Australian Software Developers Embrace QA Certification

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Abstract

This paper details a research project undertaken to assess the extent of adoption of quality assurance (QA) certification by Australian software developers. A brief history of government QA policy, the catalyst in the sudden interest in certification, is included. Primary data for the study were gathered from a survey of 1,000 Australian software developers, and were used to determine the extent of adoption of QA certification by Australian developers, their organisational characteristics, capability maturity and perceptions regarding the value of QA certification. Secondary data from the JAS-ANZ register of certified organisations enabled validation of survey responses and extrapolation of QA certification adoption.

Major findings of the study revealed that 11 percent of respondents are certified to ISO 9001 or AS 3563, seven percent are in progress and 21 percent plan to adopt QA certification. It also revealed that specialist developers are adopting QA certification at twice the rate of in-house developers. Other factors found to be associated with adoption of QA certification are large development groups, developers with government or overseas clients, organisations with whole- or part-foreign ownership, and organisations undertaking corporate TQM initiatives. From the findings, detailed implications are drawn for managers and policy analysts.

1 Introduction

With the increasing functionality and decreasing cost of computer hardware, there is a significant trend for organisations to implement new computer systems, and to redevelop legacy systems [1]. As well as being critical to the operation of their business, more software is becoming embedded in products and services [2]. Despite the growing importance of software, most software projects are completed over schedule and over budget [3]. For example, a survey conducted by the United Kingdom's Department of Trade and Industries found that 66 percent of all software projects were completed later than planned; 55 percent of projects ran over budget; and 58 percent had major problems [4]. That the Australian software industry is not exempt from similar problems is evidenced firstly by some projects being cancelled, often after a significant investment, for example the Commonwealth Bank's $100 million Mainstream project [5]; and secondly by the delivered product sometimes being infested with bugs, or falling short of the expectation of the client, for example Telstra has spent $300 million on its Flexcab

core billing system and '... all the code will now have to be re-examined, changed where necessary and retested from scratch for year 2000 compliance' [6].

These continuing problems constitute what has been referred to as the 'software crisis' [7]. Thus for large, complex software projects, it is important that the purchasers be able to assess the capability of would-be developers. However, as professional qualifications are not required to practise as a software developer, a potential client has no formal way of judging the competence of would-be developers. The use of third party certification may help to alleviate this problem. As well as describing changes in government QA policy this paper provides details related to the extent of current and future adoption of QA certification by Australian developers.

2 Australian Government Policy on QA Standards

Standards are profoundly important to industry and form a critical element in the future success of Australian industry, domestically and internationally [8]. Government QA purchasing policy is cited in the press as a key motivator for many organisations deciding to adopt QA certification [9, 10].

In 1987, during the Hawke/Keating government, Senator John Button commissioned a committee under the chairmanship of Dr Kevin Foley to prepare 'The Standards, Accreditation, Quality Control and Assurance Report'. This report formed the basis of the Federal Government's Quality Assurance Policy which was announced in May 1992. Departments and agencies were entitled to ask suppliers for quality assurance for the supply of goods and services from 1 July 1993 for manufactured goods and related services, and from 1 January 1994 for the provision of 'unrelated' services [11]. Some state governments had already adopted ISO 9000 as a mandatory requirement for all suppliers of goods and services: Queensland (January 1990), South Australia (January 1991), and Western Australia (August 1991) [12]. Although the federal government did not formally adopt a policy of QA certification for goods and services, many government purchasers stipulated on tenders that parts or all of ISO 9000 was required. The effect was sensational:

> ... soon Australia was proudly leading the world in the take-up of ISO 9000. By the start of January 1993, Australia and New Zealand had nearly 7% of all the certificates issued worldwide (the US had 4.3%). By December 1995, this had grown to 8.3%, with almost 9000 certificates issued [13].

But despite the rush to certification, many small businesses were appalled at the overhead in terms of cost and bureaucratic procedures, and they lobbied for relaxation in relation to government purchasing requirements. In response to this backlash, John Sprouster, CEO of the Australian Quality Council, announced in 1994 that ISO 9000 was inappropriate and too costly for small business. Prime Minister Paul Keating commissioned Bruce Kean to lead the Committee of Inquiry into Australia's Standards and Conformance Infrastructure, releasing the 'Linking Industry Globally' [8] report. This committee found that ISO 9000 should only be compulsory in the international marketplace [14]. However, before Keating could

act on this report, his party lost power to the Howard-led coalition in the March 1996 Federal election. Geoff Prosser, Small Business Minister in the newly-elected Howard government, announced in July 1996 that the Government was turning its back on ISO 9000 [15, 16] .

Many of the state governments are also reviewing their policies:

- Queensland had a mandatory policy in place for ISO 9000 from 1992 to October 1996, but now QA is mandatory only for high risk projects;
- Victoria is introducing a three-tier system;
- Western Australia is reviewing its mandatory policy;
- New South Wales and South Australia are not carrying out any reviews (both have a system whereby different government agencies require varying degrees of ISO 9000, depending on risk and value) [15, 16].

3 Standards Applicable to Australian Developers

Due to its generic nature, ISO 9001 is difficult to interpret in the context of software development, so guidelines have been produced to help software developers and auditors apply it to the software industry.

In the United Kingdom, a guide was produced by the British Computer Society: 'TickIT: Guide to Software Quality Management System Construction'. Based on ISO 9001, it melds the guidance of ISO 9000-3 (Guidelines for the application of ISO 9001 to the development, supply and maintenance of software) with the requirements of ISO 9001 and contains five sections: introduction, the application of ISO 9001 to software, a purchaser's guide, a supplier's guide, and an auditor's guide [18, 19].

Australia has also developed and promoted its own standard, AS 3563 'Software Quality Management System' through the efforts of the QR/3 Committee of Standards Australia. This certificatable standard extends ISO 9001 into project planning, requirements specification, and the development of programming and documents. The AS 3653 standard is highly regarded in international circles and was adopted as standard 1298 by the International Electrical and Electronic Engineers (IEEE) in 1992 [20, 21].

At the time of the data collection for this study (May 1995), Australian software developers seeking quality system certification had a confusing situation with three different options for certification: AS 3563.1, ISO 9001 (as applied via AS/NZS 9000.3), or joint certification to AS 3563 and AS/NZS 9001. In customising AS 3563 for software development, a new clause 'Control of development environment' has been included which explicitly covers sub-contractor assessment, programming standards, maintenance and configuration management.

The standards are continually reviewed and updated as a result of work conducted by standards committees and technical working groups. For example, committee QR/3 (responsible for AS 3563 and now including representatives from New Zealand) has developed a new 1996 guideline, AS/NZS 3905.8: 'Quality systems guidelines Part 8: guide to AS/NZS ISO 9001:1994 for the software industry'. AS

3563 has now been declared 'obsolete' by Standards Australia. This means that software developers will be seeking certification only to AS/NZS 9001 in the future, using the AS 3905.8 guidelines [22]. One of the major enhancements included in AS 3905.8 is the inclusion of examples of statements, documents and plans specific to software development, which practitioners should find very helpful.

4 Research Design

A survey of QA adoption by Australian software developers was conducted by Gori in 1992. His sample was drawn from a list of the largest organisations in Australia; it included large and small in-house developers but only large specialist developers. However, 97 percent of the businesses which make up the computer service industry employ less than 20 people [23]. Hence most specialist developers, being small businesses, were not included in Gori's sample.

4.1 Research Questions

The purpose of the study was to investigate the extent of adoption of QA certification, organisational characteristics of adopters, the capability maturity of Australian software developers, and their perceptions regarding certification costs and benefits.

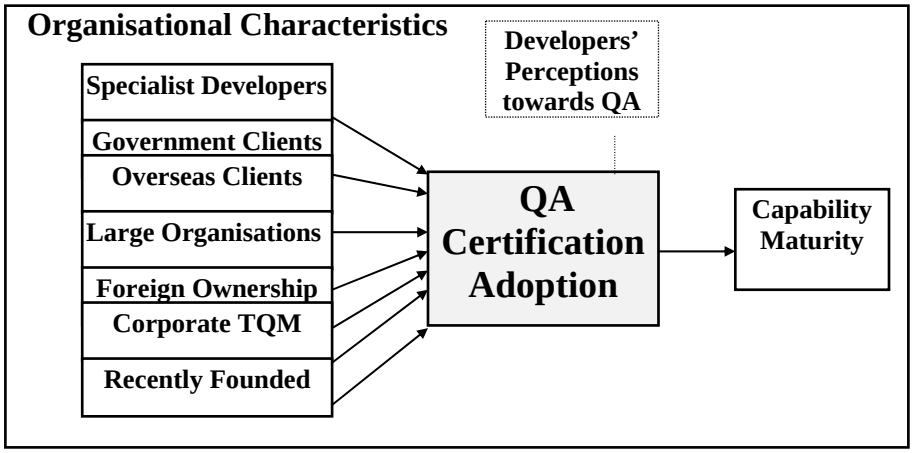

Figure 1 Research Model

As depicted in figure 1, the study addressed the following four research questions,:

(i) What is the extent of adoption of third-party certified QA standards by the Australian software development industry?

(ii) Do QA certified developers exhibit common organisational characteristics (external clients (specialist developers), government clients, overseas clients, organisational size, foreign ownership, corporate TQM, recently founded)?

(iii) Is higher capability maturity associated with adoption of QA certification?

(iv) How do developers perceive the value and effects of QA certification in relation to its costs and benefits?

As it is not possible to provide a full report on the findings within the limitations of this paper, the focus will be on reporting the extent of adoption, summarising organisational characteristics associated with QA certification adoption, and interpreting the findings in terms of implications for managers and policy analysts.

4.2 Survey Design

A questionnaire was designed and then pilot tested in two stages with suggested modifications from the first stage incorporated for the second stage of testing. The questionnaire included 12 demographic questions, 5 questions relating to QA certification progress, 13 statements probing developers perceptions regarding the value of QA certification and government QA policy and 33 questions (based on the SEI maturity questionnaire) to determine software engineering practices.

4.3 Sample Selection

The unit of analysis was Australian organisations undertaking software development. The target population was all organisations in Australia which develop software for sale (specialist developers) or for their own use (in-house developers). Two sampling frames were used, as a single list containing both types of developers was not available. Firstly, all specialist Australian software developers were extracted from the 'Oz on Disc' Yellow Pages Database. From the total population of approximately 4,000 software developers, a random sample of 500 was selected. To ensure in-house developers were adequately represented in the study, a random sample was drawn from the MIS 3001 database which contains details of the 3,500 largest users of IT in Australia and New Zealand. To maximise the probability that the selected organisations undertake software development, organisations which had not indicated usage of CASE or 4GL tools were eliminated. From the remaining 1,690 records, 500 Australian organisations were then selected at random.

5 Extent of Adoption of QA Certification

5.1 Current Status

The primary data from the survey, shown in table 1 revealed that 11 percent of respondents are certified to ISO 9001 or AS 3563, seven percent are in progress and 21 percent plan to adopt QA certification. It also revealed that specialist developers are adopting QA certification at twice the rate of in-house developers.

STATUS ISO 9001 or AS 3563	DEVELOPER TYPE					
	In-house (n=165)		Specialist (n=123)		Total (n=288)	
	Freq	%	Freq	%	Freq	%
No Plans	121	73.3	57	46.3	178	61.8
Planned	25	15.2	34	27.6	59	20.5
In Progress	8	4.8	12	9.8	20	6.9
Certified	11	6.7	20	16.3	31	10.8

Table 1 Comparison of certification status between in-house and specialist developers

Analysis of information provided from the JAS-ANZ register [24] shows that the number of organisations holding certification for software development has increased each year from 1991 to 1996. The number of certified organisations rose 78 percent during 1994 and 44 percent during 1995. At the time of the survey (May 1996), accredited registrants had already advised JAS-ANZ of a further 21 certificates for ISO 9001 or AS 3563 for 1996, bringing the number of organisations certified for software to 120.

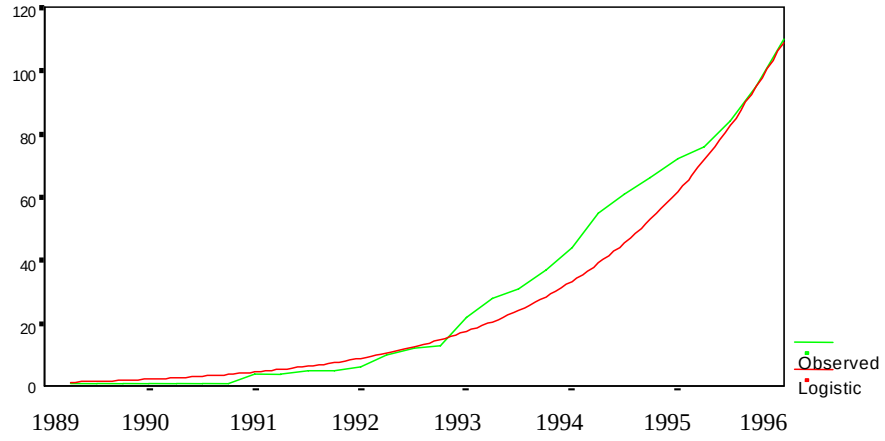

Figure 2 Logistic growth curve - cumulative certifications 1st qtr 1989 to 1st qtr 1996

The growth logistic curve [25] is often used to show how something grows or increases with time. When SPSS is applied to fit the logistic model to the secondary data with an estimated upper bound of 500 certifications, the estimated

equation is Y=1/(1/500+2.1403*.8115**t). As can be seen from figure 2, this model closely fits the data and is confirmed by a coefficient of determination (.965) which indicates that 96.5 percent of the variation is accounted for by the time variable (Beta=.374409, p<.001, adjusted R^2=.96383, n=28).

Figure 3 shows that Queensland (Australia's third most populous state) has the highest proportion of certified respondents with 17 percent of respondents certified to ISO 9001 or AS 3563. This may be explained by the fact that Queensland was the first state in Australia to adopt minimum quality standards in its purchasing policy. Figure 3 also illustrates that the states of South Australia, Tasmania and the Northern Territory do not have significant QA certification activity, however, the low number of responses from Tasmania and the Northern Territory make it difficult to generalise.

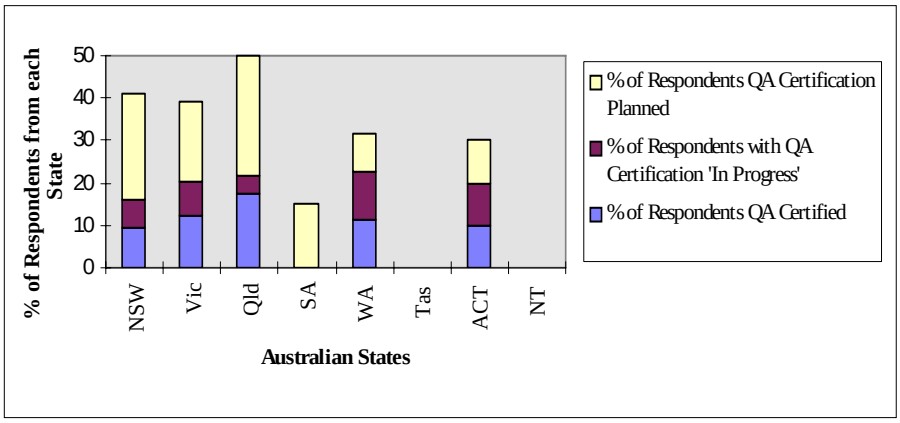

Figure 3 Certification progress shown for proportions of respondents by state

5.2 Projected Adoption

The information derived from the JAS-ANZ register can be extended by including the proportions of this study's respondents who reported that they are planning to achieve certification, or are already in the process of adopting certification. Based on the 'typical' timeframe for certification [18], it can be predicted that all the organisations currently with QA certification in progress will achieve their certification goal within 12 months, and those that are in the planning stage will have completed the process within two years. The survey responses indicate that the ratio of certified: in progress: planned is 10.8 : 6.9 : 20.5. Applying these proportions and extrapolating adoption, based on the May 1996 figures of the JAS-ANZ register, in 12 months there would be an additional 70 organisations certified, and in a further 12 months (i.e. May 1998), an additional 209, giving a total of 389 organisations certified for software development.

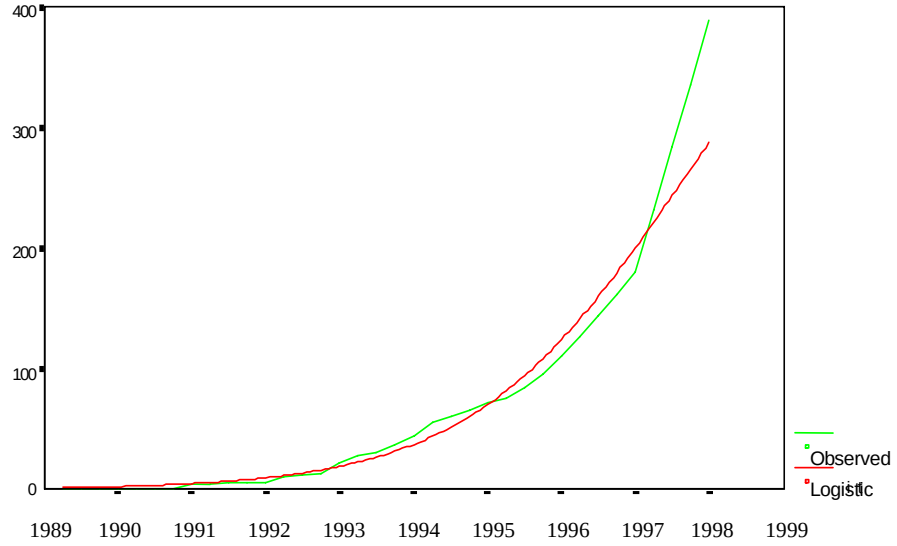

Figure 4 Current/ predicted adoption of QA certification by developers, 1989 to 1999

The logistic growth curve proposed above fits the predicted certification activity (refer to figure 4). However it would appear that the predicted upper bound of 500 certificates of the proposed model is too conservative.

It is difficult to compare the extent of adoption with previous Australian results as the only similar large scale survey, that conducted by Gori in 1994, sampled only large organisations, sourced from the MIS 3000 database. Gori [20] found that 14 percent of his respondents had no plans for a quality management system (QMS), and that many organisations who were planning or preparing their QMS did not intend to seek third party certification. These results are consistent with the findings in table 5.21, which shows that 73 percent of in-house developers (sampled from the MIS 3000 database), have no plans to achieve QA certification.

5.3 International Comparisons

The Hong Kong survey [26] sampled only *specialist* developers. Our survey data indicated that the QA activity of specialist developers in Australia is similar to that found in Hong Kong, where around half of the Independent Software Vendors (ISVs) there intend to, or are already implementing ISO 9000 [26]. The overall proportion of certified organisations in Australia (almost 11 percent) appears to be much less than in the United Kingdom. Davis, Thompson, Smith and Gillies [27] found that 22 percent of their 151 respondents were third party assessed, and that almost half of these certificates had been recently issued.

5.4 Effect of Organisational Characteristics

In order to understand how organisations are influenced towards adoption of QA certification, data on organisational characteristics were collected and analysed. Support was found for the following hypotheses:

- specialist developers are more likely than in-house developers to adopt QA certification;
- developers with government-funded clients are more likely than developers without government-funded clients to adopt QA certification;
- developers with overseas clients are more likely than developers without overseas clients to adopt QA certification;
- large specialist organisations are more likely than small specialist organisations to adopt QA certification;
- organisations funded by overseas capital are more likely than wholly-Australian-owned organisations to adopt QA certification;
- organisations involved in corporate TQM are more likely than non-TQM organisations to adopt QA certification.

6 Implications for Practice and Policy

In this section, the implications of our study's findings for private sector managers, government policy analysts and public sector managers are examined.

6.1 Private Sector Managers

The extent of adoption of QA standards uncovered by this study, has important implications for managers of specialist and in-house software development groups. There are also implications for managers in organisations which are clients of software developers, referred to here as 'client managers'. Considering the actual and forecasted number of adoptions, the following recommendations are based on the literature and the findings of this study.

6.2 Software Development Managers

- The extent of adoption by specialist developers revealed by this study indicates that those without QA certification may soon need it as a competitive necessity. This implies that the early adopters will need to continuously improve as the competitive advantage they currently enjoy is unlikely to be sustainable. To protect their market, it is recommended that specialist developers determine if their clients (current and potential) are planning to adopt QA supplier certification.

- It is further recommended that small newly founded software developers consider implementing QA standards to overcome barriers identified by Ritter [28] such as lack of reputation and lack of attractiveness as business partners.
- With the recent trend towards outsourcing IS services, in-house developers may find that QA certification provides a defence against outsourcing, and may protect them against an outsource (certified) bid. Therefore, it is recommended that in-house groups determine if QA certification is being

adopted by their parent organisation's customers or competitors, and actively participate in any corporate QA activity.

- To ensure that QA certification can be adopted and maintained in-house, minimising expensive external consultants, it is recommended that organisations consider QA training for existing staff, and specify QA skills in recruitment criteria.

- Finally, to facilitate adoption of QA certification, it is recommended that software development groups evaluate the use of more advanced CASE tools, groupware and document management systems.

6.3 'Client Managers'

By providing information about the number and organisational characteristics of certified software developers, this research has produced a profile of software developers in different stages of QA certification which 'client managers' may find very informative in deciding whether to insist on QA certification of their developers. In the past, insistence on QA certified developers for software contracts has limited the pool of potential suppliers. This research shows that the pool is growing at a significant rate, thus facilitating use of certified developers.

Although 'client managers' in Australia have not been surveyed regarding their QA policy or perceptions regarding the value of QA certification, a number of recommendations are made based on the findings from this study. The recommendations may assist these managers in deciding whether to require QA certification or not.

Therefore, it is recommended that:

- as higher capability maturity is associated with QA certification [29], and as the number of QA certified developers is increasing, clients should consider QA certification as a pre-requisite in evaluating potential developers;

- in view of the concerns highlighted in this study regarding the value of QA certification as a reliable indicator, client managers consider other indicators as well as certification in assessing potential developers;

- client managers consider the risks and value associated with a project before insisting on QA certification; for low-risk, low-value projects the added cost of QA certification may not be justified.

6.4 Public Sector Policy Analysts and Managers

Although this study did not seek to determine cause and effect relationships (associations only), it appears that government policy has a major influence on the adoption of QA certification by software developers. It was found that 23 of the 31 certified organisations have government-funded clients. Also, as shown in figure

3, Queensland - the first state to adopt mandatory QA standards - provided the highest proportion of certified responses (17 percent of Queensland respondents are certified).

Although government policy has been successful in terms of increasing the adoption of QA certification by suppliers, it appears to have failed in its objective to boost the competitiveness of local industry. The findings from this study support the view presented in the media [10] and by other research [30, 9, 31, 16] that government policy has benefited large foreign owned organisations at the expense of small local developers.

Even the architect of the Federal Government's QA policy, Dr Kevin Foley, now admits that '... in retrospect the quality movement did not take into account the cost to business and the importance of the risk and value of the contract' [13]. Another problem highlighted in the media [15] involves the implementation of the policy: 'Government purchasers publicly claimed that there had never been a policy of mandatory ISO, and they would retrain staff to stop insisting on it'. Roger Dewar, Principal Project Officer with Queensland Purchasing (Department of Public Works and Housing) explained that government purchasing officers are generally risk averse, and tend to over-specify QA in contracts [17]. He went on to explain that training purchasing officers about changes to government QA policy is effective, but changing the habits of other 'officers who purchase' is difficult. As well as complaining about QA compliance being over-specified, practitioners also complain that on occasions, the stated QA policy was ignored, with contracts being awarded to non-QA certified organisations who submitted the lowest quote [32]. In relation to government regulatory bodies setting standards, these problems confirm David and Greenstein's [33] comment that 'designing efficacious actions and appropriate guiding principles for every situation opens a large research agenda'.

7 Conclusion

With half the specialist respondents involved in QA certification and the dramatic rise in certificates issued to specialist and in-house developers, the adoption of QA represents the most pervasive effort to date by Australian software developers to improve their software processes. However, changes to government policy, although well-intentioned, may result in a competitive imbalance biased against local developers.

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