed in their state. As can be seen in Figure 2.50, although the survey responses have encompassed a wide range of organisational sizes, smaller firms were by far the most common with approximately one-third (34.2%) of all the designer organisations only having between two to five employees.

Figure 2.50 Number of people employed by each organisation

In Figure 2.51, below, we can see that medium to large size companies figure prominently in the contractor respondent organisations, with 38.1% having between in 16 and 50 employees and a further 31.1% having more than 50 employees. Those organisations that have just 5 employees or less represent only 7.6% of all the contractor companies.

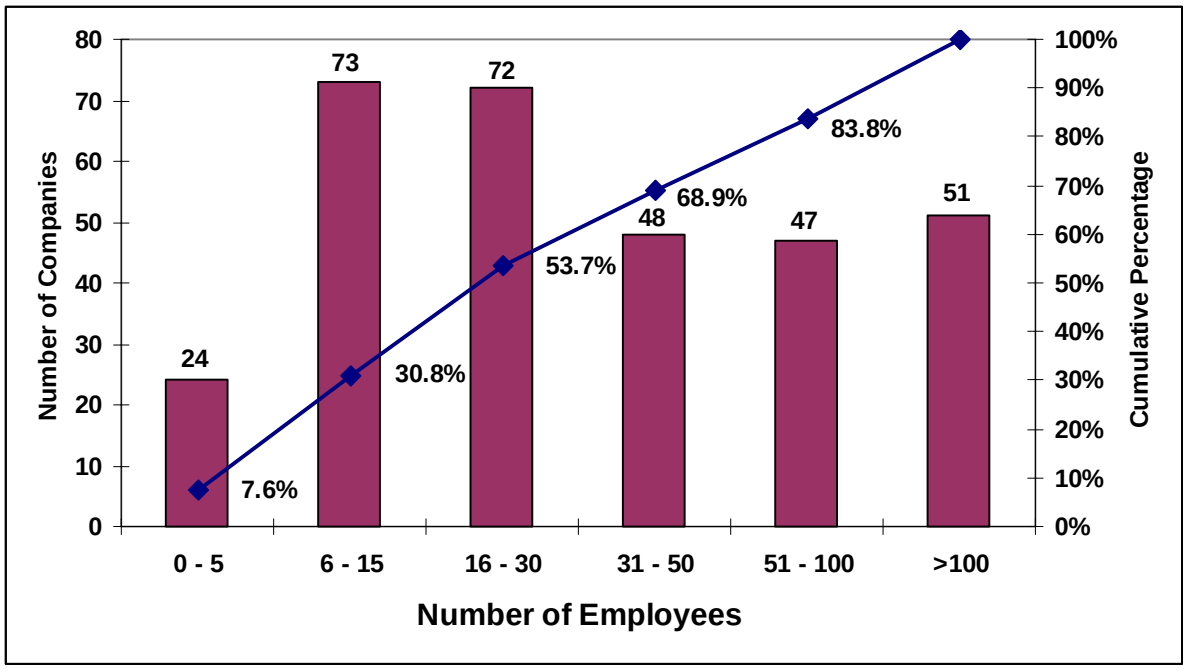

Figure 2.51 Number of people employed by the respondents' organisations

2.6.4 Breakdown of Design Income by Procurement Methodology

Designers were asked to indicate what proportion of their organisation's total design income was derived from each of the nominated procurement methodologies – *traditional*, *design and construct* and *management*. As can be seen in Figure 2.52, the *traditional* method provides a much greater proportion of overall design firm income than either of the *design and construct* or *management* methods. The chart also shows that around the extreme ends of the income scale the three methods are quite similar. Both of these observations would appear to indicate that for larger projects, non-traditional methods are used to a much greater degree, than may have been previously considered.

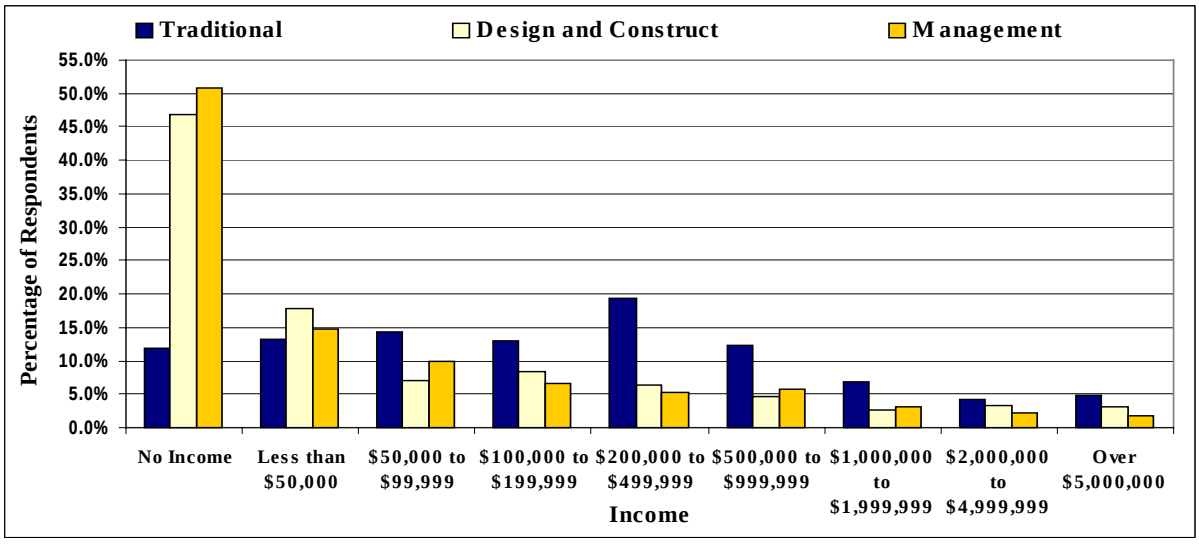

Figure 2.52 Percentage of design income derived from each procurement method

2.6.5 Total turnover range for the previous financial year (1997 / 1998) for each of the project delivery systems stated.

Contractors were asked information relating to the total turnover of their organisation for the previous financial year (1997/1998). In addition to obtaining overall totals, the contractor questionnaire also investigated the proportions shared by the different project delivery

methods – *traditional*, *design and construct* and *management* – by asking the respondents to indicate the amount of total turnover attributable to each method.

In Figure 2.53 below, the chart shows that while the usage of all three delivery methods is fairly similar for projects up to around $5Million, from then on, the *traditional* method is consistently the more preferred procurement method. Further analysis of the contractor responses indicates that while 89.0% of respondent companies carry out work under the *traditional* method, 76.5% are involved with projects procured using *design and construct* and only 58.7% have projects using one of the *management* project delivery methods.

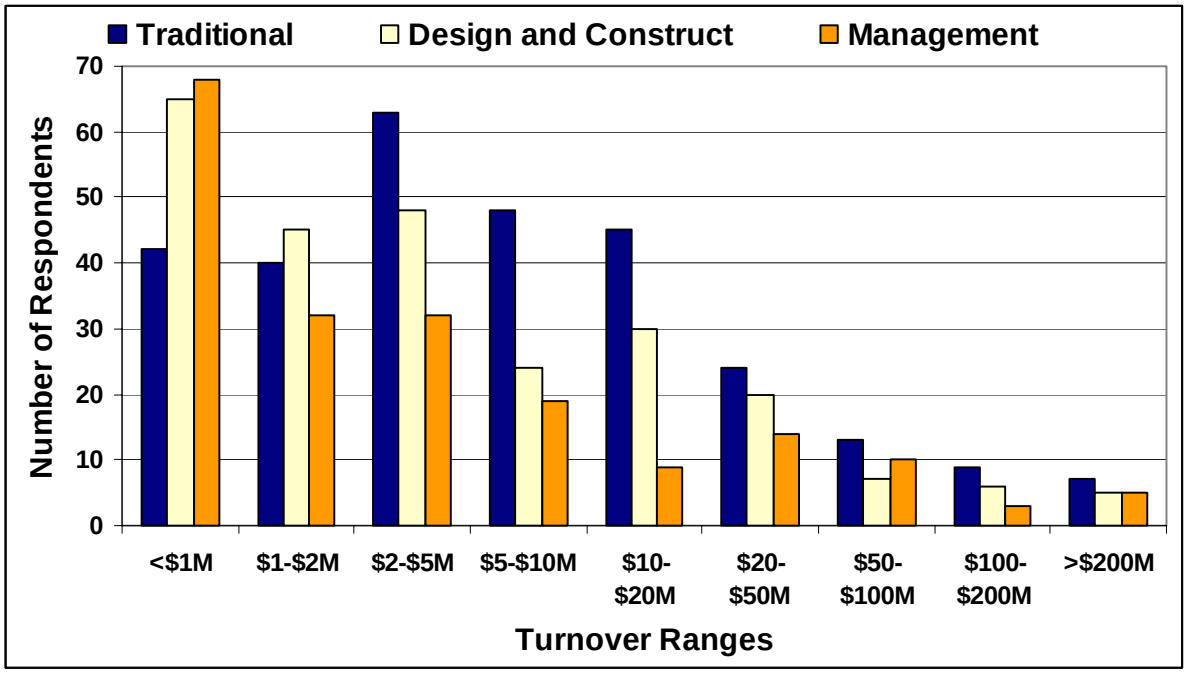

Figure 2.53 Industry turnover by method of procurement

In trying to determine the extent of total turnover attributable to the contractor group for each project delivery method, the principles of the *central limit theorem* have been used to calculate an approximate overall value of work carried out within each turnover range and project delivery method. As can be seen in Figure 2.54, the proportion of total turnover attributed to the *traditional* method (44.5%) is significantly greater than that produced under either the *design and construct* (30.5%) or the *management* (25.0%) project delivery methods.

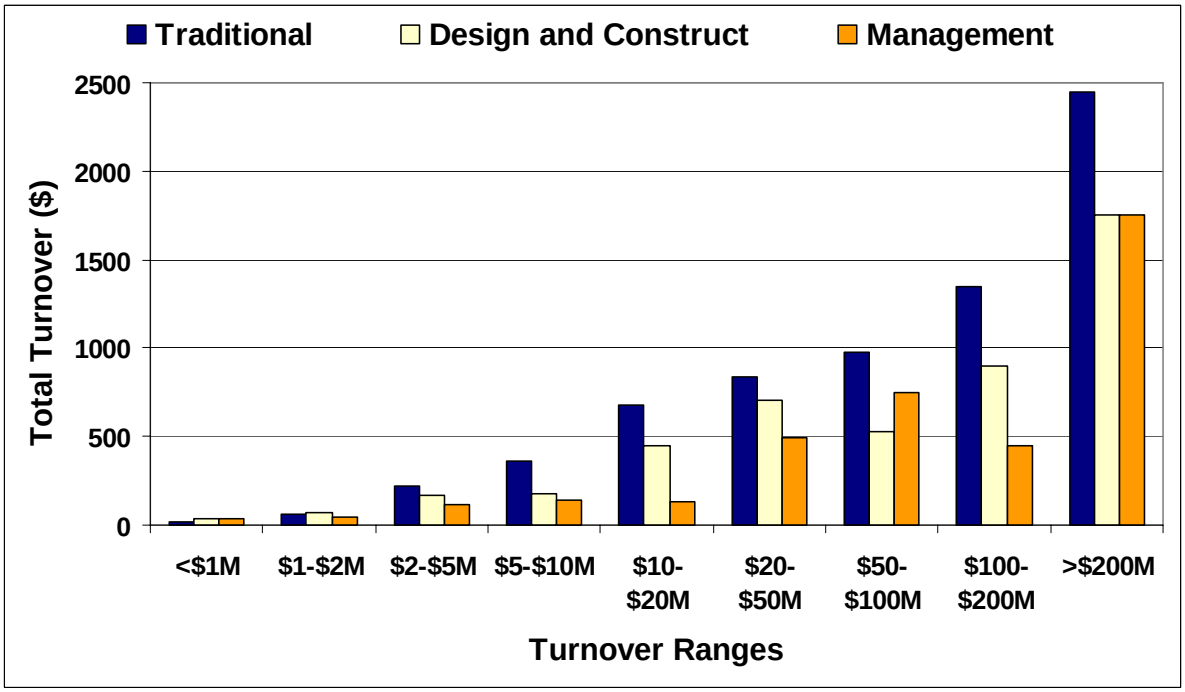

Figure 2.54 Approximate total turnover attributed to each project delivery method within each turnover range

The charts also highlight an interesting situation, in that whilst the number of contractors that operate in the $0 to $20M range may represent 83.2% of all respondents, the turnover attributable to that group is only 17.3% of the total. Or seen another way, for those contractors that have turnovers in excess of $100M, whilst they may only represent 4.8% of all respondents, the turnover attributable to this group calculates out to 55.3% of the total.

2.6.6 Breakdown of Design Income by Market Area

To further determine the makeup of the designer group, the respondents were asked to indicate what proportion of design income was derived from each of a number of different market areas, as listed in Table 2.15.

Table 2.15 Market Areas Listed

Market Areas Listed
a) Light industrial buildings
b) Government buildings
c) Commercial buildings
d) Hotels/Resorts
e) Recreational facilities
f) Apartment blocks
g) Residential housing
h) Shopping centres
i) Heavy industrial projects
j) Civil engineering projects
k) Other (specify)

As can be seen in Figure 2.55, the market area providing the greatest overall proportion of design fee income, was *civil engineering* followed by *government buildings*. *Commercial buildings* and *heavy industrial* were the next largest areas. *Light industrial* was responsible for the lowest proportion of the total design income.

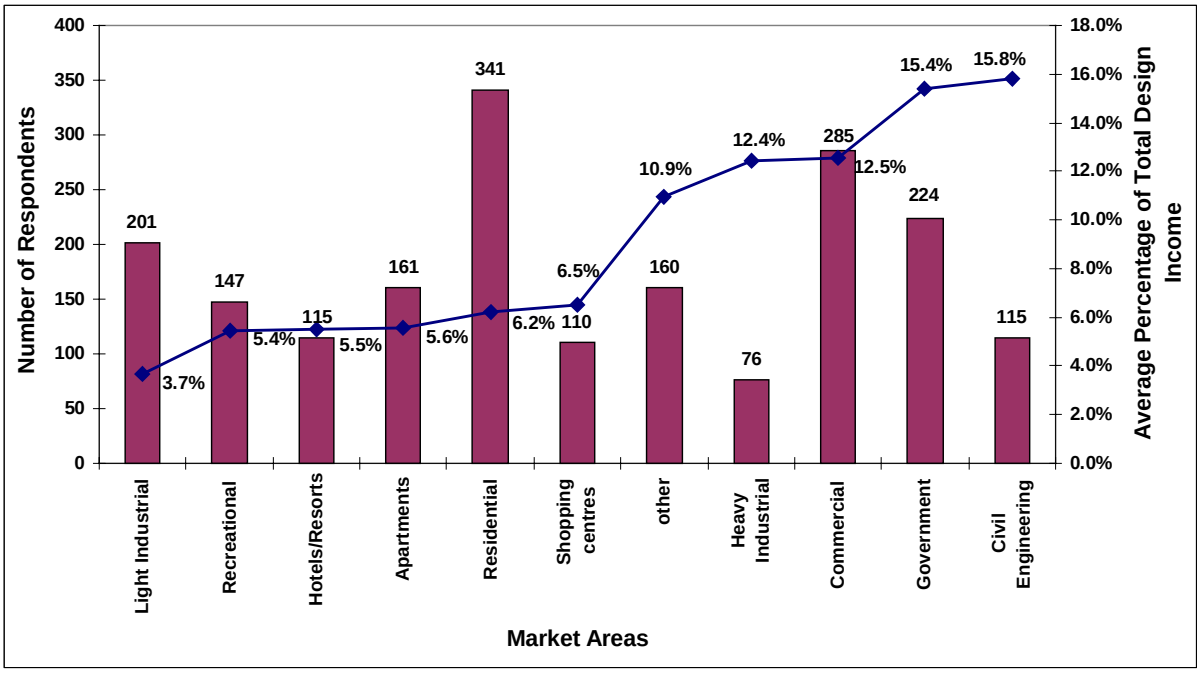

Figure 2.55 Number of designers working in each market sector and average percentage of total design income that each sector represents

Figure 2.55 illustrates that while nearly 70% (341) of the respondents operate in the *residential housing* sector it represents only 6.2% of the total design income of the respondents. Conversely, only 15% (76) of respondents work in the *heavy industrial* sector.

Further analysis was also undertaken to try to determine what proportion of the total designer income was made up by the different project delivery methods within each market area. As can be seen in Figure 2.56, the *traditional* method had the highest proportion of industry turnover within all market sectors. These results are based on an average for the responses from the individual contractors and assume that the percentage of work achieved for the particular sector was proportional to the value achieved for each delivery system.

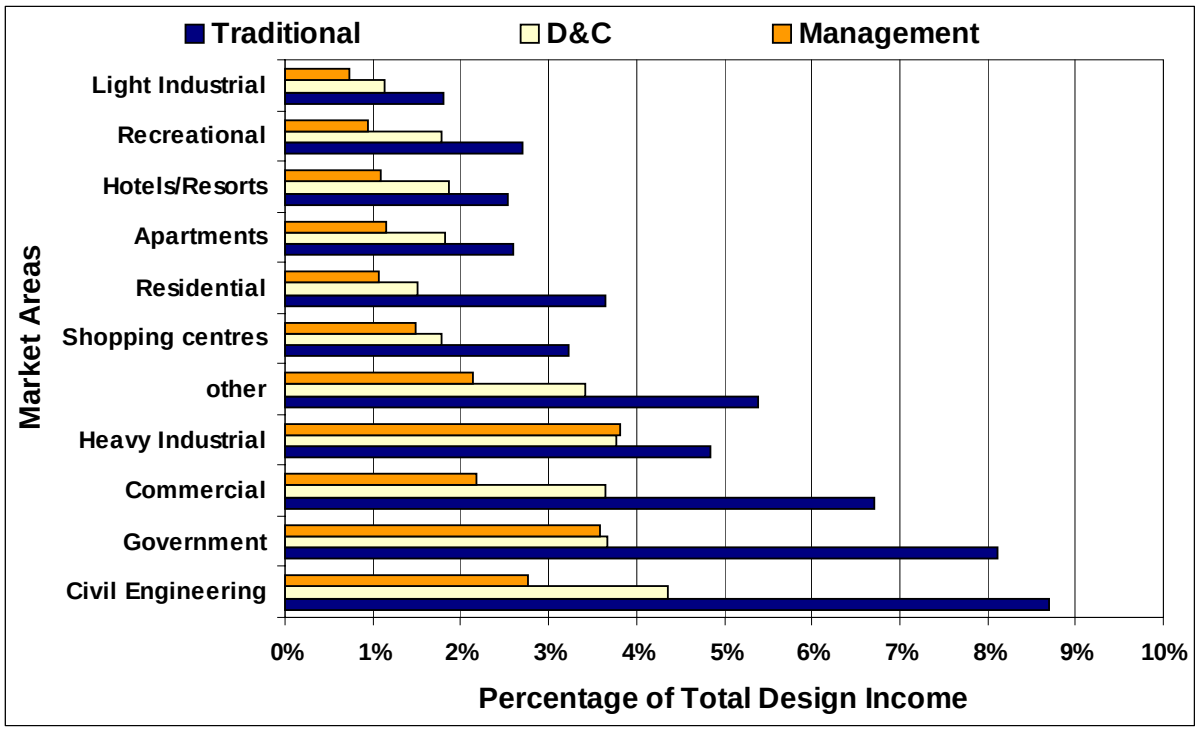

Figure 2.56 Proportion of income attained through the different project delivery methods within each market area

2.6.7 Proportion of turnover carried out in the market segments listed

To further determine the makeup of the contractor group, the contractors were asked to indicate what proportion of their total turnover was carried out in each of a number of different market areas, as listed in Table 2.15.

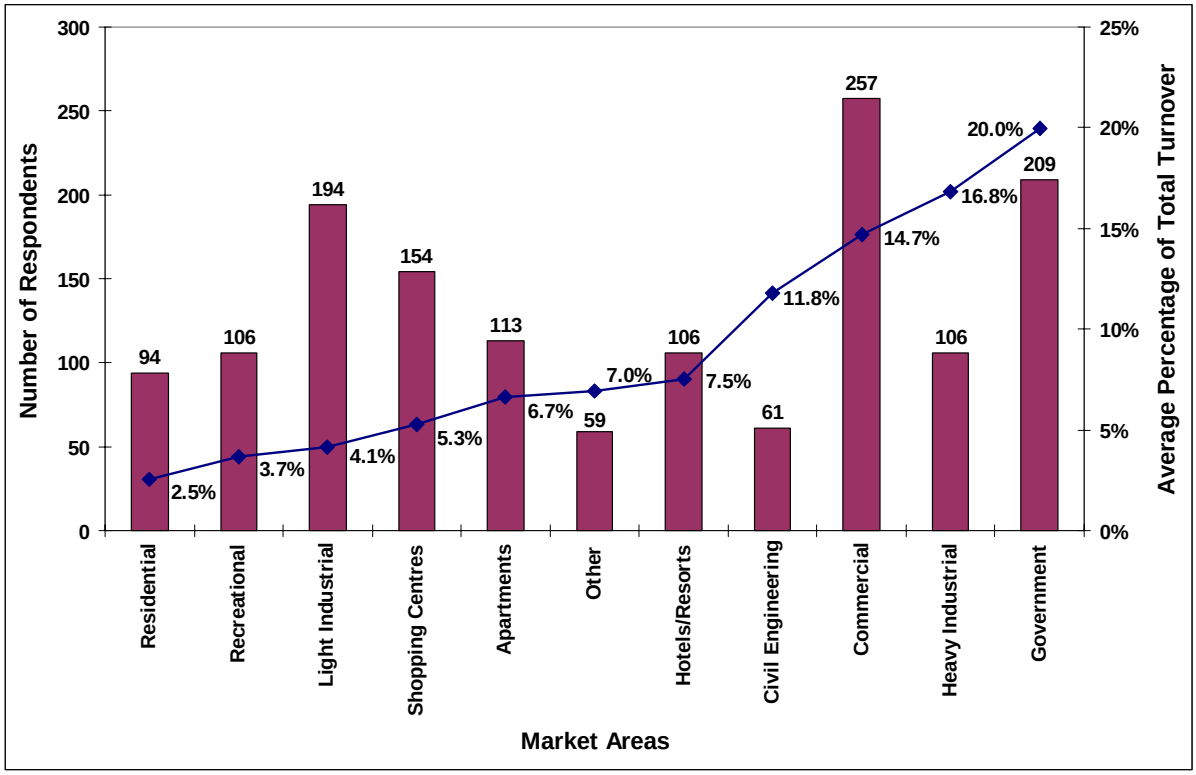

Figure 2.57 Number of contractors working in each market sector and average percentage of total turnover that each sector represents

In Figure 2.57, we can see that overall, the *government*, *heavy industrial* and *commercial* sectors, represent by far the most predominant areas of work and represent a little over half of all contractors turnover. At the other end of the scale, the *residential* and *recreational* sectors were indicated as being the areas in which they were involved the least.

As with the designers, further analysis was also undertaken to try to determine what proportion was made up by the different project delivery methods within each market area. As can be seen in Figure 2.58, the *traditional* method had the highest proportion of industry turnover within all market sectors, except for the *heavy industrial* sector where *design and construct* had the highest proportion of turnover. These results are based on an average for the responses from the individual contractors and assume that the percentage of work achieved for the particular sector was proportional to the value achieved for each delivery system.

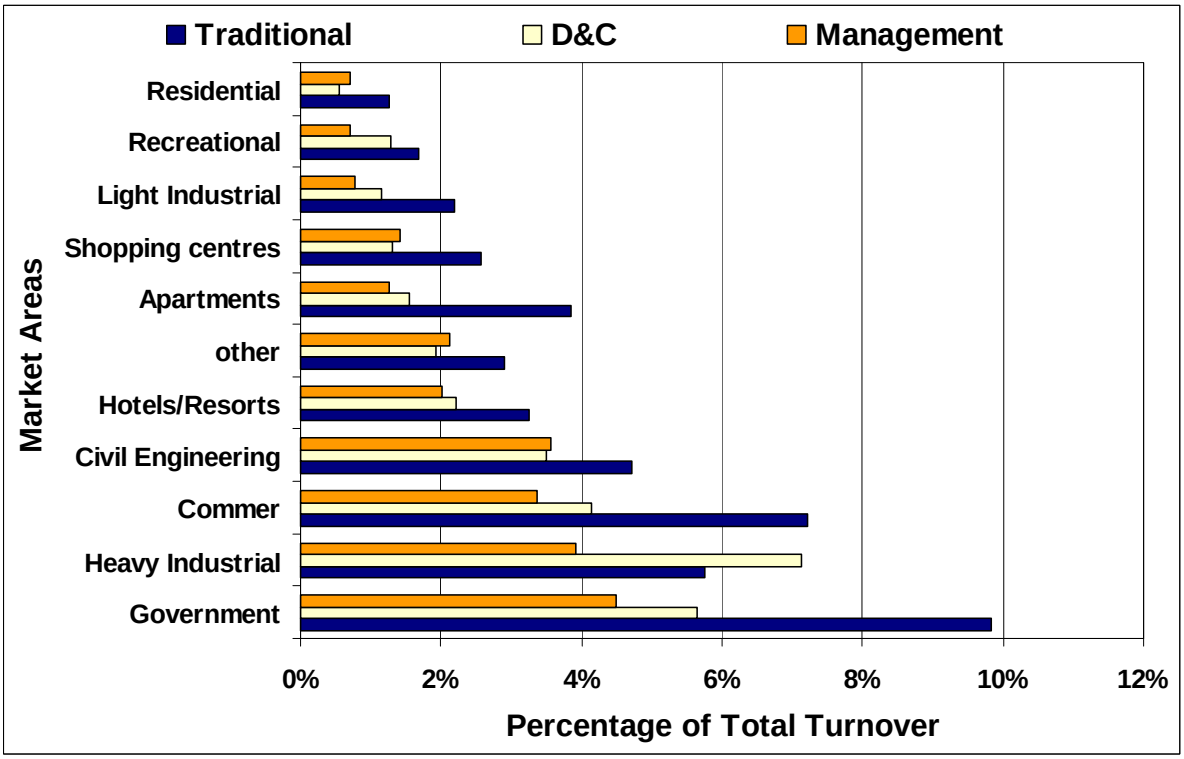

Figure 2.58 Proportion made up by the different project delivery methods within each market area

2.6.8 Breakdown of Design Income by Billing Method

Designers were asked to indicate what proportion of their organisation's total design income was derived from each of the nominated billing/fee-setting methods.

As can be seen in Figure 2.59, the lump sum fee is the most predominant method used for setting fees and is almost double that of the more traditional method, which is based on a percentage of the construction value. Although billing fees based on the hourly rate method is the least preferred method of billing, at nearly 20%, it still provides a significant contribution.

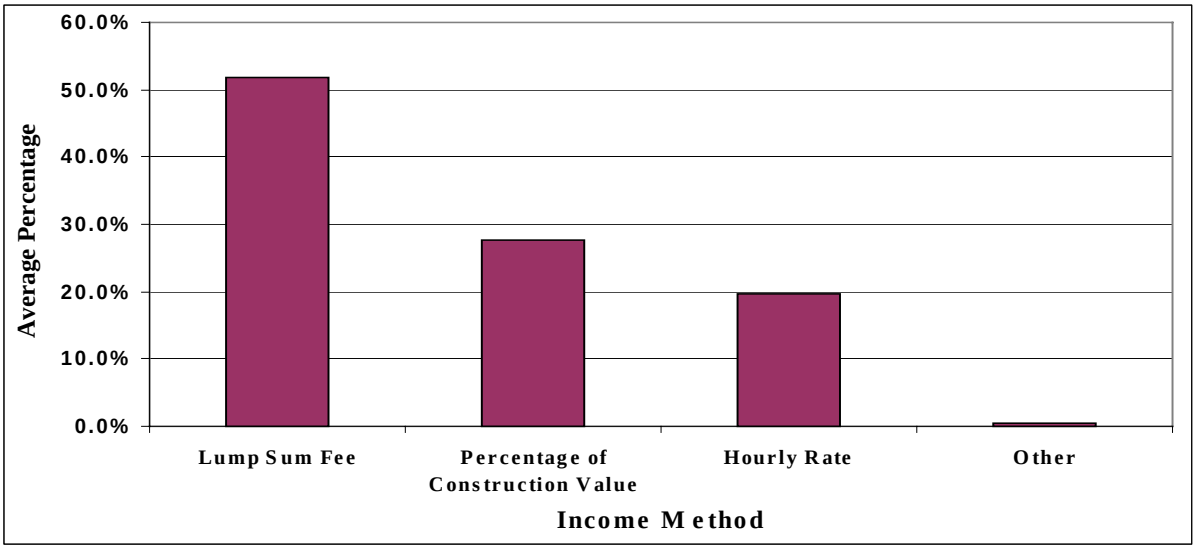

Figure 2.59 Percentage of design income derived from differing methods of billing

2.6.9 Breakdown of Quality Assurance Implementation

To try to determine the extent to which the Australian construction industry had embraced Quality Assurance (QA), respondents were asked to indicate what level of QA they had achieved, based on the list of options shown in Table 2.16.

Table 2.16 Levels of QA Accreditation

Levels of QA Accreditation
a) Fully QA accredited to ISO 9000
b) Have obtained *substantial implementation* certification
c) In the process of becoming QA accredited
d) Have own in-house quality system
e) Not started QA accreditation procedures

As can be seen in Figure 2.60, only just over 20% of all designers indicated that their organisations had full QA accreditation to ISO 9000 standards, while well over half of the designers' organisations either had no form of QA at all or utilised their own form of QA.

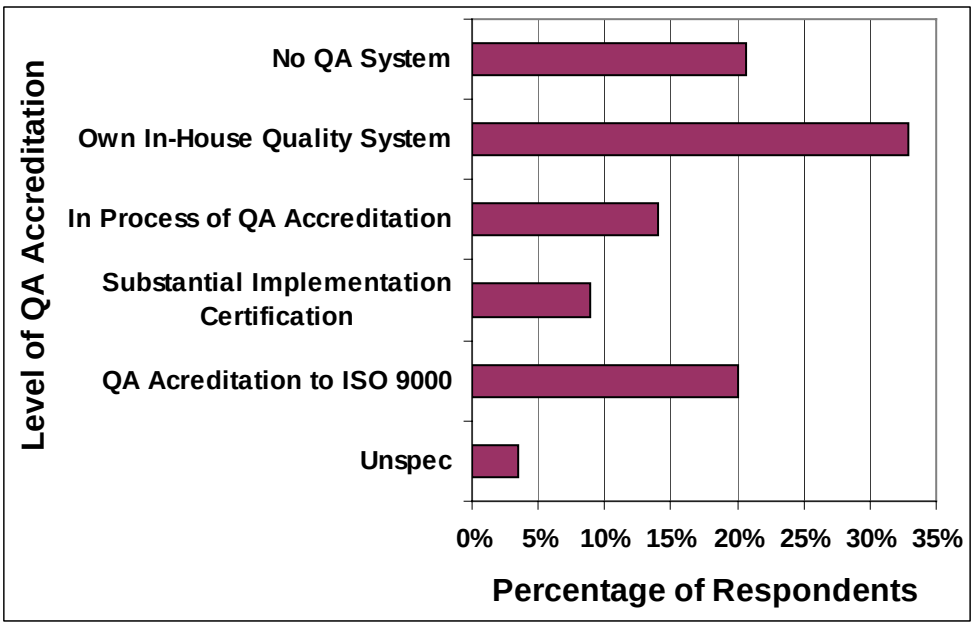

Figure 2.60 Level of quality assurance (QA) accreditation for designers

In Figure 2.61 below, the chart shows that while 40.6% of contractors were fully accredited, a further 22.5% had either achieved *substantial implementation* certification or had started the process of QA accreditation. At 29.7%, it is quite a large proportion of contractors that have decided that it is either better or easier to develop and implement their own in-house quality system than to obtain full ISO 9000 accreditation, while the remaining 7.2% do not appear to have started on any quality system.

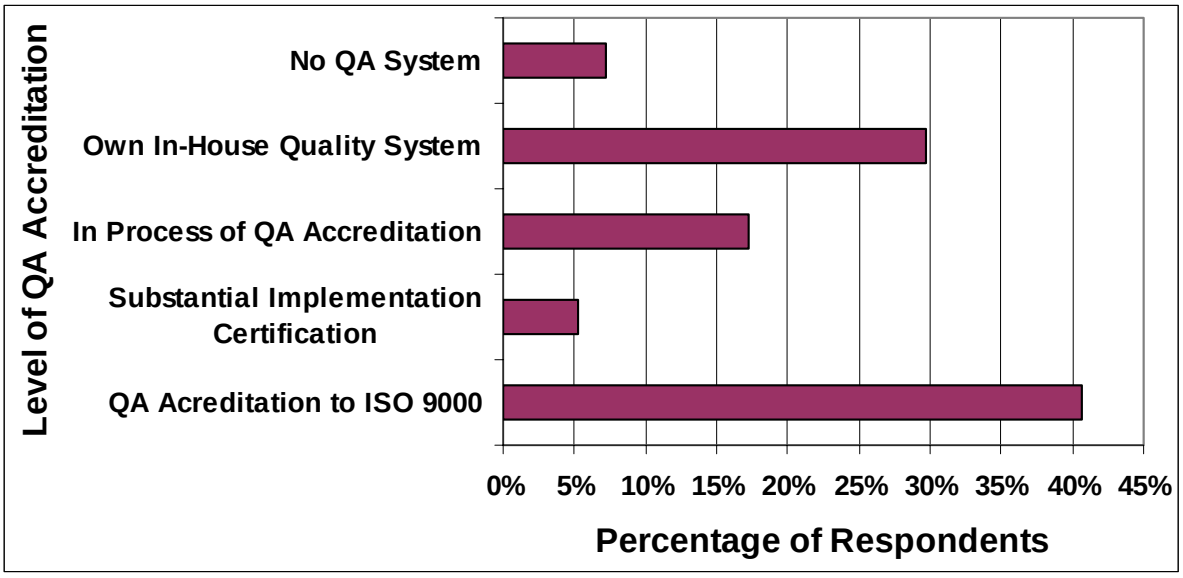

Figure 2.61 Overall level of Quality Assurance (QA) of the contractors

The higher frequency of in-house quality systems and no QA accreditation procedures used by designers would appear to provide additional supporting evidence to the designers' responses indicating their belief that QA accreditation is not the answer, and that it is generally more trouble and costs more than it is worth. As recent research has suggested that a greater adherence to QA standards is likely to improve design and documentation quality, an apparent lack of commitment by the design industry to adopt these standards may be contributing to the declining quality levels.

2.7 General Comments

In this section of the questionnaire, respondents were given an opportunity to comment on the issues raised within the questionnaire and on any other issues not raised but which they felt should have been, due to their effect on design and documentation quality or construction process efficiency.

In total 153 contractors (46.8%) and 204 designers (42%) took the extra time to comment and this represents almost half of all respondents. While some of these respondents only provided a few comments, a large number offered several observations. One respondent was so moved by the issues raised in the questionnaire, that he provided three pages of comments on what he felt was wrong with the industry and how we might go about improving the situation.

To simplify the analysis of the comments, each comment raised was classified into one of a number of categories, from which the information was then tabulated. An analysis of the actual responses was carried out and as can be clearly seen in Figure 2.62 and Figure 2.63.

The designer comments generally supported the view that the low design fees, insufficient time and a general lack of understanding of the true value of the design professions has led to a reduced standard of design and documentation. These comments are – not unexpectedly – consistent with the results from previous sections of the questionnaire.

In essence, the contractor comments argue that there is a problem with the current standard of design and documentation within the Australian construction industry and that this poor standard is affecting construction process efficiency. Various reasons for the problem are given, however the predominant ones relate to insufficient design fees, a decline in designer professionalism and professional standards and insufficient design time. The collection of comments grouped under *other* included support of issues raised in the survey document, contractors drawing attention to the true cost of deficient design and documentation to the economy and many other diverse statements.

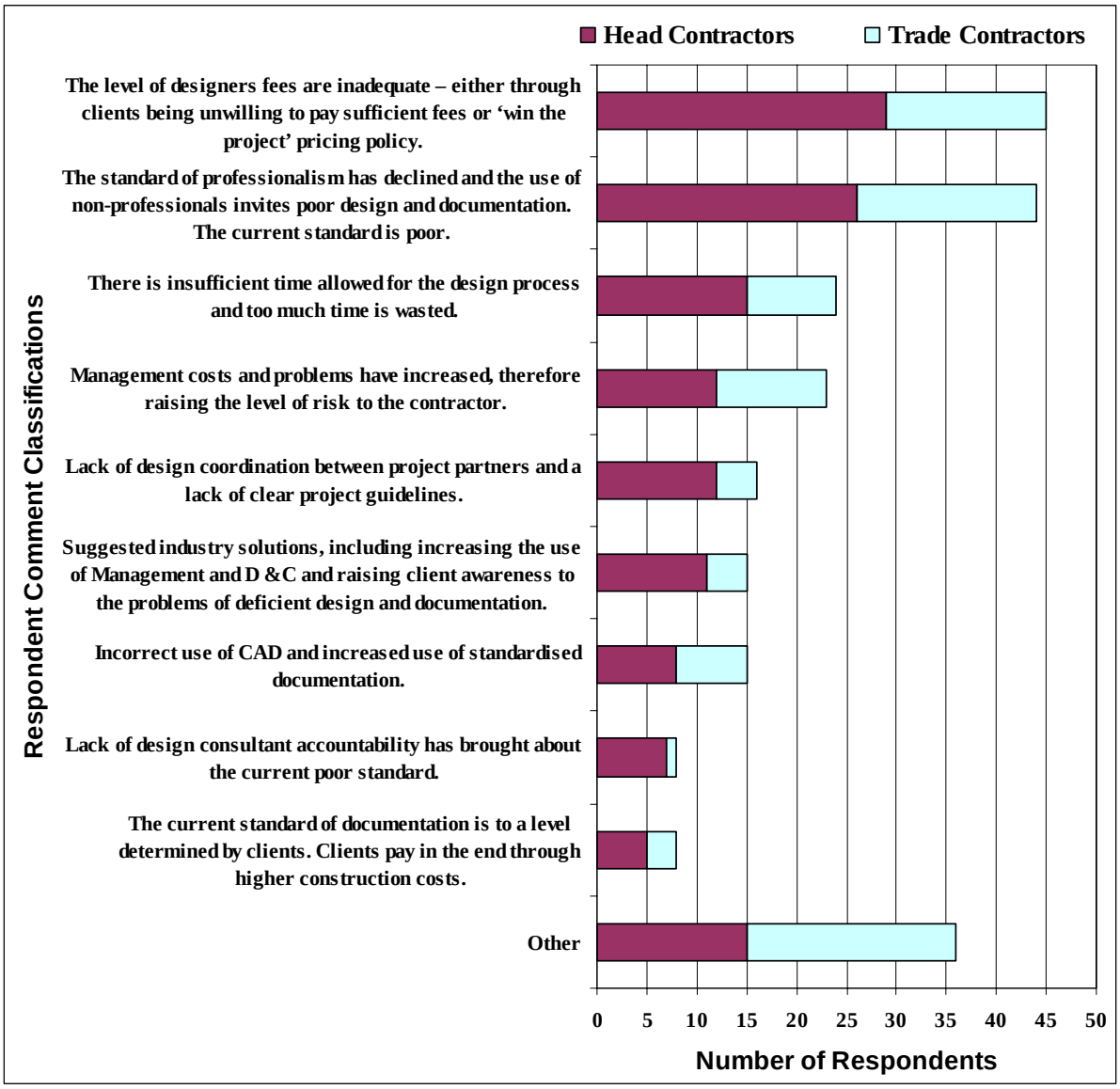

Figure 2.62 Breakdown of comments raised by contractors

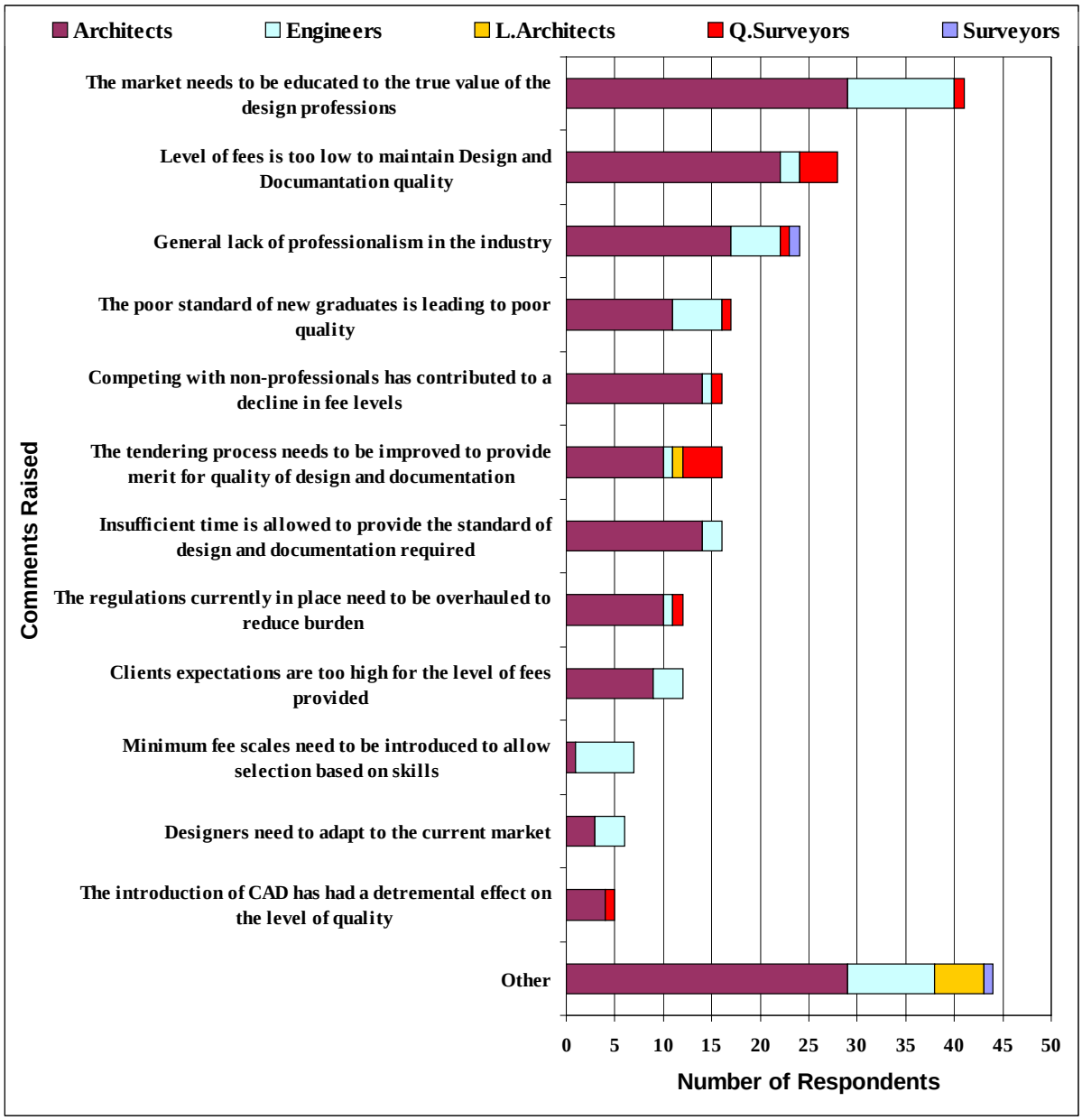

Figure 2.63 Breakdown of Comments Raised by Designers

To try to provide a feel for the types of comments given, extracts from some of the respondents' comments are listed below under the major topic areas. Overall, there were many interesting comments provided, either by way of a critique of various aspects of the industry, or as constructive insights into how we may improve the current situation.

Extracts from responses from the contractors survey

Insufficient design fees or designers being selected on the basis of lowest cost

Client reluctance to fund proper preparation of documentation and consultant designer competitive cut pricing of documents with withdrawal of supervision rate is causing the current approach occurring. "Pay peanuts and you get monkeys and we've got a zoo full'

Questionnaire has ignored possible causes for poor design and documentation. These are: - poor selection of consultant; ever declining design fees; low salaries for design staff; quality of design staff; design time allowed. Situation is going to get worse unless these factors are addressed

I think a lot of the problems with design and documentation are related to designers being secured on a cost basis.

The deterioration in design and documentation is a direct result of the squeeze on design firm fees. Design criteria today is more in an implied form, hence contractors are forced to accept more risk. Also the cost squeeze inhibits consultants being able to ensure that clients receive what they pay for. Some would argue that clients deserve cost blowouts due to their reluctance to pay the correct design fee at the beginning.

Design and documentation quality varies greatly per consulting firm. We are getting what the client is willing to pay for.

Other causes of design and documentation deficiency

It's all about money. You get what you pay for. If the client only budgets 2% for design and documentation that's all he gets. The entire industry is dollar driven and with small margins and tough competition everyone is cutting corners just to survive. You can't blame the designers for the current state of our industry, we're all guilty one way or the other.

As a general comment, I would view the decline of documentation standards to align closely with the introduction of CAD & computers (word Processors) into the industry. These were seen as a method of improving efficiencies and delivering cost reductions. The lowering of costs was a justifiable requirement in the interest of delivery of cost efficiency, however with the lowering of fees we have seen a corresponding decline in the quality and efficiency.

The current design and documentation process has created high volumes of "Generic" CAD based information which is often poorly coordinated and generally lacking in overall understanding of the clients goals in commissioning the project. Lack of people contact by designers is an ever-increasing factor.

Our Company specialises in D&C. Technology has allowed advances in delivery & quality of documentation, at the same time designers are not given sufficient time to complete and coordinate documents mainly due to unrealistic time constraints put on them by clients, in many cases caused by their own lack of knowledge or inability to make timely decisions and then expecting the designer & builders to meet unrealistic deadlines. Clients need to become part of the design team to gain better understanding of issues involved.

The main problem in the industry is the continuing trend for designers to take less and less responsibility for full extent of what they should provide as coordinated design and documentation (mainly under pressure of client to minimise design costs) and transfer more design elements such as mech., electrical, fire, hydraulics, etc onto the builder

In my view the decline in quality of design and documentation arises from the clients' lack of understanding of value of high quality design and documentation. This partly arises from there being no industry-recognised methods of measuring the value added by good design and documentation.

The noticeably lower quality of young professional experience / construction knowledge is also a major factor.

There is only one winner – the client

The design process has generally improved with time, however market forces are taking their toll on the score and quality of the documentation that is being produced. Building contractors are being required to interpret documentation and accept some of the risks associated with poor documentation. The result is that contractors need to devote management resources to clarifying ambiguities. Market pressures are such that it makes it increasingly more difficult for contractors and consultants to recover these costs. While consultants and contractors are willing to put up with this treatment, clients will continue to drive costs down, and profit from the situation.

Or, do clients really pay for it all in the end

It would appear the problem with documentation starts with the actual client screwing down the consultants fees trying to save $ but what they need to realise is that all the contractors and sub-contractors have had to add to their overall quotes to cover or at least to try and cover the costs involved with lack of and conflicting information on the consultants documents.

Cost savings in fees is more than offset by increases in administration & project costs.

With reference to fast track projects I believe that if the developer (public or private) allows sufficient time to complete documentation prior to tendering, the end result would be:- More competitive pricing, -A reduction in variations, -A reduction in use of RFI's (a major cost to Eng., Arch., Fabricators etc), -Less extensions of time claims, -A better (both financially and timing) return to developer, engineer, architect, builder, fabricator etc.

There appears to be a common perception from clients that paying less "up front" will reduce the overall cost. This is incorrect as I believe the survey shows that builders administration has increased and inadequate design results in additional variation costs. The true cost of construction will ultimately be realised, and I believe it would be less stressful for all if this work was performed up front.

A popular solution – Design and Construct. Is this the way to go?

Quality of design is largely dependent on the quality of the people within the design team and the amount of the fee. If a relationship (D&C) exists with the team then the quality and quantity of design can be both managed within the fee structure.

Design and construct affords the opportunity to have control over the process but time and cost factors generally prevent the design and documentation from being fully

developed hence putting the onus on foreman and project managers to finalise the design as they are building, leading to time and cost inefficiencies.

I have found the quality in design and specifications to be below average to poor quality, I think due to financial restraints put on consultants and feel that we offer a lot more in the field of design and construct and would like to see more projects go this way.

Margins are lower. Architects & consultants fees are lower. Project overall time duration's are less. Quality has suffered. Bills of Quantities are not guaranteed. The contractor is taking more / most of the risk. Bankruptcy & closures are common. Design & construct appears to be the solution.

Other solutions to improve design and documentation quality and industry relationships

Overall the level of design and documentation has been reduced. An architect isn't considered as an important player in construction. The level of design obviously has a bearing on fees and is also the responsibility of the client taking the design serious and paying decent fees.

Inordinate amounts of time and cost are thrown away through unnecessary rectification and/or redesign. I feel higher levels of communication are required and an easier access to information by all design disciplines is needed.

Our industry is entering into a new era where the concept of "partnering" will evolve due to cost / time constraints placed on our designers and consultants.

Accurate design, planning and documentation (particularly Bills of Quantities) along with equitable contracts would save vast amounts of time and money which are currently wasted in the construction industry today and getting considerably worse over time.

Extracts from responses from the designers survey

Design fees and the time available to carry out the work

Time constraints and tight fees together make the design & doc. process unpleasant & risky.

Time is not considered as important; eg: expectations by clients that we will work weekends, evenings etc. and be available for advice on holidays.

Basically the problem is that projects are cost driven & the risk of litigation or other legal consequent is always increasing. More information & more detail is required by clients yet there are less fees available & less time to produce the design/documentation (due to external money markets). This is more pronounced in the public sector where political careers are more important.

Economical & financial issues are greatly affecting the construction industry with the majority of clients expecting high level of performance, but not prepared to pay for it.

The requirements for designers are more intensive & onerous than previously. The fees are always on the low side, yet clients always demand more without wanting to pay. Overall, the standard of design in the industry is below par. Cut price fees are the norm…

In rough terms, our fees are 60-70% of ten years ago. While some of the difference has come from better technology, most has come from forgoing profits, reducing wages of senior staff & directors & cutting out training both of existing staff and apprentices. We are so busy that just keeping our overdraft within limits that we have no time for any "extraneous"(professional development) matters. I am witnessing, at first hand, the death of my profession.

Public and Private sectors will both negotiate fees even after you may have won the project. They all know the work is too valuable to give up.

I liquidated my last practice rather than undertake work for unrealistic fees to unreasonable time programs. I don't think much has changed - we are our own worst enemy

Quality of design staff, design education and training

Poor or very poor education of our young architects in "commercial" practices and particularly in their university training is lowering skill levels of the profession.

Less fees results in less salary and slower implementation of technological aids. The result being employment of less experienced staff.

Reduced fees have meant that adequate staff training is impossible. Adequate staff are not being trained as site time cannot be permitted.

A major problem for architectural firms today is the lack of basic training in the various institutions in the areas of building construction documentation, building regulations & drafting skills. Many graduates have very poor manual drafting skills, freehand drawing skills, are not familiar with basic building construction & do not understand or know how to use BCA.

Education standard at universities and those accepted by the institution are becoming less, leading to poorer quality staff.

Decline in quality of new engineering graduates is a serious issue. Only a small percentage of graduates are capable of the demands of a modern consulting practice. This is probably due to reduced standard of intakes into engineering degree courses.

Architectural education is generally failing to provide design professionals who are literate both in a design sense and literally. There is no time or money for a genuine apprenticeship, once graduates enter the workforce.

Graduates now have more understanding of design & the "archi" jargon. But in the real world they are unable to deal with building issues. They know little about building details and less about how to deal with builders. Tertiary training does not prepare you for the real world, and offices can't afford to do this - you no longer learn the ropes for 5yrs, it is expected to start on day 1.

Issues relating to Quality Assurance (QA)

Despite being fully QA accredited we are unable to obtain/tender state gov't works because as we had not done any for 2 yrs we were now "not experienced". Up till QA became a necessity we always had a PWD job in the office. It seems a catch 22 situation. Hold off whilst obtaining QA - then you're no longer experienced due to the time when getting QA.

QA has not improved the standard of work on building sites. Reinforcement is never checked by builders prior to consultant check, although QA staff and forms float around. Formal QA is unnecessary and a burden (cost) on small practices.

I have not started and will not start QA proceedings as it's a scam and has a massive detrimental effect. You should have asked 'Is QA viewed as a marketing tool or a means to better quality.

Issues relating to clients

Professional clients in government are generally appalling. Private enterprise project managers may pay more but put extraordinary time constraints on the delivery of services.

The client communication interface adopted by many project managers has severely restricted the interaction between clients and design professionals to the detriment of both parties and to the detriment of the overall built result.

Clients should be better educated about the architects project input and should select a person appropriately qualified and experienced

All clients should be made aware of 'Life Cycle Costing'! The contribution of all consultants, including the architect, is essential to proper long-term performance of the building. The cost of this contribution is a very small proportion of this 'Life Cycle Costing' and yet people argue of small percentages of consultant's fees. Crazy!

The extent of work required to design and document adequately is not understood by clients.

Public sector at least 2-3 times more likely to engage in fee bidding than private sector. Much greater drop in quality of design & construction in public sector.

It is extremely difficult to obtain quality briefs from clients or their representatives and a general unwillingness to make the hard decision to reconcile brief requirements with budgets.

The biggest problem by far in managing programmes and meeting deadlines is a severe lack of discipline and commitment to client decision making.

Our major concern is the lack of understanding by our clients (both private & public) of the importance of quality design and documentation in providing not only the best possible product but at the best possible construction cost. They cannot conceive that the additional cost involved in the provision of thorough design & documentation will in fact provide much greater savings than the additional architectural fees would ever be. Few clients understand how much time is involved in design and documentation and assume that every architect, regardless of their fee, will produce comparible work. Until the public ie: private and public sector are better educated in this regard, quality of design and documentation will continue to decline.

I believe design and documentation quality is simply a measure of the strength of the relationship between owner/client and consultant. Consultants need to be able to establish relationships and convince clients of the value of their services, not complain about low fees.

In a nutshell, I would say that only the rare client truely realises that they get what they pay for. I think they think that higher fees is more profit not more output. I would also say that only the rare client would know good design if they saw it. Adequate, workable, affordable they know, Exceptional, timeless, worthwhile - who needs it? I'd like to run a boutique, but the shoppers are all at Silly Sollies.

CAD and other IT issues

CAD can be a very useful tool if used by the right people for the right jobs. However, I believe there are CAD operators who are not architects and do not know how to put a building together. They can draw fast but this is not the only issue.

CAD has very limited applications on small jobs and staff is expensive. Greater time is required to produce adequate documents and many operators have inadequate building & design experience.

Computers & IT have streamlined processes in offices, which means more profitable practices.

Although CAD is a very useful tool in an architect's office the operators & architectural staff must understand & be able to translate their knowledge of construction, regulations & drafting skills on CAD. At present this ability is rare & much time is spent cross checking documentation & training staff.

Computer aided drafting is not seen as a saving grace since skillful operations familiar with building and construction techniques are not proliferating. IT is providing means

for the swift transfer of information, but the process of design has not changed for the wishing to maintain the same standards of output and client service.

The advent of the use of CAD in architectural practice has grown & developed over the last10-15yrs. This falls withihn the period being investigated and has caused significantly increased costs, for limited increased productivity or design flaws. Hopefully, as this technology in the levels out, this deficiency will decrease and an economic balance will be reached to the business of architecture. Our sphere of upper / small practice finds client expectations of CAD usage to be beyond what they are prepared to pay fees for.

CAD operators have different methods of operating and are usually incompatible when combined - ie working on the same project. Architects with some CAD skills are put on the same 'level' as draftsmen with CAD skills, and as a result "drafties" perceive that they can do an architects work. Some firms allow this to happen, because its cheaper to engage a "drafty". Older generation architects, not so familiar with CAD, rely on juniors, and invariably don't check work - "It was done on the computer so it must be right". Work is no longer able to be supervised 'over shoulder! You cannot see the full size sheet unless you print out, and the coloured layers can be confusing and incorrect if not done properly - inexperience.

Over the last 10 years we have heavily invested in CAD systems and QA and this has enhanced the quality and accuracy of our deliverables. These CAD systems, particularly 3D CAD, have other advantages in client review, operator training and material control. The company is accredited to ISO9001 and we are convinced that our system helps us to improve quality.

Changes to design professional's role and image within the industry

The level of respect and therefore relevance afforded to design consultants has reduced as their role in documentation and on site contract administration has reduced. The tendency for a number of architectural practices to have extremely limited roles in the overall management process & the construction site itself limits self corrective feed back and erodes the profession's competence and therefore its profile.

Engineers have not addressed their status and are willing to work for wages without adequate levels of profit. Engineers do not understand what the word profit means almost to admit that it is a sin to make one.

Overall, the perception of engineers is they are a necessary evil, & demanding excessive fees.

It seems to me that an orchestrated attack on the profession, initiated by the state & federal governments, has downgraded us to "businessmen/&/women". For example, I now spend over 50% of my time on tendering, management and paperwork. During the 1980's this was less than10% and I was able to use my training (which had been paid by the public purse) in providing society with a better built environment.

Architecture is a dying profession due to the cost imposed to practice that profession, the general public belief that anyone that can draw plans are "architects' and that cheap is always best.

The questionnaire does not deal with a "waste" time component, which is becoming a larger issue year by year. In the mid 1980's we lamented only being able to spend 80% of a project time on issues directly related to the project ie: design, doc., construction attendance/contract admin. The remaining 20% was spent on addressing the 'politics' of the project, its PR, extraneous paperwork particular to the client and his project demands (eg: internal government budget attendances etc...). In 1998 that direct project time percentage has dropped to 60% with the extraneous requirements now requiring 40% of the time. This is largely a consequence of also now attending to others QA requirements, apart from an increase in the political and internal client support services required.

Competition from non-design professionals

The standard of design & documentation has been detrimentally effected by the increase of so called "building designers" that provide architectural services at fee scales that qualified architects find it had to compete with. They are unable to do this because:
(1) The standard of design & documentation they produce is diminished because of lack of proper training particularly in design skills;
(2) They provide only minimal service, which is lacking in detail and functionality.
Legislation needs to be put in place to control these practices and only then will the standard of design and documentation be elevated to a higher level. I find it strange that a building structure can only be designed by a qualified structural engineer but anyone is able to design a building have it approved and erected without any formal or proper education in that field.

It is definitely getting harder to make a buck! Clients expect more and pay less. They expect that architects should compete in fees with plan services & draftsmen, even though those people are under-skilled & unregulated. The architect's liability however is increasing. Good design is being devalued.

Drafting firms are still widely accepted as being architects. This is very detrimental to the uniformed client who is then usually disappointed with the results then blames the architectural profession.

Solutions to the problems

This self-defeating cycle has to stop.

First: *Collective action - stop fee bargaining;*
Second: *Invest in your staff - greatest resource yet undervalued;*
Third: *Raise expectations over time and time with realistic outcomes. Most firms fail to deliver, but do not deliver a failure.*
Fourth: *Integrate with other team members, - fellow consultants get them on side.*
Fifth: *Educate the client on design quality & value for money.*
Sixth: *Thereby raise the standard of architecture & the profession will be elevated in the eyes of their peers.*

Perhaps minimum design & documentation standards need to be created and enforced under the BCA. This may not be so easy, but it would force a minimum level of standard in the marketplace. Additional to this would need to be educating the market place on the VALUE of design and documentation.

Fees must rise!! The institute is failing the profession. Doctors & lawyers maintain their fees to the betterment of those professions. Our institute & some architects are failing to see that reduced fees will eventually destroy the profession.

Architects should form more of a cohesive group instead of undercutting each other's fees to the point that they cannot service to contract & destroy the profession in the process.

3 Discussion and conclusions

The purpose of these surveys was to firstly investigate the relationships between the changes that have occurred over the past 15 yaers, to:

- the level of design fees paid to design consultants (attainable);
- the level of service provided by the consultants; and
- the overall quality of design and documentation produced.

Having determined these relationships, it was then necessary to determine what effect, if any, such changes may have had on construction process efficiency. The questionnaires were specifically designed to obtain from the respondents their perceptions of not only the changes in design and documentation quality being produced, but also the impact these changes are having on the way business is carried out within the Australian construction industry.

In all there were 818 respondents to the surveys of which designers provided 491 and contractors 327. While the overall response rates were below expectations, the number of responses received for the survey has ensured that the results determined are statistically significant. The range of disciplines and organisation that responded has ensured that the results were generally representative of the opinions of the members of the Australian construction industry as a whole.

To enable us to make inferences about the results of the survey, we first needed to understand what issues designers believe are important to ensure quality in design and documentation. The survey indicated designers believe that the design should effectively serve the purpose it was intended and project requirements are met. This requires a through examination of the design proposals ensuring the proposals are functional and relevant in the first instance. Once the design stage is affected, the completed documents need to be legible, easily read and interpreted, free of errors and inconsistencies and be properly checked prior to release to the contractor. Designers believe there should be a competent manager in charge of the design process, to ensure design and documentation quality. While the designers themselves traditionally undertook this role, a decline in the level of fees available has had a detrimental effect on their ability to carry out this critical function within the design and documentation process.

The responses from the designers' survey showed there has been a reduction in the level of design fees over the past 15 years. Designers were asked to provide an estimate of both the fee level required to provide a proper service, produce quality design and documentation and make a reasonable profit, and the fee level submitted to win the work. Overall, the results indicate that while the *required* percentage fee levels have only declined marginally over time, the percentage fee levels required to be *submitted* to actually obtain the work have significantly declined over the past fifteen years – for all project budget ranges and levels of project complexity.

The decline in the *required* fee levels may be due in part to the increased use of technology, which would compliment other areas of improved efficiency. Designers indicated in their responses that there has been a dramatic increase in use of CAD for the production of drawings and in the use of information technology to improve project communications. While there was not total agreement among designers that the introduction of CAD has improved the efficiency of the design and documentation process, consultants generally agree that the technological issues have had a beneficial effect on design and documentation quality.

Client fee bidding practices and increased competition would appear to be the major factors influencing the decline in *submitted* fee levels. The designers collectively feel that economic conditions have tightened and that clients tend to *shop around* more for design services. The designers believe clients rate the *"level of design fees submitted for the project"* to be the most important factor in obtaining work, for both *public* and *private* sector clients. On top of this, there has been a proliferation of what the designers call *'backyard'* operators prepared to work for minimal fees. An issue that has had a large impact on design firms over the past 10 years or so - the *"quality assurance accreditation of the design firm"* – was not considered all that important as a factor in obtaining work. While the designers did not all agree that quality assurance requirements have helped improve the efficiency of those firms that have adopted it, there was agreement that this factor was seen as being of much more importance to *public* sector clients than to *private* sector clients in relation to them obtaining work.

The overall results indicated the fee levels required to be *submitted* to actually obtain the work have declined significantly over the past fifteen years, the decline averaging around 26.4%. These results were consistent across the different project budget ranges and levels of project complexity, although it was noted that as projects became smaller and simpler, the decline in fee levels and difference between *required* fee levels and *submitted* fee levels, became greater. The lower level of fees available emphasises their view that designers are selected based mainly on the level of fees submitted. Other factors in the selection process such as the design firm's reputation, capabilities, experience and qualifications and quality assurance accreditation is perceived to be of secondary consideration. When comparing public and private sector clients, designers believe both offer a lower level of fees now than was the case 15 years ago. Designers have also indicated that the level of fees available from the public sector are on average approximately 16% lower than those available from the private sector. Interestingly, this also coincides with the overall perceptions that design and documentation quality is lower on public sector projects.

A regression analysis of the fee levels submitted, supported the result and revealed that the decline in fee level was marginally greater in the period 12 – 15 years to 5 – 7 years ago. A possible explanation for a lower rate of decline in recent years may be due to the initial decline being within the capacity of the fee structure to sustain, but subsequent reductions in the fee levels may have required sacrifices of other design services.

The overall quality of the design, the design process and documentation on a project is to a large degree determined by the extent to which the issues and attributes of design and documentation quality are incorporated. Initially both the designers and the contractors were asked for their perception of whether there had been a decline in the overall quality of design over the past 15 years. Both groups indicated they believed the quality had declined. In all 52% of designers and 69% of contractors responded, "*Yes*" to this question. Similarly, designers and contractors were asked for their perception of whether there had been a decline in the overall quality of documentation over the past 15 years. For this question, the response was much stronger with 69% of designers and 88% of contractors stating they believed the quality of documentation had declined over the past 15 years.

Looking at the individual issues, both groups agreed that the incorporation of *ecological sustainability* issues had the greatest improvement of the design attributes over the past 12 – 15 years while *standardisation* was the documentation issue that had the greatest level of improvement. While all issues were rated as important in determining overall project design and documentation quality, these two issues were rated by designers as being among the least important of all issues surveyed.

Due to a lack of relevance, some of the design issues were not presented to the contractors. These issues included staffing issues and others related to client/designer relationships. When assessing the responses for the individual issues, designers indicated the staffing issues such as *balance in the ratio of junior to senior staff, competence and experience of design process manager* and *availability of experienced design personnel* had the greatest decline in incorporation over time of the design issues presented. Comparing only the issues presented to both groups, designers and contractors agree *proper examination of design proposals* was the issue that had the greatest decline in incorporation over the past 12 – 15 years. While designers indicated that a reduction in design fees was detrimental to this issue, they also rated it as one of the most important design quality attributes.

According to the designers, the most important design attribute was *relevance – ensuring project requirements are met*. The responses from both designers and contractors indicated this issue attained the highest level of incorporation of all of the design quality attributes listed.

The documentation issue that declined the most over the past 12 – 15 years according to designers was *completeness*, and again this was one of the issues designers indicated that a declined in design fee levels had had a detrimental effect on. Contractors believed that the *accuracy* of the documentation had declined the most. *Accuracy* was also the documentation quality attributes that designers rated the most important in determining overall documentation quality.

When considering the overall design quality with all of the issues pooled, the results of the designers' survey indicate that the level of incorporation of design attributes had increased over time, suggesting designers believe the quality of design has improved slightly. This was in contrast to their earlier indication that the quality of design had declined. Further analysis revealed however that the responses from those who indicated the quality of design had not declined (35%) suggested the incorporation of design attributes were greater now than 12 – 15 years ago, while those who believed the quality had declined (52%) suggest there had been no significant change over time. This result explained the apparent discrepancy in the earlier responses for the designers. The contractors responses, with all of the issues pooled, although also showing a slight improvement, generally indicated there had been no significant change in the level of incorporation of design quality attributes.

Considering overall documentation quality with all of the issues pooled, the designers and contractors responses indicated the level of incorporation of documentation quality attributes had declined – which agrees with their earlier assessment of a decline in overall documentation quality.

A factor analysis was carried out on the responses to determine if any of the issues could be grouped together and classified. To allow a comparison of the results between the designers and the contractors only those issues presented to both groups were uses in the analysis. The analysis of the design issues extracted three factors that were able to successfully include most of the information provided in the survey document pertaining to the thirteen issues. The three factors related to different aspects of the design function. One factor summarised the *practical construction* issues, another the *conceptual-creative* issues and the other *future resource utilisation* issues. The application of these factors to the responses for the level of incorporation revealed the area where the greatest improvement over the past 15 years has been in *future resource utilisation* issues – with both groups agreeing. The designers believe the *practical construction* issues had remained constant and that the *conceptual-creative*

issues had declined, however conversely, the contractors believed the *practical construction* issues had declined and the *conceptual-creative* issues had improved.

As with the design issues a factor analysis was performed on the responses for the documentation issues. The result grouped all issues excluding *standardisation* under one factor. The application of this factor to the responses of the level of incorporation data showed that the documentation quality had declined over time supporting the earlier assessments. Contractors however, believe that the decline has been far more significant than designers indicated.

A regression analysis was performed to allow us to compare the rate of change for the issues over time. For this analysis, all issues were weighted equally. The results of the design analysis indicated that the designers and contractors perceived a decline over time of between 2% (designers) and 5% (contractors) and the decline was mostly evident in the period between 5 – 7 years ago and 12 – 15 years ago. The analysis showed that the general perception is that there has been little change (approximately a 1% improvement) in the past 5 – 7 years according to both groups.

The results of the regression analysis for the documentation issues confirmed both designers and contractors agree the quality of documentation has declined over time. However, it is the degree of that decline, which is in debate. The analysis indicated that designers believe the decline had been around 6% on the quality delivered 12 – 15 years ago. This result was boosted somewhat by the inclusion of the variable *standardisation* in the analysis. When this variable was excluded, the decline was slightly more at 7%. A slightly greater proportion of the decline was in the period 5 – 7 years ago to 12 – 15 years ago. The results of the contractor regression analysis suggested a serious decline of approximately 35% since the period 12 – 15 years ago. In contrast to the designers, the contractors have indicated that the decline has been more significant in the recent time period.

A rank correlation analysis comparing the contractors and the designers ranking of the level of incorporation of issues as determined by the mean responses was carried out to determine the relationship between the views of the two groups. For the period 12 – 15 years ago, the correlation coefficient was 0.90, this represents a strong relationship between the groups. Over time the statistic has declined and is now approximately 0.22 (design issues) to 0.27 (documentation issues) indication that designers and contractors now have differing perceptions of the level of incorporation of the issues.

As stated before, designers were asked to indicate what issues were affecting the design and documentation quality. Designers believe clients did not seem to understand that the level of fees provided and the time available determine the quality of design and documentation. They believe that *unrealistic expectations by clients - in relation to fees, service and timing* had a detrimental effect on the quality of design and documentation produced. *Low fee structures, an inadequate or moving client brief* and *insufficient overall design time* were also detrimental to design and documentation quality.

Designers have indicated that *low fee structures* have effected the design and documentation quality. They indicated that this and *unrealistic expectations by clients in relation to fees, services and timing* were the issues occurring most frequently that affect the quality of design and documentation. Although, *low fee structures, insufficient overall design time* and the *proliferation of 'backyard' operators prepared to work for minimal fees* had the greatest effect on design and documentation quality. The later issue was seen as adding to the designers' burden in securing a satisfactory fee level.

The lower fees available from both sectors have impacted on the adequacy of time available to provide quality design and documentation. According to the designers' responses, there is insufficient time available for each key phase of the design process to ensure high quality design and documentation. Not only is there is insufficient time available to compare and discuss project details with other design disciplines, there is also insufficient time to investigate innovative approaches to better meet the specific project requirements. The level of service requested by the client has remained constant according to designers underlining their belief that the design function has been downgraded from a client's perspective. When comparing the results for design and documentation it is evident that reduced design fees had affected documentation quality attributes slightly more than design quality attributes, although all attributes have been affected. Over the past 15 years, there has been a decline in the accuracy and completeness of documentation probably reflecting the decrease in the level of fees and time available.

Lower fees impact on every area of design and documentation quality. There is less time available to preserve the quality of the design and provide the level of service needed. Designers are unable to carry out to the degree they did 15 years ago attributes of design quality. Issues like coordinating design details from various other consultants and providing practical design detailing and construction methods have been significantly affected. Without sufficient time to adequately review the design and documentation, there is more risk in the process and the likelihood of higher project costs due to increased variations, delays, rework and the potential contractual disputes and legal action. The increases in the number of contract variations, drawing revisions and RFIs requesting design clarification over the past 15 years, has also had a dramatic affect on the time and effort required to manage these issues, thereby adding an additional cost burden on the process.

Other areas affected by lack of time are innovation and staff training. Time is needed to explore innovative approaches to meet project requirements and investigate alternative designs and comparative cost analyses. New ways of approaching design problems need time to be considered. Without the necessary time to develop new solutions, the advancement of design, construction methods and material efficiency is stifled. By not being able to explore innovative design solutions, the opportunities to improve overall project outcomes are lost. Lower fees also impact on the profitability of a firm. With less profit there is insufficient money to provide on-the-job training for junior staff. Future design quality depends on the training provided to the junior staff. Without sufficient training the designers of the future will have limited ability to provide adequate designs for projects. Over the past 15 years, there has been a decrease in '*in-house*' training. There has also been a decrease in the availability of experienced design personnel.

The effect of the lack of time available has been some what reduced due to improvements in technology. The use of CAD, IT and computer software has helped speed up the design process allowing better use of the limited time available. This may account for the increased use of standardisation in documentation. Lack of time may have also increased the use of standard specifications.

Designers have indicated that the amount of time necessary to complete the design and documentation process is not adequately accounted for within the fee structure. However, they also believe that regardless of the fee level, there is insufficient time being allowed to not only enable the production of high quality design and documentation but also to adequately incorporate innovation and life cycle considerations. They believe if more time was made available for design and documentation, the level of overall project quality would be higher.

Designers indicated there is not sufficient time available to investigate innovative approaches to better meet the specific requirements of the project and there is insufficient time is provided early in the design stage to consider whole life-cycle issues. Designers indicated that clients did not seem to understand that an increase in project costs can be due to cut backs in the initial time allowed for design.

The respondents were also asked to assess the quality of design and documentation produced under the various procurement methods. Designers were asked for an assessment of the extent of use of each procurement method over the past 15 years and to rate the adequacy of time and extent of service requested under each of the procurement systems nominated. According to designers the *traditional* procurement method was the most utilised and they perceived it to provide the highest quality standards of the three procurement methods over the past 15 years. They believed it also showed the greatest decline over that period, with the extent of that decline (nearly 10%) being statistically significant.

Contractors were asked to assess the quality of design and the quality of documentation produced under the various procurement methods. Their responses for the overall quality of design being produced at the specified time periods for each procurement system showed a perceived decline in the quality of design, particularly for the traditional procurement method. Like the designers, the contractors perceive the quality under the *traditional* procurement method started at a much higher rating 12–15 years ago, although unlike the designers, the contractors rating for design quality has now dropped to below the standard of the other two procurement methods. Contractors and designers however do agree that under both the *design and construct* and the *management* procurement methods design quality has declined slightly, with the indicated levels not being significantly different from each other at any of the time periods.

When considering the overall quality of documentation being produced at the specified time periods for each procurement system, the contractors responses were similar to their perception for the design quality although they perceived a much greater decline overall. According to contractors, the rating now for documentation quality was below the rating for design quality for each procurement method indicating the decline in documentation quality had been more severe in the past 5 – 7 years. This supports the respondent's perception that the decline in documentation has been greater than the decline in design.

In relation to the adequacy of time available, the designers determined that the adequacy of time available for the design and documentation function was greater under the *traditional* procurement method, than under either the *management* or *design and construct* procurement methods at all time periods. However, the designers considered that there had been a significant decline in the availability of time to carry out the design and documentation function over the past fifteen years. This level of decline was consistent – at around 20% – for all three procurement methods.

The designers were also asked to rate their perception of the overall level or extent of the design and documentation service requested by clients, under each of the three different procurement methodologies and at each of the three different time periods. They indicated that the level of design and documentation service requested by clients was perceived by designers to be greater under the *traditional* procurement method, than under either the *management* or *design and construct* procurement methods. The designers consider that there had been a slight decline in the levels of service being requested for all three procurement methods over the past fifteen years but only the decline for the traditional method – at around 7% – was considered statistically significant.

When comparing the results it is apparent that the time available to carry out the level of service required has declined significantly over the past fifteen years, while the level of service required has itself, only declined slightly by comparison. It is this disparity that the authors believe may well be a major contributing factor in the perceived decline in the quality of design and documentation. From this, it is reasonable to deduce that the main reason why the quality of design and documentation produced under the *traditional* procurement method is perceived to be greater than that produced under the other methods, is directly related to the extra time available to carry out the design and documentation function.

Although there has not been a significant decline in the level of service requested by clients designers have indicated there are a number of areas where there had been a decline in the level of service provided. Providing complete and accurate documentation and design detailing; checking that dimensions are correct and appropriate; and coordinating design details from various other consultants are the major concerns of designers. These are the areas designers perceive there had been a significant decline in the level of service provided over the past 12–15 years. Contractors had indicated that insufficient design coordination causing clashes between building elements and insufficient design coordination causing clashes between services elements were two issues that had a highly detrimental effect on construction process efficiency.

Other areas of design and documentation deficiency specified by contractors as occurring frequently include inadequate or insufficient design work carried out and the design not being achievable within the project budget according to contractors. While those issues that occur most frequent have a detrimental effect on construction process efficiency, other design problems that contractors have suggested had a detrimental effect on construction process efficiency were fast–track design not keeping pace with construction activities and design changes causing disruption to critical construction activities. Designers have indicated that clients do not understand the impact that a changing design brief has on the efficiency of the design team. A high proportion (85%) of the contractors who responded stated that there had been an increase in the frequency of occurrence of design problems identified as contributing to a reduction of construction process efficiency. Documents issued with conflicting, incorrect or inaccurate information, and documents lacking clarity and forcing contractors to interpret requirements were the documentation issues that contractors perceive as contributing to a reduction in construction process efficiency.

Contractors were asked to indicate whether the quality of design and documentation supplied has an influence on the tender price submitted. The responses from nearly all contractors (93%) indicated that the standard of design and documentation has an influence on the price submitted. Similarly, contractors were asked to indicate whether the quality of design and documentation supplied has an influence on the project time allowed. Overall, 75% of respondents stated the quality of design and documentation influenced the time allowed to complete the project.

Further, contractors were then asked to indicate to what degree the quality of design and documentation supplied influences the tender price submitted and project time allowed. The question provided contractors with five design and documentation standards ranging from very poor through to excellent. They were asked to indicate the percentage reduction or increase on the project tender price and project time allowed for each specific standard. The responses indicated that poor quality design and documentation was costing clients and developers an average of 7% on the estimated project cost and a similar amount in time for the project duration. Even when the standard of design and documentation was considered

good an average of 0.3% was added to the tender price. This reflected a strong negative relationship between the standard of design and documentation and the price submitted for a project. As the quality of design and documentation declined the tender price and time allowed increased. A correlation analysis of the percentage change in the price submitted and the time allowed for a project given the standard of design and documentation indicated a strong positive relationship. The correlation statistic is 0.87.

Contractors were provided a list of construction process efficiency indicators and asked to indicate the proportion of the total amount achieved on a project was due to design and documentation deficiency. The contractors' responses suggest that for each of the construction process efficiency indicators provided, a high proportion of their occurrence is due to design and documentation deficiencies. They indicate that when there is a request for information (RFI), variation, cost over run or contract dispute, it was due to design and documentation deficiencies more than 40% of the time, with RFIs approaching 50%. They indicated that other issues were due to design and documentation deficiency just under 40% of the time. The extent of occurrence of the construction process efficiency issues have increased over time according to contractors, with requests information providing the greatest increase to an average rating of 7.3 on a scale of 0 – *no occurrence* to 10 – *extremely excessive occurrence*. Variations had the next greatest increase.

Designers were presented a list of indicators of design and documentation deficiency and were asked to indicate whether in their experience, there had been an increase in the occurrence of each of the issues listed over the past fifteen years. A majority of designers (between 55% and 67%) believe that there has been an increase in each of the indicators representing deficiencies in design and documentation quality, over the past 15 years. Given the contractors perception of the relationship between design and documentation deficiency and construction process efficiency this would seem to support the their assertion that there had been an increase in the occurrence of issues that contribute to a reduction in construction process efficiency. Comparing the responses we see that both designers and contractors agree there has been an increase in the extent of rework and the number of RFIs and variations in the past 15 years.

The effect of the occurrence of construction process efficiency issues on managerial or administrative time and cost allowed has been dramatic. Contractors stated that the total amount of managerial or administrative time spent on the issues was an average of 33 % 12 to 15 years ago and had increased to an average of 72% of time allowed now. The two issues that have had the greatest increase in occurrence over time, requests for information and variations, were consuming an average of 27% of the total time available now. This increase was double the total time allowed 12–15 years ago. The responses were similar for managerial costs where, once again, the increase was double with an average of 30% of the total managerial / administrative cost 12–15 years ago expended on these issues and an average of 64% of the total cost allowed now.

The nature and the extent of the impact of design and documentation deficiencies on construction process efficiency indicators is clear, most contractors add a percentage to the tender price submitted for a project to allow for poor quality design and documentation and also increase the estimated duration of a project. For the work currently being carried out, design and documentation deficiency has caused a high proportion of the problems. Both designers and contractors agree that there have been increases in the occurrence of the indicators listed. Requests for information and variations were particularly of note, but all areas identified contributed. Similarly, the managerial time and cost expended on the

problems has also increased. High proportions of the increases have occurred in the recent period.

We have related through this report from the responses received, the perceptions of the industry members with regards to:

- Perceived changes in design and documentation quality over time.
- Areas of design and documentation deficiency.
- Perceived causes of design and documentation deficiency.
- Changes in the level of design fees over time.
- Impact of reduced fees.
- Changes in level of service and involvement.
- Effects of design and documentation deficiency on CPE.
- Differences in level of quality of procurement.
- Other Changes in the past 15 years.

The survey results indicate that all sections of the industry agree that there are major problems with the design and documentation process in the Australian construction industry and that these problems are leading to construction inefficiencies and increased project costs.

From a contractors' perspective, the deficiencies occurring in design and documentation being provided by consultants, have been steadily increasing over the past 12–15 years and are causing corresponding increases in the extent of inefficiency within the construction process. As a consequence, decreases in project quality and increases in overall project costs result. Of major concern are the additional costs – which to a large degree end up being absorbed by contractors – caused by the delays and disruption in trying to clarify inadequate, impractical, conflicting or ambiguous design and specification documentation.

The designers, whilst also acknowledging this reduction in design and documentation quality and the services being provided, consider the primary causes to be reducing design fees, decreasing project design and delivery times, and an increasing number of clients with unrealistic expectations and an inability to properly define project objectives and requirements. Both contractors and designers indicated the increasing use of junior and inexperienced staff to carry out the design function. Designers suggested that this was a direct result of reduced fees and inadequate design time, limiting the type of staff available and the extent of supervision and in-house training provided. Concern is raised that if, due to modern design firm pressures, adequate supervision and in-house training from senior staff is not supplied, the knowledge base of future designers may be diminished.

During the analysis of the responses for each area, special attention was placed on the interpretation of the responses in consideration of the responses to each of the other sections. Bearing in mind the Bradford Hill criteria outlined earlier, we have assessed the responses in an effort to determine whether it is plausible to conclude a causal relationship between the level of design fees, the quality of design and documentation and the extent of construction process efficiency.

This analysis has revealed a strong association between the decline in design fees and the perceived decline in design and documentation quality. Complementary to this there is also a strong association between the quality of design and documentation and construction process efficiency. The responses throughout were consistent and this is borne out by the relatively high level of agreement in the responses for the various issues surveyed. The designers' responses for the different procurement methods and budget ranges were similar, revealing a decline in the fee structure. The designers and contractors agreed there had been a decline in

the quality of design and documentation and an increase in design and documentation deficiency, which was affecting the extent of construction process efficiency.

Given that only three specific time periods were surveyed and the interval between the time periods we were not able to absolutely determine temporality. We were able to see that the rate of decline for the level of fees, design and documentation quality and construction process efficiency were similar.

The strong association revealed, accompanied with the weak temporal assignment of the changes, the consistency of responses and similarity in the rate of decline provides sufficient evidence to support a plausible claim of causality. It is the belief of the authors based on the responses of the surveys that the reduction in the level of design fees together with a reduction in the time made available to carry out the work, has caused a decline in the quality of design and documentation. Further, the decline in design and documentation quality has caused a reduction in construction process efficiency.

By reducing design fees to minimise costs, clients and developers were by their own actions, contributing to the problems which lead to inefficiencies in the construction process and increases in overall project costs. The results of the surveys clearly show a need for clients and developers to allocate adequate funds and time to the planning and design phases of a project, in order to maximise construction process efficiency and minimise overall project costs.

Improvements in construction process efficiency will result from creating an awareness of the value of quality design and documentation and the introduction of selection criteria that includes consideration of the designer's skills and experience. Once developers fully understand the value of quality design and documentation, they would then ensure that sufficient time and fees are available to allow designers to provide the level of service needed to carry out the design function completely. The benefits would be more projects being completed on time, within budget and with a reduced likelihood of legal action due to contractual disputes. Also, with less RFIs, variations and rework, contractors would be able to minimise the management time and cost spent on non-value adding activities. These benefits would be reflected in reduced project and contractual risk and a higher level of profitability for both developers and contractors. More reasonable fee levels would also enable designers to restore staff training programs – to develop a higher standard of designer – and encourage innovation. Increased fees may also stem the outflow of experience designers, which has the potential to diminish the knowledge base of the industry.

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