



A study of software quality assurance in practice

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ABSTRACT

This paper discusses a research project to survey a representative sample of the Australian software industry as to the actual use and application of quality assurance techniques in the development of software. The survey aims to confirm previous survey findings through a management questionnaire and to investigate the software development practices at the 'screen face' through a developer questionnaire. The separate responses are analysed to rate the extent to which quality management practices have penetrated the information systems department. The project commenced in July 1994 and, whilst some organisations have completed the survey, other responses are yet to be received. The paper will report on the survey method and statistical techniques employed as well as discussing preliminary results from the survey to date.

INTRODUCTION

A survey of 50 leading Australian IT companies, conducted in January/February 1992 by the University of Technology, Sydney (UTS) on behalf of the Department of State Development and the NSW Information Industry Advisory Council (with funding provided by the NSW National Industry Extension Service), showed that 'quality' is one of the key challenges to the survival and competitiveness of organisations in the IT industry over the next

160 Software Quality Management

five years [1 - 3] – over 68% of the respondents rated 'quality management' as either 'very important' or 'important' and quality management was ranked third in absolute order. The survey also showed that 88% of respondents claim to have used quality management in their organisations. This claim is supported by another survey, conducted by the Australian Information Industry Association (AIIA) [4] – a key finding is that 41% of respondents have documented quality assurance practices in place, while 36% are in the process of implementing such practices (a total of 77% are using quality management). Also, 23% of respondents are certified to either AS3563 or ISO9001, while 40% are currently progressing such certification.

A more recent study [5], conducted in January 1994, further confirms these findings. 228 large IT organisations or departments were canvassed in a postal survey. 110 (48%) valid responses were received showing that 30% of respondents have a quality management system in place, 33% have one in preparation and 24% have one planned (a total of 87% will be using quality management). This study also showed that 51% are or are about to be certified.

However, the authors' knowledge, experience and observation suggests that this high level of activity in quality management is not always reflected at the 'screen face'. Any organisational programmes do not necessarily appear to have started to change the attitudes and culture of the systems developers at lower levels of organisations. This paper reports on a study to investigate what is actually happening at these lower levels. The purpose of this study is to produce meaningful and useful statistics on the actual use of quality assurance techniques in the IT industry, enabling comparisons with previous surveys and analysis of the differences between the manager and developer responses. The project commenced in July 1994 and, whilst some organisations have completed the survey, other responses are yet to be received. The paper will report on the survey method and statistical techniques employed as well as discussing the preliminary results from the survey to date.

TWO-STAGE SURVEY METHOD

As with any study investigating general 'state of practice', a survey is a feasible means of providing data with sufficient external validity [6]. A postal survey was chosen as the survey method, due to its low cost and low overheads. Postal surveys generally have a low response rate [7], but the initial sample was chosen because of their good

response to the 1992 survey (just over 80% response rate [2]). The method of sampling was two-stage as described below.

The first stage was to select an 'expert' or 'judgement' sample of organisations – a judgement sample is one picked from the target population by the subjective decision of an individual [6, 8, 9, 10]. Although expert samples can be at "risk of bias of an unknown magnitude" [10, p91], the organisations were selected for the 1992 survey as they were judged "to represent a cross section of the IT industry rather than a statistical sample ... because there was greater emphasis placed on capturing the views of all sectors of the IT industry, than on quantitative outcomes" [2, p4]. The sample includes major users of IT as well as IT companies and was chosen to encompass adequate representation of:

- different sectors of the economy;
- foreign-owned as well as locally-owned companies;
- public sector and private sector;
- hardware suppliers and software suppliers;
- computing technology and data communications technology;
- information technology services;
- small, medium and large companies.

The second stage was for a representative of top management to select a sample of 10 or 20 software developers from within the organisation (the actual number determined by the size of the IT section of each organisation). Again, this expert sample could introduce bias as it is not random. Although managers were asked to distribute the survey such that a reasonable cross-section of different application areas, different projects and different development jobs was achieved, they may have selected staff who were on the whole more familiar with the organisation's quality assurance policies. Note, however, that any bias would tend to be in a positive direction.

The survey was designed to use two different types of questionnaire : one to be completed by a representative of top management, to confirm and extend the findings of the previous surveys and to provide demographic information; one to be completed by a representative sample of system developers within the organisation, to gauge the actual use of quality assurance techniques.

162 Software Quality Management

Management Questionnaire

The management questionnaire comprises three sections. One management questionnaire is to be completed for each respondent organisation.

The first section is concerned with the nature and size of the organisations responding to the survey. Nine questions cover contact details, the nature of the primary business of the organisation, the size of the annual budget (IT departments) or annual turn-over (IT companies) and the number of employees. Quantitative questions offer tick-box choices from pre-determined parameters which were derived from the 1992 survey [2].

The second section is concerned with the respondent organisation's overall approach to software quality assurance. Nine questions cover the organisational definition of quality, the extent of their adoption of a formal software quality assurance programme, their position with regard to certification and the reasons why they have (or have not) implemented such a programme. Where appropriate, the use of national and international standards is confirmed.

The third and final section seeks any further information or comment the respondent would like to include.

Developer Questionnaire

The developer questionnaire comprises six sections. Ten or twenty developer questionnaires are to be completed by ten or twenty developers from each respondent organisation (the actual number determined by the size of the IT section of each organisation).

The first section is concerned with the respondent organisation's overall approach to software quality assurance and seeks to confirm that management's approach (from the management questionnaire) is being communicated to the developers themselves. The nine questions correspond to the nine questions in the second section of the management questionnaire.

The second section is concerned with management responsibility for software quality and seeks to confirm that this responsibility is clearly communicated to the developers themselves. Three questions cover the documentation of the organisation's policy and objectives for software quality and the identification of who in the organisation structure has the responsibility and authority for software quality.

The third section is concerned with the quality assurance system used in software development. Twelve questions cover the requirements for verification and validation of software deliverables and the adoption of specific procedures for software product requirements, software product design, programming, and user and operational documentation. These questions were derived from the requirements of a software management system described in AS3563 [11].

The fourth section is concerned with the methods and techniques used to develop software. Ten questions cover the standards and procedures that prescribe the specification and design of systems within the organisation and the specific techniques used for analysis, design, programming and review.

The fifth section is concerned with change control during software development. Three questions cover the adoption of formal change control and configuration management procedures.

The sixth and final section seeks any further information or comment the respondent would like to include.

STATISTICAL TECHNIQUES

Overall, the techniques used were those appropriate to categorical data, in some cases nominal and in other cases ordinal. Proportions of a particular response were examined, and two-way or multi-way cross tabulations of responses were examined for independence using chi-squared distribution.

The response to those questions that required a Yes/No/Don't Know answer were combined to form an index of quality (IQ) for each organisation. For each of sections 2, 3, 4 and 5 of the developer questionnaires, the proportion of 'Yes' responses for all respondents from an organisation was obtained. This proportion was multiplied by 10 to give an index for each organisation for each section. The index was then classified in accordance with the descriptions in Table 1.



164 Software Quality Management

Class	IQ Average	Comment
A	9 or 10	Excellent : quality well supported by procedures and developers
B	7 or 8	Good : quality largely supported by procedures and developers
C	5 or 6	Still some work to do
D	4 or less	Poor : quality not supported by procedures or developers

Table 1 : Classification of Index of Quality

SURVEY RESULTS TO DATE

Of 45 organisations contacted initially, forty-three (96%) have responded with thirty-seven (82%) agreeing to participate in the study. To date, only thirteen sets of surveys have been returned and analysed. The preliminary results based on these thirteen organisations are presented here to provide an insight into the eventual results of the study.

IT organisations were classified either as being IT companies in their own right or as being IT departments of non-IT (user) companies. A profile of the respondent organisations is shown in Table 2 (all percentages are of the preliminary sample), while Table 3 shows the size of the respondent organisations. Tables 2 and 3 show that, despite the small size, the preliminary sample reasonably reflects the industry characteristics exhibited in the original sample [2], with the exception of the number of IT employees.

			Fry [2] 1992
IT Departments	4	30%	32%
Public Sector	2	15%	15%
Private Sector	2	15%	17%
IT Companies	9	70%	68%
Hardware	3	23%	24%
Software	7	54%	29%
Services	6	46%	15%

Table 2 : Profile of Respondent Organisations

			Fry [2] 1992
1994 Turn-over/Budget			
more than \$150 million	4	31%	33%
\$50 million to \$150 million	2	15%	17%
\$10 million to \$50 million	4	31%	39%
less than \$10 million	3	23%	11%
1994 Total Employment			
more than 2000	4	31%	—
501 to 2000	3	23%	—
101 to 500	3	23%	—
less than 100	3	23%	—
1994 IT Employment			
more than 500	1	8%	34%
101 to 500	7	54%	51%
51 to 100	2	15%	7%
less than 50	3	23%	8%

Table 3 : Size of Respondent Organisations

Analysis of the management questionnaires shows that twelve of thirteen organisations have implemented a formal software quality assurance programme. Of these, five are already certified, three have certification in progress and two are planning certification. Table 4 compares these results with those of previous surveys (not all the studies total 100%, to account for no responses). With the exception of the Gori study [5], the trend is as expected with a steady increase in the proportion of organisations that are either certified, are progressing certification or are planning certification – rising from 44% [12] in 1991 through 63% [4] in 1992 to 77% in 1994 (although this figure may be biased by the small preliminary sample and will only be meaningful once the study is complete). In Australia, the Federal and State Government purchasing policies [1] and, in the UK, the Department of Trade and Industry involvement in the TickIT scheme have raised the IT industry awareness of software quality assurance and have encouraged them to seek certification – these initiatives are now realising their objectives with a significant number of IT organisations now either certified or well down the path to certification.

166 Software Quality Management

Study	Wilson	Gori [5]	AIIA [4]	Davis et al [12]
Year	1994	1993	1992	1991
Place	Australia	Australia	Australia	UK
Certification				
Yes	39%	15%	23%	22%
In progress	23%	n/a	40%	n/a
Planned	15%	36%	n/a	22%
No	23%	34%	37%	35%

Table 4 : Certification, Comparison of Studies

Analysis of the developer questionnaires, however, shows that the adoption of software quality principles is not nearly so advanced as suggested by twelve of thirteen of respondent organisations claiming to have implemented a formal software quality assurance programme. The results are summarised in Table 5.

Section 2 of the questionnaire measures the establishment and promulgation of management responsibility for software quality assurance. Only five of thirteen of respondent organisations rate as 'excellent' (class A); in a majority of organisations there is still not a clear understanding of who is responsible for the software quality programme.

Section 3 measures the use of quality assurance procedures. Although ten of thirteen of respondent organisations rate as 'good' (class B), no organisations rate as 'excellent'; overall, organisations appear to be making reasonable progress in implementing quality assurance procedures but have yet to instigate a quality approach to all software development projects.

Section 4 measures the use of rigorous, formal approaches to software development. Again, ten of thirteen of respondent organisations rate as 'good' or better, with two of thirteen rated as 'excellent'; overall, a majority of organisations appear to have good software development processes in place.



	Section 2	Section 3	Section 4	Section 5
Class A	5 (39)	0 (0)	2 (15)	8 (62)
Class B	3 (23)	10 (77)	8 (62)	3 (23)
Class C	3 (23)	1 (8)	1 (8)	2 (15)
Class D	2 (15)	2 (15)	2 (15)	0 (0)

Table 5 : Number and Percentage (in brackets) of Respondent Organisations showing Section by Classification

Finally, Section 5 measures the use of change control and configuration management procedures. This section showed the best result, with eleven of thirteen of respondent organisations rated 'good' or better and eight rated 'excellent'. The adoption of change control and configuration management procedures appears to be well advanced.

Despite only one organisation admitting to not having implemented a software quality assurance programme, two respondent organisations rate as 'poor' (class D) in three of the four sections (these are not the same two organisations in all cases). This appears to support the hypothesis that software quality assurance programmes have not yet penetrated to the systems developers at lower levels of organisations. However, this hypothesis cannot be conclusively tested until the study is complete.

CONCLUSION

The results and inferences drawn from those results will not be meaningful until the study is complete and analysis of a larger sample is possible. The purpose of this paper is to describe the survey method and to illustrate the likely results of the study through examination of preliminary results from the survey to date. These preliminary results appear to support the hypothesis that software quality assurance programmes have not yet penetrated to the systems developers at lower levels of organisations, but such a conclusion cannot be drawn until all the responses have been analysed.

When complete, the study will provide a measure of the extent of certification and the adoption of formal software quality assurance techniques in Australian organisations, enabling comparison with previous studies; analysis of the motivation for software quality and

168 Software Quality Management

the actual techniques being used at the 'screen face' including a comparison of management views with those of developers; and details of the quality assurance and software development techniques actually being employed in the industry.

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