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Overcoming the problems associated with quality certification

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Serendipitous findings are reported from an on-going research project that seeks to determine the effectiveness of quality assurance systems certified under the ISO 9000 series in Australian contracting organizations. In Australia, certification has become mandatory for all organizations wishing to do business with government agencies and major private companies. While certification was designed so that purchasers could have confidence in the quality of the vendor's product or service, not all organizations have been able to implement certification processes in a way that supports this original intent. Instead, most construction organizations have opted to go through the motions without an underlying sustainable continuous improvement philosophy. They simply wish to gain marketing benefits, while others have been overcome by the mass of paperwork required for achieving the quality 'seal of approval'. This paper uses a case study to examine the experiences of a major building and engineering contractor threatened by the paperwork dilemma. However, by adopting a radical shift in the management of the certification programme the contractor was able to implement a quality system that reduced rework significantly and brought about marketing benefits. This case study is used to present a company's experiences in solving problems associated with the certification process, and offers a learning opportunity for other organizations facing similar difficulties.

Keywords: Quality certification, ISO 9000, documentation, rework, continuous improvement

Introduction

The issue of quality certification to recognized standards such as the International Organization for Standardization (ISO) 9000 series has become a contentious issue within the construction industry. In order to have any chance of gaining government contracts, consultants and contractors are required to show that they have been given the 'quality stamp of approval'. In essence, becoming certified to a recognized standard has become a matter of survival for many organizations. For some organizations, certification has become an end in itself, rather than a means of implementing on-going quality system, which seeks the objective of sustainable continuous improvement.

Many organizations in the construction industry have started out with the best intentions regarding the

use of certification, but the documentation requirements of the ISO standards have proved to be extremely onerous and bureaucratic (Love *et al.*, 1998a). Each of the twenty elements of the ISO 9000 series requires its own documentation and procedures. Indeed these need to be maintained effectively. If they are not, then organizations may find themselves being channelled into managing the documentation aspects of the certification process, rather than into achieving the objectives of the quality system itself (Kelada, 1992). Equally important, staff motivation may become a serious problem, since staff tends to review certification as a necessary non-productive evil, and may resent the extra work it imposes on them.

According to Low and Chan (1998) the type of power in organizations, the distribution of authority, the degree of empowerment, organization politics,

employees' resistance to change, leadership style and conflict within construction organizations can severely affect the implementation and maintenance of a quality management system. They suggest that in order to implement an effective quality management system, diverse management factors such as support of senior management, appropriate leadership style, the cultivation of employee's behaviour and attitude, open communication and feedback must be considered.

This paper describes a case study to analyse the experience of a medium-to-large building and engineering contractor that was confronted with the problems mentioned above. Yet, through a radical shift in the management of its certification process it was able to reorganize its quality system while simultaneously gaining the support of its workforce. Therefore, the reorganized system significantly reduced the costs of rework experienced in projects and brought about marketing benefits. Research undertaken by the Construction Industry Development Agency (CIDA, 1995) found that when a formal quality management system was used by construction organizations the cost of rework decreased significantly. According to Burati *et al.* (1992) when total quality management (TQM) is applied in a holistic manner, rework can be virtually non-existent, especially if incentive/bonus schemes are introduced.

The organization used as the case study in this paper is one of a number of organizations being examined as part of a wider study to determine the effectiveness of being quality assurance systems (QA) certified under the ISO 9000 series. The case has been singled out because the organization's experience in solving problems associated with certification process offers a model learning opportunity for other organizations facing similar difficulties.

Quality certification

Assurance to the ISO 9000 standards provides proof that an optimal level of quality is being obtained throughout all stages of the product's quality cycle. Quality assurance is simply an overall system of monitoring activities and a mechanism that aims to prevent quality deviations and to give early warning of poor quality produced, from the design of the product to its delivery and use by the customer (Kelada, 1992).

There is a great deal of confusion surrounding the terms certification, registration, and accreditation. Typically, these terms frequently are used interchangeably in an informal context. However, these terms have different meanings. Traditionally certification applies only to products, and is a procedure whereby a third party gives written assurance that a product performs

to specified requirements. Conversely, registration applies to the assessment and approval of quality systems, not products. Accreditation has its own distinct meaning when compared with the aforementioned terms. It is simply the provision by an authoritative body of formal recognition that a quality system is competent for specified conformity assessment tasks.

Driving forces for certification

Since their release the ISO 9000 standards have become increasingly accepted as a set of quality assurance standards in almost all developed countries. For Australian construction organizations exporting their services the accreditation to such standards is a qualification for them to operate across national boundaries into markets supporting ISO 9000. To implement an ISO 9000 standard, an organization must recognize why such a standard should be used. According to Love and Li (1998), many organizations in the Australian construction industry have taken this certification route for the wrong reasons: e.g. because they see that 'everybody else is doing it' or 'because it is supposed to improve performance'. Yet the research undertaken by Buta and Karkhanis (1996) suggests that quality certification was sought to reduce the incidence and cost of rework and improve marketing. According to Kelada (1996) an organization should introduce an ISO 9000 quality system for the following reasons:

1. to achieve total quality;
2. to satisfy a specific requirement from one or more customers; and
3. to open up new domestic and foreign markets in cases where ISO 9000 is neither compulsory or mandatory, thus giving the organization a competitive advantage.

Similarly, Wenmoth and Dobbin (1994) suggest that the fundamental factors that influence organizations to become ISO 9000 certified can be categorized as:

1. customer demands and expectations;
2. competitive pressures;
3. regulatory environment; and
4. internal benefits.

Rothery (1993) considers ISO 9000 to be a tool that can be used as an effective control mechanism, which seeks to reduce waste and labour inefficiencies in a process so that quality in the production and delivery process can be ensured. The justification for an organization to become certified to ISO 9000 normally is based on the premise that it will acquire benefits such as improved performance, increased customer satisfaction, better customer and staff morale, and that it will be a first-class marketing tool (Street and Fernie, 1993).

Barriers to certification

Indeed, the path to becoming third-party certified can be a long and tedious process. Many small and medium size organizations in recent years have voiced their concerns over the difficulty and cost of introducing an ISO quality system (Buta and Karkhanis, 1996). Accordingly, Gnome (1995a) contends that the ISO 9000 series is irrelevant to small and medium organizations as the high costs associated with achieving and maintaining a certification programme could damage their business significantly. In fact, Gnome (1995b) goes as far as stating that ISO 9000 requirements are far too sophisticated and do not add value to small and medium size businesses. The direct costs of obtaining and maintaining ISO certification are its associated registration fees, auditing fees and the optional consultant fees (Kennedy, 1995).

The QA practice developed within the construction industry has tended to be based on post-production quality control, and as a result this has meant an increase in costs without commensurate savings (Jaafari, 1996). Tucker *et al.* (1996) found that most organizations did not consider that being third-party certified increased their turnover, although it was felt that the organization's image improved. Another barrier to certification that often is experienced is an increase in paperwork. Thus, organizations do not see the advantages of improved productivity and reduced rework (Sanders, 1994). Ho (1995), however, points out that if an organization can gain a comprehensive understanding of the flexibility of the ISO 9000 standards then it can implement an effective system with minimal paperwork.

ISO 9000 and TQM

The internal auditing process for ISO can be used as a tool, which can contribute to continuous improvement. If used effectively it can facilitate process improvement by identifying poorly performing activities (Kalinovsky, 1990). The use of corrective action analysis can be used to determine the causes of poor performance in a process. The identification of such causes will influence the appropriate actions used to solve the problem at hand. In this way the internal audit process associated with ISO 9000 can be used for sustaining continuous improvement. The fact is that on its own QA does not provide enough benefits to justify its implementation in terms of cost, particularly considering the prevailing industry practices. To reap benefits and improve the overall cost competitiveness of construction one needs to implement a comprehensive company-wide TQM system, locking in systematic processes and creating a

permanent culture for sustainable and continuous improvement.

Many companies have found it easier to aim for technical aspects of quality by gaining ISO 9000 status than having to implement TQM. Primarily this is because TQM is a management philosophy that has no commonly agreed definition. This poses a problem for an organization that embarks on such a venture without being sure whether it is actually in line with its goals. However, ISO 9000 standards are universal and are not simply the decree of one quality guru, but have been devised by an international committee. Before TQM can be implemented effectively, the foundations of quality must be in place; that is, a culture built around ISO 9000 and continuous improvement (Love *et al.*, 1998a; Kalinovsky, 1990). ISO 9000 and TQM should not be seen as competing approaches but as being complementary. TQM simply assumes that a quality system is in place and compliance is being adhered to. Despite the increasing demands of customers and the intensive competition in both domestic and overseas markets, third party certification has been the only major dimension of TQM that most Australian construction companies have sought to implement (Jaafari, 1996).

The case study presented in the next section of this paper describes the experiences of a medium to large building and engineering contractor that overcame the barriers of ISO 9000 and, through implementing a continuous improvement philosophy, was able to reduce the amount of rework experienced in its projects.

Methodology

Four building and engineering contractors are involved in the research that seeks to determine the effectiveness of quality certification in construction. To obtain a balance between deductive and inductive reasoning we have undertaken a case study approach in an attempt to understand why and how building and engineering contractors use their quality systems.

Case study

A case study can be defined simply as 'methodology based on interviews, which are used to investigate technical aspects of a contemporary phenomenon with its real life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used' (Yin, 1989, p. 3). The authors have based their methodological framework on theoretical replication. Yin (1989) supports this approach and specifically notes

that multiple cases should be regarded as multiple experiments and not multiple respondents in survey, and so replication logic and not sampling logic should be used for multiple case studies.

In this paper, serendipitous findings from a single case are used to dispel the notion that ISO 9000 certification is simply a marketing tool but instead is a mechanism for continuous improvement. This single case provides valid findings from which other organizations can learn.

Background to the company's quality certification process

The building and engineering organization described in this paper will be referred to as ABC. At ABC, the decision to implement a quality system and the decision to gain ISO 9000 certification were quite distinct. In 1989, ABC committed itself 'to do it right the first time and every time'. It saw a need to develop and implement a quality management system to better understand, control and measure the performance of its projects. Moreover, ABC sought to obtain a competitive advantage in both domestic and international markets.

Initially some exploratory certification work commenced within all of its five divisions using ISO 9000 as the basis for a quality system. There was resistance to the quality scheme primarily because employees and site management teams were unfamiliar with fundamentals of quality. Therefore, an external consultant was invited in to introduce and improve employees' attitudes towards quality concepts. Working within continuous improvement and teamwork philosophies, the consultant made a number of recommendations, such as implementing training, incentive schemes, partnership formation with subcontractors, and other initiatives, that management should adopt and implement. Accordingly senior management took note and had the consultant's recommendations implemented. There was a marked and positive change in employee attitudes towards quality, and as a result ABC became certified in 1991.

Within twelve months of being certified the quality manager reported that rework in projects had significantly reduced and within eighteen months the costs (direct and indirect) of being certified to ISO 9000 were beginning to pay dividends. Coincidentally, many of the recommendations made by the external consultant were in line with the twenty requirements of the ISO 9000 series standards. Since becoming certified in 1991, the company has gone from strength to strength and has managed to increase its market share and profitability, despite the recent recession of the early 1990s experienced in Australia. The company believes

that its now firmly established quality culture has encouraged customer loyalty and will contribute to its future growth.

Data collection

The data collection procedure has followed the major prescriptions by most textbooks in doing fieldwork research (e.g., Fiedler, 1978; Dane, 1990; Yin, 1993). A variety of sources is being used to collect data with regard to the effectiveness of QA, e.g., its costs per project, the amount of non-conformance, the company's investment into QA, types of training, and the costs of auditing. Various data have been used to derive the findings presented in this paper, and include interviews, observations, illustrative materials (e.g. newsletters and other publications that form part of ABC's history), and past project documentation. The authors have several years work experience with major building and engineering contracting organizations and have used this experience, together with a predefined protocol, to determine the data needed. However, the authors point out that they have used the same procedure for collecting data for each case (Yin, 1981). Bearing in mind the array of evidence that was accumulated, great care has been taken to ensure that the data collected converged on similar facts (Jick, 1979).

Interviews

Interviews were conducted with the construction and engineering manager, the quality manager, three project managers and quality engineers from each division. The duration of each interview was approximately forty minutes. Every interview was conducted on a one-to-one basis so as to stimulate conversation and breakdown any barriers that may have existed between the interviewer and interviewee.

The interviewee was allowed to talk freely without interruption or intervention. In this way the interviewer acquired a clearer picture of their perspective. Interviews were used to gain (Easterby-Smith *et al.*, 1991): (i) an understanding of the constructs that the interviewee used as a basis for forming opinions and beliefs about the performance of the organization's quality system; (ii) an understanding of the step-by-step logic of why and how an event occurred; and (iii) the confidence of the interviewee, to overcome the reluctance to be truthful about an issue other than through a confidential one-to-one situation. The authors acted as a neutral medium through which questions and answers were transmitted, and therefore endeavoured to eliminate bias. Essentially, bias in interviews occurs when the interviewer tries to adjust

the wording of the question to fit the respondent, or records only selected portions of the respondent's answers. Most often, however, interviewer bias results from the use of probes. These are follow-up questions and typically are used by interviewers to get respondents to elaborate on ambiguous or incomplete answers (Shaughnessy and Zechmeister, 1994).

With this in mind, in trying to clarify the respondents' answers the interviewer was careful not to introduce any ideas that may form part of the respondent's subsequent answer. Furthermore, the interviewers were mindful also of the feedback respondents gained from their verbal and non-verbal responses. Thus, the interviewer avoided giving overt signals such as smiling and nodding approvingly when a respondent failed to answer a question. It was decided that such actions could lead to respondents withholding responses to later questions. The interviewees reviewed the reports from the interviews and their views were invited to help ensure accuracy.

Findings and discussion

The establishment of a new quality system is an arduous task for companies. The utmost care must be given to involve staff who will have an effect on or be affected by the quality system. Documenting existing informal procedures and writing new procedures to be followed should be done by the people who perform, or will perform, the activity in question. According to Kelada (1996) companies seek registration of their quality system for a number of basic reasons, such as to comply with a customer request, to increase their own satisfaction and bolster their pride, to motivate their personnel, or use the registration as a marketing tool. The initial exploratory programme was by no means straightforward for ABC. The path to certification caused additional work and a certain amount of resentment from employees. This was due to a number of factors, which included the documentation requirements of the certification process, the focus of third party audits, and the stress imposed on staff created by the certification process. The problems associated with each of these three factors are described below. There are numerous paths an organization can take in acquiring certification but perhaps the most widely recognized is the working guide developed by DuPont and identified in Hockman *et al.* (1994), which can be seen in Table 1.

Documentation

Before an organization decides to implement a quality standard such as the ISO 9000 series, they should first become acquainted with its contents. Reviewing the

Table 1 Road map to ISO 9000 registration^a

Steps	
1	Management decision commitment Developing a strategic plan
2	Establishing and training management representatives, and quality coordinators Communicating to the entire organization Defining and training audit teams
3	Beginning internal audits Initiating the first round of internal audits Defining areas for improvement Establishing documentation teams
4	Beginning documentation efforts Analysing work processes Writing and updating procedures and instructions Creating a first draft of the quality manual Implementing procedures and instructions Continuing internal audits and corrective actions
5	Choosing the registrar Setting up the initial visit
6	Documenting and implementing practices Revising and approving the quality manual Continuing internal audits and corrective actions Management review
7	Pre-assessment Correcting deficiencies Practices documented and implemented Management review
8	Registration assessment Correcting deficiencies
9	Registration Continuous improvement Continued internal audits Corrective actions Surveillance audits Management review

^a Source: Hockman *et al.* (1994).

ISO series gives a good idea of the standards, its philosophies, and the basic concepts and terminology they employ. The standards are not a recipe for quality, but a guide to implementing a quality system. Thus, the standard fundamentally identifies the ingredients that should be included in a quality system; it does not prescribe how that system should be designed.

An organization interprets the requirements of the standard in relation to their own business. From a practical point of view ISO 9000 is valuable to an organization because it provides a holistic framework so that they can assess where they are and where they would like to be. In simple terms, ISO 9000 directs an organization to document what they do and then do as they document. Thus, the senior management of ABC assumed that the design and development of a quality system would be straightforward, and

therefore sought to design their system around the criteria highlighted in the standard. One major aspect, however, appeared to be overlooked or taken for granted by management; they simply did not convey to staff how the quality system was to be designed, and neglected the fact that they did not have any supporting education or training programmes with respect to the principles of quality.

In hindsight, the quality manager suggested that the organization's initial path to certification was too bureaucratically based and, consequently, resistance and resentment from staff became an apparent evil of the quality system. Management failed to acknowledge that certification was the first step towards a much larger goal, which was the achievement and maintenance of total quality. Similarly, Love *et al.* (1998b) suggest that certification should be seen as being only part of the quality conundrum, and invariably is instrumental in achieving an organization-wide approach to continuous improvement. Needless to say, at the heart of the certification process is the requirement that organizations prove they have established procedures that are being followed. Such proof can be provided only by means of audited paper trails. Thus, documentation has a major role to play in the certification process. In the case of ABC they had to ensure their documentation reflected current work practices requiring considerable financial and human resources. Furthermore, the requirements of certification seemed to lead to excess amounts of paperwork, and were seen to be quite separate from the on-going income-producing activities within the organization.

In fact there was a temptation to write more into the documentation than the job actually entailed. According to the quality manager some staff started to expand their activities and build a picture of what they would like to do rather than document the work they actually did. This had the potential to create problems in the future, as the standard requires organizations to demonstrate that the work practices within the organization reflect the procedures documented. If there are any discrepancies between them then this could lead to a nonconformance being incurred during a third-party audit. Almost all staff had no experience in procedure writing and, as a result, the process of documentation became a stressful, tedious and arduous task for all concerned. Invariably, staff who preferred working under very specific guidelines tended to write too much detail. This was an attempt to expand their own importance and cover all situations, thereby creating considerable amounts of work for themselves. Furthermore, there were staff with a more *laissez-faire* approach who went to the other extreme and wrote high level generic guidelines that failed to provide sufficient detail pertaining to the work they actually performed.

Third-party audits

Research conducted by Tucker *et al.* (1996) and Buta and Karkhanis (1996) suggests that almost all organizations have some elements of a quality system in place, be it formal or informal, complete or incomplete. The emphasis in the ISO 9000 standard, however, as with other quality assurance systems such as AS 3900, is on formalizing the process through documentation (SA, 1993). The formalized nature of certification has been a fundamental factor that has inhibited the uptake of quality in the Australian construction industry (Tucker *et al.*, 1996). We suggest that many organizations in construction do not realize that documentation can result in traceability, that is, being able to trace an effect back to its causes. This encourages clarity and order (eliminates confusion) and can help facilitate learning. Indeed the reduction of confusion and enhancement of learning are not contradictory imperatives. On the contrary, they are closely related and powerful in combination.

There is a mass of paperwork required for certification, but it is the price an organization must pay if it wants to eliminate and ensure no reappearance of poor quality service or inadequate products. Nevertheless, to gain and maintain certification, an organization must show it is continually correcting non-conformances, both major and minor. On-going audits typically occur every six months and are conducted by accredited organizations such as the Standards Australia and Bureau Veritas. One of the complaints that have been levelled at these organizations is that they focus on the letter of the law, rather than its spirit.

Auditors may examine the paperwork without any apparent concern for the implications it may have on procedures. For example, a non-conformance may be raised because a training list is out of date: an incident that has little bearing on the actual performance of the organization, or the quality of the product or service delivered to customers. At times the focus of the audit was such that more attention was given to getting the minutiae right. There was also the problem of the occasional auditor not being familiar with the construction process. Faced with an external auditor who focused on activities that had little bearing on the performance of ABC, or one who was ignorant of the construction process, it was difficult for staff to see the relevance of the certification process to their work, to overall business performance and to sustaining a competitive advantage.

Stress

The documentation process of certification potentially can be stressful for all those involved inasmuch as

it is resource intensive and time consuming, and managers expect to see tangible results. At ABC pressure was placed on staff to produce these results. Staff became stressed and it appeared to originate from a lack of fit between the person, circumstances and reaction. This was also exacerbated by a lack of training and experience in documentation and the demand for immediate results. At ABC, additional stress was caused by the third-party audits. The quality manager reported that on days of assessment it was '... like having an exam, everyone was nervous'. Also, the period immediately before the audits was similar to last minute examination preparation. Intensive effort was channelled into bringing paperwork up to date in time for the visit by external auditors. Following these periods of concentrated activity, the certification process would almost be forgotten for the next six months. When another compliance audit loomed, staff would expeditiously endeavour to have everything ready. The quality manager pointed out at every surveillance audit that there was an enormous effort being compressed into this period, and as a result it was 'burning staff out'. This meant that the benefits of having procedures in place during other periods of the year were not being realized.

The combination of the above factors indicated to management that the quality system was more a burden to ABC rather than a means for continuous improvement. Something needed to be done to overcome the drain on resources and the escalation of poor morale brought about by forcing conformance with the certification process.

Overcoming the obstacles

After considering the problems being encountered with certification, senior management decided to obtain an external consultant to assist the organization with its problems. Before the consultant was hired their experience was thoroughly evaluated. The consultant was briefed by management about ABC's problems and was required to present a submission, along with their credentials, about how they proposed to tackle the certification process. The consultant was sympathetic to ABC's problems and recognized that management had not made it clear to staff that standards do not improve quality – only people do. Moreover, it was revealed that management had not communicated to staff the organization's objectives. Management had not intentionally taken this route as they simply did not understand the process of certification and, as a result, became entangled with implementing the standard.

Reorganization of ISO 9000

Instead of opting for an incremental improvement programme, ABC with the consultant's advice given, decided to implement a strategy that would bring about significant changes in employee attitudes and performance. To the relief of all, ABC's management then publicly abandoned the quality system. Management in an attempt to gain employee commitment announced that their primary objectives were not to obtain registration or to implement a new quality system, but to use ISO 9000 as an opportunity to improve competitiveness, profitability, customer satisfaction and the environment in which staff worked. Both management and the consultant reorganized the implementation of ISO 9000 so that it could be integrated into everyday activities of the organization, thereby gaining commitment from its employees. Instead of having twenty major procedures to match the twenty elements of the standard, the new quality system reflected the methods by which ABC's staff performed their jobs. It was then relaunched under a new banner – the sustainable continuous improvement plan (SCIP). To ensure ABC met the requirements of the standard, management allocated each of the twenty clauses of the standard to a working group. The quality system was no longer seen as being separate from people's jobs. Instead of having quality built around the standard, the standard was adapted to the work that people were doing both in the office and on site. While recognizing that every project is different, a generic project quality plan was established so that it was not reinvented every time a new project commenced.

The quality manager emphasized that the contributing factor to the success of this change of strategy was senior management's recognition that they had made a serious mistake and, as a result of this, they advertised the abandonment of the initial quality system. Interestingly, the procedures themselves did not change significantly. Instead the quality system was renamed and repackaged in a very well planned marketing exercise. This revised strategy significantly reduced the problems that had been associated with the certification process. The quality system was no longer seen as an imposition, but an integral part of daily work. The artificial activity to satisfy third-party audits was no longer necessary, since the quality system was maintained on a daily basis as part of everyday work practices. Documentation was no longer a burden, but instead, a reflection of the way things were done. SCIP became something that staff could take pride in, and became part of ABC's culture. In support, several authors believe this is the essence of implementing a successful quality system (Stebbing, 1989; Tennor and De Torro, 1992; Dale and Oakland, 1994).

Teamwork

To overcome the problems specifically associated with documentation requirements, ABC worked on making the documentation process more effective. A team approach was taken much in the manner recommended by Hockman *et al.* (1994). Since an activity relating to the standard may occur in different departments and projects, the approach taken was to take a person from each section with experienced project managers who all contributed to an overall generic procedure. This reduced the amount of duplicate work being undertaken by individuals within different departments and in the projects undertaken by ABC. Once the generic procedure was established, individuals then concentrated on writing procedures to describe how the activity was to be implemented. The team approach combined with a one-day training course on procedure writing helped to ensure consistency. Experience also enabled staff to settle into a pattern where procedures were specific enough to be useful, but not so detailed that they were too onerous to follow.

A good quality system will not function without audits or reviews. The reviews, which needed to be carried out periodically and systematically, were conducted to ensure that actual methods were complying with the documented process. ABC had established a number of continuous improvement teams to monitor the quality system. Each team had between five and eight employees with the knowledge and skills needed to identify and solve problems that were likely to emerge. The teams found and sometimes continued to identify problems with the system, especially in projects. The reviews undertaken by the continuous improvement teams found in many instances that procedures in projects were not being adhered to, because documentation was considered to be too time consuming. The quality manager stated that before the introduction of QA he estimated that their mean cost of rework per project was approximately 5%. Bearing in mind the competitive nature of construction and the tight margins contractors operate under the authors consider the figure of 5% to be unrealistic. The authors' estimate that the actual cost of rework for a contractor may actually be less than one per cent of a contract value (Tables 2–4) and that a contractor will invariably always try to offload any additional costs on to their client and subcontractors. In fact a contractor's estimate/tender figure may also allow for some degree of rework (in the form of a contingency) based on their knowledge and experience from previous and similar projects that they have undertaken. Thus, the actual cost of rework to a contractor may even be negligible, especially projects procured under a design and construct arrangement with a guaranteed maximum price.

Recent case study research on the residential and industrial buildings (identified in the Table 2 and Figure 1) found the direct cost of rework for these projects to be 3.15% and 2.40% of the original contract value, respectively. Yet the actual cost of rework to the contractor for these projects was found to be 0.14% and 0.98% of contract value. For more information about this research refer to Love *et al.* (1999, 1998b).

Since QA has been introduced the contractor believes that rework has been reduced significantly and consequently the organization's performance in the marketplace has improved. Tables 2–4 identify the costs associated with implementing QA in some projects since the organization became certified in 1991. The total cost of implementing QA is calculated as follows for each project identified: 1. salary and on-cost of the QA personnel involved in the project; 2. vehicle expenses; 3. accommodation allowance for remote site locations; 4. cost of preparation, review and up-date of the 'Project Quality Plan', technical and process procedures, inspection and test plans and checklists; and 5. internal auditing.

Quality certification has made it possible for ABC to save a considerable amount of money. For example, during the latter portion of the Highway and bypass project, identified in Table 2, several areas of instability in the pavement became evident. The QA documentation proved that the work had been performed to specification and, as a result, saved the organization A\$700 000 in removal and replacement costs.

Similarly, in the Highway (Section 1) project also identified in Table 2, the concrete base showed some distress. A study of the QA documentation revealed that work had been undertaken precisely in accordance with the specification. This averted the potential for dispute and focused the post construction investigation on the technical reasons for the concrete cracking, thereby avoiding a potential cost of A\$1 million for its removal and replacement.

A re-examination of system procedures actually being used has led to system improvements, which would have been difficult to obtain by other means. ABC has been able to reduce their rework significantly since becoming certified to ISO 9000. With the adoption of a continuous improvement philosophy the challenge of process improvement is seen as a continuous process of small wins.

The approaches that ABC take to continuous improvement as a process range from very structured programmes utilizing statistical process control tools such as cause-and-effect diagrams and process flow charts, to simple suggestion systems relying on brainstorming and 'back-of-an-envelope' analyses. Another tool used by ABC is the 'plan-do-check-act' cycle,

Table 2 Civil and rail engineering projects

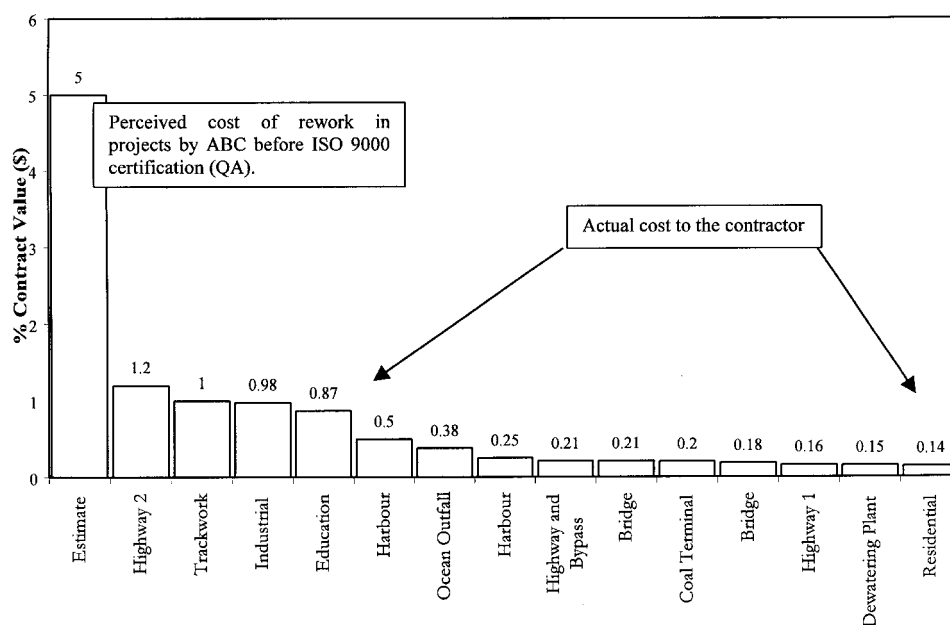
Project type	Contract type	Contract value (A\$m)	Duration (weeks)	QA costs % of contract value	Rework costs % of contract value	Total QA costs (%)
Coal terminal	Design and construct (GMP)	63	68	2.1	0.2	2.32
Bridge	Traditional (Lump sum and schedule of rates)	3.67	50	1.76	0.18	1.94
Bridge	Design and construct (GMP)	4.09	60	1.71	0.21	1.92
Dewatering plant	Design and construct (GMP)	3.33	50	1.57	0.15	1.72
Highway and bypass	Traditional (Schedule of rates)	8.54	72	1.00	0.21	1.21
Highway Section 1	Traditional (Schedule of rates)	11.82	37	0.65	0.16	0.81
Highway Section 2		11.30	42	0.79	1.2	1.99
Trackwork	Traditional based (Schedule of rates)	9.5	60	0.48	1.0	1.48

Table 3 Marine engineering projects

Project type	Contract type	Contract value (A\$m)	Duration (weeks)	QA costs % of contract value	Rework costs % of contract value	Total QA costs (%)
Harbour	Traditional (Lump sum)	1.8	22	0.41	0.25	0.66
Harbour	Traditional (Lump sum)	3	40	0.5	0.5	1.50
Ocean outfall	Traditional (Lump sum)	15	60	0.38	0.10	0.48

Table 4 Building projects

Project type	Contract type	Contract value (A\$m)	Duration (weeks)	QA costs % of contract value	Rework costs % of contract value	Total QA costs (%)
Education	Design and construct (GMP)	8	50	1.2	0.87	2.07
Industrial	Design and construct (GMP)	4.45	30	1.15	0.98	2.13
Residential	Traditional (Lump sum)	10.96	43	1.35	0.14	1.49

**Figure 1** Rework as a percentage of contract value

often called the Deming Wheel, which conveys the sequential and incessant nature of the continuous improvement process.

Education and training

Responsibility for training of employees in quality rests with management at all levels and, in particular, the person nominated for the coordination of the organization's quality effort. As mentioned above, training had been neglected from the initial certification programme so under the redesign of the quality system the quality manager made it clear to staff that additional education and training would be high priorities.

To increase the relevance of the quality system to individuals, the benefits for each person within the various departments were examined, and some intense one-to-one interviews were arranged. Training was conducted also on the ramifications of the certification process to the whole organization. Management commitment was evident throughout the entire process. The quality manager reported that support from managers could be called upon any time to overcome any obstacles that may occur.

Conclusion

Since implementing the quality system, management has reported that ABC has achieved benefits relating to process improvement (e.g. reduction in rework), and through improved marketing they have increased their market share. A limitation of this study is that it is not possible to assess the extent to which the implementation of the certification process was responsible for these benefits. Only limited numerical data before the organization was certified had been collected relating to changes, and so the benefits are only partially quantifiable. These benefits can be summarized as follows.

1. There has been a significant increase in the number of public sector tenders won. The perception is that these would not have been successful without certification.
2. Human resources are used more efficiently. Rather than have employees waste time and energy in re-inventing the wheel, procedures enable employees to follow a preset plan. If more than one person is working on a task, it is approached with sensitivity for improving coordination.
3. New employees become productive more rapidly than they did previously.
4. The amount of rework experienced in projects has been reduced significantly (Tables 2–4).
5. Work practice improvements are now developed more comprehensively and rapidly.
6. Written procedures and physical audits stimulate process improvement and help prevent staff regressing into former habits.

A wide variety of benefits have been observed since the implementation of the certification process. ABC realized these benefits only because it radically altered its approach to implementing its quality system. By publicly abandoning the first poorly functioning quality system and then re-introducing one specifically adapted to and owned by ABC itself, the company was able to bring about substantial changes in employees' attitudes, behaviour and morale. Additional training and education also fostered these changes. Using a team approach to procedure writing enabled ABC to reduce the burden of documentation on individuals and also to enhance consistency throughout the organization. This case study demonstrates that, above all, a quality system is a tool. Used inappropriately, the certification process can cause considerable harm to an organization and its workforce. Implemented in a manner consistent with sound management philosophies, it has the potential to change the organization in a positive way so that continuous improvement becomes part of the culture of the organization. Thus, ISO 9000 certification is not an option but rather a reality for construction companies who wish to retain and sustain their competitiveness in today's highly competitive markets.

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