

TENSIONS IN THE ADOPTION AND EVOLUTION OF SOFTWARE QUALITY MANAGEMENT SYSTEMS

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ABSTRACT

This paper reports some results from a project to uncover the non-technical factors that affect the adoption and evolution of Software Quality Management Systems (referred to here as 'the quality effort'). The data which the paper discusses comes from interviews with people involved in the quality effort in four different companies. Our approach to data collection was to use semi-structured interviews and to encourage interviewees to talk about their experiences of quality management in their own organisations. We analysed this data using discourse analysis, informed by ethnographic observation, and identified a number of themes, one of which was the tensions that exist between developers and the quality effort. In this paper, we present and discuss some data which illustrates the tensions we found.

1. BACKGROUND

This paper describes the collection and analysis of qualitative empirical data to investigate the non-technical factors influencing the adoption and evolution of software quality management systems (SQMS). We collected a variety of data through our project, but in this paper we concentrate on data from semi-structured interviews conducted with quality managers.

The importance of non-technical factors in the success of software engineering projects has been recognised for many years (e.g. DeMarco & Lister, 1987; Curtis et al., 1988). Few empirical studies have been reported that look at the impact of non-technical factors on software development practices, although work in the area is growing (e.g. Baddoo & Hall, 2002b) and the significance of studying the human aspects of software engineering through qualitative methods is receiving more attention (e.g. Seaman, 1999, Seaman, 1998). We began our project because of our concerns that technical innovations did not appear to be producing better quality software systems. Our particular focus was on the effectiveness of quality initiatives such as accreditation to ISO9000, and the social factors affecting their success, their adoption and evolution (Hall et al., 1993; Hovenden et al., 1994, Sharp et al., 1999).

In the next section, we introduce the methods used for data collection and analysis. In Section 3, we present the results of discourse analysis that led to our focus on the tensions in the adoption

and evolution of SQMSs. This section includes example discourses from our data that illustrate the tensions we found, where these tensions occurred and where they did not occur. In section 4 we discuss our results in the context of other relevant work.

We start by giving some background on software quality management systems, empirical work in the software quality area, and the wider project of which this work forms a part.

1.1 Software quality management systems

An SQMS is intended to make the process of software development visible and public. This is partly about accountability, but, more pragmatically, makes knowledge communal, minimizing the problems arising when team members are away, or have left. It also helps to make the process visible to those who have not been involved in the development, such as senior managers, auditors and customers. An SQMS makes the process auditable because it provides guidelines, or benchmarks which can be tested against, and it provides some assurance of adherence to house style. This fulfills a range of requirements, including indicating to customers that certain standards are being met, strengthening a market image by ‘branding’ through conformance to certain standards, reinforcing management control, and meeting international guidelines.

The following are quoted from (ISO8402, 1994) which provides internationally standardised definitions of quality terms:

quality: the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

quality policy: The overall quality intentions and direction of an organisation as regards quality, as formally expressed by top management.

quality management: That aspect of overall management function that determines and implements quality policy.

quality system: The organisational structure, responsibilities, procedures, processes and resources for implementing quality management.

This set of definitions have arisen from a desire to have organisational and managerial forms of quality management, following on from the works of gurus, such as Deming, (1982), Juran, (1988), and Crosby, (1979). This in turn led to certification schemes such as BS5750, (1987) and ISO9000, (also known as ISO EN BS 9000). Other, more sophisticated models have also been developed, such as the Capability Maturity Model (Paulk et al., 1997) and later the People CMM (Curtis et al., 2002), and Total Quality Management (Oakland, 1994).

1.2 Empirical studies of software quality

Much is written in the literature about the importance of various factors for the success of quality management initiatives (e.g. Adam et al., 1981; Deming, 1982). These factors include the importance of senior management commitment, active quality leadership by managers and the inclusion of employee considerations in improvement initiatives. Empirical work in the area is scarce, but is growing. For example some empirical work has been done to identify and validate measures of critical factors discussed in the literature (e.g. Saraph et al, 1989; Black and Porter, 1996; Dyba, 2000), which incidentally throw some light on the acceptance of these factors, but do nothing to expand upon them.

A group at the University of Hertfordshire, UK (e.g. Hall & Wilson, 1997; Baddoo & Hall, 2002b, Baddoo & Hall, 2002a) have been looking at the factors affecting the success of software process improvement initiatives (SPIs). They conducted focus groups with different developer groups (developers, project managers and top managers) to identify factors affecting the success of SPIs. Analysis of their findings reveal factors for each of these groups, which differ in significance

between the groups. For example, all groups cited visible success of the SPI as a key motivator while developers also quote bottom-up initiatives, resources and top-down commitment, project managers also want the resources to be able to carry through the initiative, and for senior managers another key motivator was meeting targets.

1.3 The SoFEA Project

The SoFEA project aimed to identify non-technical factors influencing the adoption and evolution of quality management systems. It began in 1993 when we sought stories from attendees at a conference on software quality. From this initial contact, we visited five companies to explore the issues further. In each case, we interviewed the initial contact (the quality manager). Further contact with the organisation varied, and was dependent on the opportunities that presented themselves. For example, in one organisation we conducted a participant observation study, have made several visits to the site, and maintained an on-going dialogue with staff members, while in another we were limited to a single interview of our initial contact.

The project has focused specifically on the introduction of software quality management systems in the context of accreditation to Standards such as ISO9000 (2000). We have used qualitative data collection and analysis. Our analyses so far have underlined the importance of involving influential developers in the production of the SQMS (Hovenden et al., 1996), observations on the effect an organisation's culture may have on attitudes to software quality (Sharp et al., 1999), and some reflections on the implications for software engineers of our interdisciplinary approach (Sharp et al., 2000).

2. RESEARCH METHODS

In this paper we focus on data from one phase of the SoFEA project: the initial interviews with quality managers. We do not consider the data gathered from the company where we conducted participant observation, since the type and amount of data available for this company is very different from the other companies, and this would lead to an imbalanced view. The data was analysed using discourse analysis.

2.1 Data collection

Over a period of 6 months, we interviewed quality managers in four separate companies, who volunteered themselves as potential participants after a presentation at a UK software quality conference (Hall et al., 1993). Each interview was approximately 3 hours long. For all of our visits we took an ethnographic approach in that we paid attention to the physical and social environment of our interviewees, and any clues we could observe about the organisational environment (in addition to any comments made by the interviewee) (see, e.g. Hammersley & Atkinson, 1995). This led us to collect data such as copies of notices on pinboards, technical documentation, marketing literature, and field notes of our observations.

The interviews were semi-structured and were audio-recorded. Before recording began, we asked the interviewee if they were comfortable with this approach, assured them that the recording could be stopped at any time, and that if we wanted to quote any of the data it would be anonymised. This was acceptable in each case.

For each interview, two of the three researchers were present: one was principally in charge of conducting the interview, while the other made notes and ensured that the audio recording equipment was working; the latter researcher attended all interviews and helped to maintain a level of consistency through them. We did not ask direct questions about the factors affecting the

quality management system, but had some initial questions to start the interview, a list of topics that we wanted to be covered, and some follow-up questions to be used if the interviewee did not mention a topic of interest spontaneously. In addition, we had some specific questions that we asked of all interviewees to elicit particular individual or company attitudes. We made the tone as informal and conversational as possible and did not adhere to a pre-determined order because we wanted to encourage them to talk about issues that they saw as important in their work and thence to find out their and their company's attitudes to quality. The list of initial, specific and follow-up questions, and topics of interest that we wanted to be covered are shown in Table 1.

Table 1 The questions and topics used in semi-structured interviews

Initial questions asked of all interviewees	
What is your area of work?	What is your official job title or titles?
Please tell us the story of your experience with the company's QMS?	
Specific questions asked of all interviewees	
Are there any mottoes which fit your team's work?	What publications do you read? Do you feel that they influence you very much?
Within your field do you have a favourite guru?	How would you define or describe 'quality'?
Follow-up questions used as necessary to cover topics	
What do you regard as the most important aspect of your work?	If you were writing a book about your job what would the chapter headings be?
How do you see your department/area evolving in the next five years?	What methodologies do you prefer to use?
How do you see your particular job evolving in that time?	What languages (computer) do you prefer to use?
Do you think 'quality' is important?	Do you feel that team-building is part of your job? How do you go about it?
How would you describe your company's attitude to 'quality'? Is it the same throughout the company?	Do you purchase from other suppliers? What's the worst case scenario that you have experienced?
What software and hardware do you prefer to use personally? Why?	You've been offered a contract with a 10% risk or reward option for completing On time On budget Do you take it? Why/why not
Say it's Friday afternoon and you are going on holiday for two weeks. You have to ensure a project's success while you are away – what action do you take? What if the project is running over time and budget?	If you had to choose between being sure that a project would deliver a high quality product, and being sure that the project would finish on-time within budget, not necessarily with a low quality product, but you couldn't guarantee anything, what would you do?
Do you do testing? What type?	What kinds of staff training do you offer?
How is your work reviewed?	Please tell us something about your own

	training generally?
<p>Topics to be covered</p> <ul style="list-style-type: none"> • the organisation’s structure, main business, training opportunities, market attitude, and market position • the history of the organisation’s SQMS • the interviewee’s responsibilities and attitude towards quality • publications, gurus, conferences or any other fora which influence the interviewee 	

2.2 Data analysis

The interviews were transcribed and themes were extracted from the data using discourse analysis, informed by the ethnographic data. We used discourse analysis to focus on the structures of text to explore people’s attitudes and intentions, and ethnographic data to inform our interpretations by providing a context and framework. For example, in one organisation we visited (Company B below), there was a series of quality certificates hanging on the wall of reception which related to another section in the company. This may have indicated that the company culture would be accepting and supportive of quality initiatives. However, although one of the topics to be covered was the influences on the interviewee, the existence of these other quality activities were not mentioned. Other clues elicited from the ethnographic approach concerned a company's attitudes to security, adherence to rules, formality, and hierarchical structure.

Discourse analysis is concerned with the collection and analysis of spoken or written data. It considers what people do with words and how they achieve certain ends (Potter & Wetherall, 1992; Lee & Poynton, 2000). In our analysis, we were therefore interested in what words our interviewees used and when. For example one of our interviewees when asked about his definition of quality answered by using 'we' and 'our' rather than 'me' and 'my'. When he used 'we', he was referring to the organisation, and this showed a very close alignment by this quality manager to the organisation and its goals.

At another level of analysis, we were also interested to see what comments were made by the interviewees spontaneously. The data collection approach we used meant that interviewees were encouraged to express their own attitudes and beliefs, and what they chose to say or not to say was just as insightful as how they said it.

We proceeded with our analysis one interview at a time. First, it was transcribed, and then we tried to identify themes, patterns, attitudes or other noticeable traits that might indicate the factors we were searching for, i.e. non-technical issues that had influenced the adoption and evolution of this organisation's quality management system. Each of the three researchers tackled the transcription independently, and then we came together to discuss our findings.

3. RESULTS

A variety of issues emerged from our use of discourse analysis. One of these was a re-thinking of our view of SQMS adoption and evolution. This was a significant finding as it affected our framing of the problem, and our subsequent discussion of other observations. Before studying any data, we had imagined a simple serial timeline for the process under study: the SQMS would be produced, it would be adopted for day-to-day use, and then it would evolve over time.

However, in studying the data, a more complex situation emerged around these three phases. The way in which an SQMS arrived in day-to-day use varied between companies. In one approach, the SQMS evolved from other documents and in this sense had no phase of production as such. In another, the production process itself was highly iterative with periods of writing followed by use, then evolution and more writing, so that a fairly complete SQMS was available before it went into use. In yet another, the SQMS was produced, went into use but then had to be withdrawn and re-written. In most cases the three phases overlapped considerably.

Another of our findings was a set of recurrent themes that were in one way or another highlighted by the interviewees in their data. These included organisational coherence (indicated by the attitude of the interviewee to the company); degree of involvement from developers in the quality process; motivation for developing a quality management system at all; the (lack of) formal external influences such as quality agencies; and informal influences through peer networks and colleagues.

One very strong theme that emerged was the existence of tensions reported by the interviewees between themselves (and others involved in producing and implementing the quality management system) and the process of quality management system adoption and evolution. This theme was very strong and so we chose to pursue this in more detail. It is this theme that we concentrate on in the rest of the paper. For brevity, we refer to the process of quality management system adoption and evolution as 'the quality effort' and those involved in the quality effort (including the interviewees) as 'the developers'.

3.1 Tensions between the developers and the quality effort

In this section, we present observations and quotations from each company that illustrate the common theme of tensions between the developers and the quality effort. This data suggests that some companies do not experience such tensions, while in others quite serious tensions exist.

We discuss the data in terms of the three phases of SQMS adoption and evolution: production, evolution and day-to-day operation. Whilst recognising that the situation may be more complex than a simple categorisation implies, we present the results this way because we can clearly identify tensions which relate primarily to each of these three phases. At the time of visiting the companies they were at different stages in the process, so the data does not address all phases consistently. We identify the stage of each company's SQMS in the data sections below.

For confidentiality, the discussion does not use the companies' real names and refers only to companies A–D. Quotations from the interviewees are presented in table format with an associated number; in the discussion of the data, these numbers are used to identify evidence which supports the observation, e.g. "the SQMS was introduced in response to developers' needs [A.3]", where A.3 is a quotation in the table for Company A. Occasionally words used by the interviewee which may have identified the company are replaced by equivalent words placed in angle brackets <>.

Company A

Company A was a large software house with international links. Its SQMS was mature and had been operating for many years. Our interviewee here was the quality manager for one of the company's sections; other quality managers existed in other sections. The company chairman (referred to in the data) had a very high profile within the company and appeared to exert great influence on staff.

Production

In company A, our interviewee reported that the quality management system began life as an 'encapsulation of useful information' [A.1] which had been compiled in response to developers [A.1]. This early, in-house, 'grass roots' move toward documenting useful information seems to

have merged seamlessly with a later, more formally introduced quality regime. A push for quality came from senior management [A.2] in the mid-1980s when everyone in the company was sent on a quality course, based on the work of a particular guru. At the same time, ISO9000 registration was being sought, and the two initiatives supported each other [A.3]. The overall impression is a system initially developed with enthusiasm and optimism [A.8].

Day-to-day operation

This company has a high-level SQMS which outlines how quality should be implemented in a general sense, with the details being left to the individuals working in specific areas [A.4, A.10]. The attitude within the company is that staff need to be involved in developing the SQMS, that they understand best how to get the job done, and that they need to be free to do it [A.4]. There is also a clear message here that the quality manual should reflect *actual* practice, rather than idealized intentions [A.5].

In terms of maintaining the SQMS certain comments were of particular note. For example, our interviewee refers to this activity as 'a game', but one which involves a specific focus upon culture and working practices [A.6]. He also emphasizes that a sense of pride is essential, and specifically describes this in terms of clarity, and of acknowledgement in the form of visible signs, such as the use of numerous promotional mottos which change regularly [A.7], and the annual staff quality awards to recognise any exceptional contribution to quality [A.8].

Evolution

Although an apparently healthy and well thought-out SQMS, the effect of the recession and consequent downsizing upon the culture was noticeable [A.9]. However, despite problems, there is still an ongoing commitment to developing the SQMS. For example, there is also a policy to encourage staff to make suggestions for how to improve quality in their part of the company [A.10]. Thus, the SQMS evolves through suggestions which, like the original document, arise from the developers themselves. Any new procedure which is suggested is trialled first, and if it is successful, it can become part of the quality manual [A.5]. It would appear that some managers have difficulty coping with this idea, though [A.11]!

Table 2: Company A quotations

[A.1]	Well I wrote one when I became a quality professional in 1977 for the unit that I had then which immediately achieved a degree of fame within the unit because it was a collection of things that people wanted to know and were always having to ask and never knew what the answers or who they were meant to ask. So I started it as an encapsulation of useful information, but it sort of grew from that ... So writing down some rules in that sort of situation was seen to be helpful.
[A.2]	The history here was that <the chairman> was a visionary, with um, with sufficient foresight to realise that um the old <Company A> needed to dramatically improve things, and this wasn't going to happen by incremental internal improvement and that the only way of getting anything radically done about the company was getting people motivated ...
[A.3]	This was the same time as going through ISO9000 registration. They overlapped, and the mixture worked incredibly well.
[A.4]	You write down what you need to write down but no more, you try and supply helpful guidance to allow people to make their business objectives, not overload them with bureaucratic demands... of a nature that doesn't help their business
[A.5]	The problem comes when management say 'we want you to do something in this different way and just slip it in the manual, and my stance is no, no, no what we put in the manual is the way we do things and I don't mind you trialling our procedure first, but when you have got the working practice changed we will then put it in the manual', and that both has people on our side and also means we aren't caught out by BSI by having wishful thinking in the manual but nobody doing it. So that's the right way round.

<p>[A.6] This whole game is about um changing cultures, changing working practices, getting people to do what you want them to do</p> <p>[A.7] I think it is important that people have pride in the group that they work for which usually derives from being very clear about what one is trying to achieve at the global level and being very clear about what one's own responsibilities are, and being very clear as to how one's contribution helps towards the global aim. Having slogans, or notice boards or badges or ties or anything else they are all things that can help that and equally, they are indicators as to whether you've got it, but I don't think there's anything magic in having a slogan, but it's all part of it.</p> <p>[A.8] it's one of these things whereby everybody denigrates until they find they've got an award themselves, and then they think it's quite good really.</p> <p>[A.9] I think that there was a great deal of enthusiasm, a growing market, no thought of recession or declining margins and a feeling of being willing to try anything. Since then the recession has hit, market pressures have hit, er a lot of retrenchment, a lot of redundancies and people are busy enough thank you. It's quite hard to change working practices in an environment like that, whereas in the <guru> days people were willing to give anything a go.</p> <p>[A.10] In fact lately I have been spending a lot of time on this continuous improvement scheme that's called <Scheme>. This is based on the ... the Japanese approach of having everybody contributing lots of ideas and these being small, easy to implement and perhaps of local scope, that is better and that a company has to adapt to changing market conditions is going to be helped to do this if the people that are doing the jobs are the ones that dream up ideas for improving it</p> <p>[A.11] But changing the culture so that people are willing to make suggestions about how their jobs should be changed in a small manner, or how the processes should be changed or something, is quite a culture change.... but people still have to internalise it 'What, you mean my staff are going to give me ideas?'</p>

Company B

Company B's main business was to provide computing services and other plant to scientists. At the time of interviewing, Company B had only just started developing their SQMS, and was also undergoing some restructuring, including relocation. Here we spoke to one management-level employee involved in the development of the SQMS; no quality manager as such had been identified.

Production

In company B, the need to develop an SQMS was driven by a belief that certification to ISO9000 was required because of commercial pressures. This drive was seen by the staff as an imposition from above which led to resentment [B.1–3]. Against a background of concern over the relocation plans, the perception that adopting an SQMS was somehow doing management a favour, further inhibited enthusiasm for the project [B.4]. When we visited the company, a group of engineers, including our interviewee, were writing down the procedures already in operation. This was seen as unproblematic in itself, but there was concern about subsequent activities. For example, checking that existing procedures followed the requirements for certification might reveal inadequacies, and writing new procedures to fill the gaps in current practice would require changes in working practices [B.5]. In this company there was a strong feeling of pride in the service that they offered and in this sense there was no perceived requirement for certification of any kind [B.6]. The quality of work was felt to be inherent, and ensured by expertise and commitment to service [B.7].

Table 3: Company B quotations

<p>[B.1] I'm not convinced what the Senior Management's real reasons are for wanting QA certification but the way it has been sold is that if we have the magic letters BS5750 we will be able to compete better, we will be able to say to people 'we are the best', and that is the only way it's been sold there is no suggestion that it might make our work more interesting ... it's been badly sold over such a long time that I can't see it being .. I think it will take a long time to rectify the damage that has</p>

been done because the view of a quality system is its a lot of paper. There was a document put out from upstairs that actually said what you had to do to get certification was to write procedures and someone would come in and say they were good procedures and then you were certified and I think they honestly believed it.

[B.2] I think my feeling towards QA is that quality would be a good thing it would help our job, but the last thing I want is somebody saying we're doing it so we can get a bit of paper.

[B.3] the first meeting was a week before Christmas and a lot of people were saying this is a waste of time and effort.

[B.4] The other background to it is that in the end of April early May ... we are moving to <a new place> to become part of <the new place> because it is felt that we will get funding more easily ... the staff are being faced with a compulsory move to <the new place>. Because of the way our contracts are written if you say you're not moving you are held to have resigned—no compensation or anything—so it is felt introducing a QA system is something that management are asking us to do and at the moment there isn't much feeling to do what management want us to do

[B.5] We've got our second meeting tomorrow, and I handed in three procedures this morning which are the output of the last three weeks, but they were well defined things that were already known. The problem we're going to hit is when we discover that what we do isn't actually any good, I mean as long as it is just documenting what we do, fine, all you've got to do is throw effort at that to write the document but the development and release and config control we don't do. So there's going to have to be changes in working practices

[B.6] there are commercial people running similar, well not similar <plant> that can do some of the basic work...quite often other commercial people will be <engaged> to go and <set the plant up> or if it's nice summer weather go and pick them up, the difficult things like putting them there and doing it in winter are bound to come back to us.

[B.7] I don't think there's anybody else who's got <our> expertise

Company C

Company C was a large avionics organisation which had traditionally been heavily involved in the defence industry. Company C's SQMS had just moved into everyday use. Our interviewee had been involved in developing quality systems in a number of companies and was responsible for quality procedures within Company C.

Table 4: Company C quotations

[C.1] ...There has been a lot of internal publicity to get people into the mood for it, ... The latest is a little plastic stick-it-in-your-pocket calendar and the statement of quality policy on the back... There's also been a lot of posters stuck up exhorting the staff to er quality improvement. Most of them have seen very little other than these exhortations, and they are usually the subject of humorous annotation.

[C.2] People actually said to me 'This is patronising, we know what needs doing. What we need is the actual support to do it', and there seemed to be some gaps there...

[C.3] There was a gap between what was almost bubbling up from the engineers at the bottom, and coming up to the sort of principal engineer level and to all the QA people who understood what was going on, they understood the technology and so on and there was a management requirement, yes, we must have some standards because our customers need them. There was a gap between the two.

[C.4] There were two parallel texts, or merged texts. One was written in normal typeface and was essentially the mandatory procedures and full of stuff like such-and-such an action shall be taken er in these circumstances this should be done, slightly lower level of importance, may be done, whatever, means allowed... but attached to that were paragraphs written in italics which were wise engineers comments 'We do this in this way because', and so they were written in a much more conversational tone.

[C.5] These were normally based on agreed company standards and in fact the whole software development procedures were was out in a volume which stood about 3 inches thick and the described in enormous detail all the methods and means of producing software. It was particularly opaque to any one who had not lived with it for years, if I explain that, it was divided into sections at three levels, so you would find a section such as 2.14.1 and those sections were then divided into paragraphs also at three levels, so you could find on to section 2.14.1 paragraph 3.5.7 and seeing whether that related to point 6 or point 8 or to anything else in the book was ..[small sigh].. tricky.

[C.6] The crazy thing is of course that software procedures document, ... which amounts to so many pages has a little clause at the end or beginning of it, no I think its the beginning which basically says, 'that in the absence of any project specific procedure this document shall apply'. Which is a basic way of saying you can use any standards you like ... if you don't specifically say that you're using something different then this one will apply.

Production

In company C, although the requirement for quality standards had existed for many years, it was the need to conform to ISO9000 which led to the introduction of a unified quality management system. A sense of injustice was felt by the imposition of a new quality system, through lack of consultation [C.1–3]. In the final document, the mandatory information was backed up by wise engineers' comments, explaining why it was important to do things in a particular way [C.4]. This may have helped overcome the resentment, but the document appears to have become unmanageable [C.5], and they are left with a document which allows a marked degree of flexibility [C.6]!

Company D

Company D was owned by a non-UK parent company and was the only subsidiary whose main business was software development. Company D had a mature SQMS which had been operating for many years. We interviewed the quality manager who had been in the company for 16 years and who also had experience of running his own software company.

Production

Company D had been a subsidiary of a larger, non-UK company for many years. They had adopted quality management early on, and this was suggested as a natural progression from their earlier Technical Assurance programme [D.1]. They were the only software house owned by this company, although software development pervaded many other subsidiaries. There were thus many influences brought to bear on the development of their quality procedures [D.2]. The SQMS currently in use is divided into prescriptive procedures, and guidelines [D.3].

Day-to-day operation

The emphasis in this quality manager's mind was on maintaining the high profile of quality, and encouraging an attitude to ensure that quality never slips and that a long term view of the company's business is maintained [D.4]. A salutary tale was told of another arm of the business, also in the computer industry which had decided not to try for TickIT certification, when it already had ISO9000. The board of this division decided that there was no reason to expend the effort necessary, but our interviewee offered a different interpretation of their actions [D.5].

Evolution

The SQMS was developed iteratively and is continually improved [D.6]. The system is substantially written by people 'on the ground' since ownership is seen as an important factor [D.7]. Despite also experiencing the downsizing that seems prevalent in the industry from the late 1980s onwards this company's commitment to quality had not, apparently, wavered [D.8]. This may be due to the fact that staffing had been stable, and that the quality function has a direct reporting line to the executive [D.1].

Table 5: Company D quotations

<p>[D.1] we moved into Quality Management very, very early in the software business in fact we virtually invented it, ..[laughs].. not quite, we first had a Quality Management System in <name> in 1980, um, we had a before that we had a service called Technical Assurance which was, which was started in 1978. I joined the Quality Group which was then only two people in 1980. Been there ever since. And as such we get sort of put on one side, it's a direct reporting line to the executive.</p> <p>[D.2] At one time we held six certifications for the manufacture of hardware, the installation and maintenance of hardware, the development and the application of software, the maintenance of software and the installation and maintenance of telecommunications systems.</p> <p>[D.3] We divide the QMS into procedures which are prescriptive and guidelines which are advisory. The guidelines are very much to do with the people aspects of it, you know, what turns people on, ... what upsets customers, ... how not to upset the customer.</p> <p>[D.4] .. there is a danger that ... a <member of staff> will want a product to go out of the door when it is full of faults and it is my responsibility to stop it going out of the door. ... because these decisions are usually made pragmatically with a very short term view and not considering the long term impact. It's part of a culture. If people get the idea that it [quality] doesn't matter then they'll do it, if they get the idea it does matter, they won't. Generally speaking, they don't. They understand that in the long term, it's against the interests of the company. ... It is always difficult when <some members of staff> are involved because it may be against the interests of the company but in the interest of the individual concerned.</p> <p>[D.5] This is to do with commitment and understanding, and all sorts of things like that. In my view the executive of the other division, by not going for TickIT um made a public statement of lack of commitment to quality.... certainly gives totally the wrong message to their staff, and a lack of commitment to their customers... It's quite interesting that er last year, on a routine assessment, routine surveillance.. that division picked up a major discrepancy...</p> <p>[D.6] Well I think my major sort of role is to maintain the Company's quality reputation as accepted by our commitment to the Quality Management System which was put in place years ago and tries to continually improve.</p> <p>[D.7] Um well basically we don't write the guidelines, we get them to write them themselves. I mean we never write, the people who write procedures and standards have to be the people who are going to use them not people like me, I mean I never write anything. ..[laughs].. I just make sure it gets done. The ownership has to be with the people who do it.</p> <p>[D.8] Interviewer: By implication you are happy with <name> as it is now, with commitment in the Company now? Interviewee: Yes I think so, the fact that, yes I am, I am because I could see that because of the downsizing and the fact that the TickIT, our TickIT re-registration, was coming up, the whole question of added value of that Quality Management System to a much smaller Company must have been discussed at some meeting when I wasn't there, and in fact the commitment to it has been total.</p>

3.2. Summary of findings

The previous section presented some of the evidence we have for suggesting that tensions exist between the developers and the quality effort. Tensions can be productive, but most of those identified above appear to be counter-productive, acting as barriers to the quality effort. Where tensions exist, this is mainly due to imposition from outside, and a lack of explanation or consultation. Where tensions are not apparent, we found collaboration, negotiation and mutual respect. More specifically, tension is observed under the following circumstances:

Production: Inadequate or obviously unreasonable explanation is given regarding the need to introduce an SQMS (Companies B, C);

Production/Evolution: There is a general lack of consultation with staff concerning the introduction and subsequent development of the SQMS (Companies B, C)

Production/Evolution: Procedures which ignore current practice are imposed with no explanation of their rationale (Companies C);

Production/Evolution/Day-to-Day: Existing pride in the company is undermined by undervaluing expertise (Companies B, C);

Day-to-Day: Management commitment to quality and quality initiatives falters (Company D)

Day-to-Day: Procedures are written in a rigid fashion, ignoring the practicalities of day-to-day working (Companies C);

Circumstances in which tension appears to be resolved or at least alleviated are:

Production: The need for a quality manual, and for quality initiatives, is accepted by all staff (Companies A, D);

Evolution Staff who have to implement the procedures write them (Companies A, D);

Day-to-Day: The manuals themselves include explanation and varying levels of insistence, or are not entirely prescriptive (Companies A, C, D);

Day-to-Day: The manual is flexible and allows decisions to be taken 'on the ground' (Company A, D);

4. DISCUSSION

The existence of tensions highlights the importance of employee relations, and the need to include employees in discussions. These issues have been identified by others, and are sometimes portrayed as being tensions between 'management' and 'workers'. However, in our case, all of our interviewees were 'quality managers', a role that does not fit neatly into traditional organisational structures.

In two cases, the quality manager was a senior developer, but still engaged in the day-to-day hands-on activity of producing and maintaining code (Companies B and C). In the other two cases (Companies A and D) the quality managers had other development management duties as well as managing the quality system. None of our interviewees could be classed as 'senior managers', and nor did they class themselves as such. Revisiting the summary of our findings with this in mind, it seems that companies A and D have on the whole found ways to alleviate tensions while companies B and C have not. It seems therefore that the tensions were felt by senior developers but not by those in a more managerial role. In a sample of four companies, this division may be coincidental, however, another factor that might be influential is the maturity of the SQMSs: In companies A and D the SQMSs were more mature than in B and C, i.e. the system had been in place for a number of years.

Our observations reflect findings from other work in empirical investigations of software process improvement and organisational change literature. Below we compare our results with these.

4.1 Empirical investigations of software process improvement

The adoption and evolution of SQMSs is one form of process improvement initiative, and it is accepted that people factors affect process improvement (e.g. Wilson et al., 2001). We have been unable to find any work that focuses specifically on SQMSs, nor any work that uses an approach combining ethnographic field studies and discourse analysis. However, the work of Baddoo and Hall (Baddoo & Hall, 2002a, Baddoo & Hall, 2002b) addressing motivational factors in software process improvement (SPI) has some overlaps with our work on tensions. They conducted focus groups with practitioners in 13 companies. Practitioners were divided into three categories:

developers, project managers and senior managers, and each focus group was asked to discuss two questions: What are the motivators for SPI in your company? and What would motivate you to support SPI? They then used content analysis to identify motivational factors for each group, and summarised their findings in terms of a numeric count of the number of groups in each category who mentioned each factor.

They found that 43% of the developers rated visible success as a motivator, with 24% quoting bottom-up initiatives and top-down commitment each. Thirty-one percent of project managers asked were also motivated by visible success and 31% by having adequate resources. Twenty-five percent listed empowerment and process ownership as motivating factors. For senior managers, visible success and meeting targets were mentioned by 25% of them. In summary, visible success, reward schemes, resources, process ownership and a maintainable/easy process were mentioned to one degree or another by all groups.

Apart from the number of practitioners involved, the research methods used by Baddoo and Hall were different from ours in two respects: first in the questioning of respondents. We did not ask questions specifically about the software quality management system, but allowed the interviewees to raise whatever issues that were forefront in their minds, while Baddoo and Hall gave their focus group specific SPI questions to discuss. Second, our analysis techniques were different. We identified tensions within different phases of SQMS adoption and evolution, while Baddoo and Hall did not distinguish any such phases. We used discourses analysis which allows us to explore people's attitudes and intentions, while Baddoo and Hall used content analysis to produce a numeric count. In addition, we used ethnographic data to frame our analysis, an aspect not considered by Baddoo and Hall.

Despite these differences in approach there are some similarities in findings. For example, top-down commitment was cited by 24% of the developer groups, and we found that tension emerges when management commitment falters. Process ownership was mentioned by all practitioner groups: 19% of developers, 25% of project managers and 17% of senior managers. In our study, tension was alleviated when staff write the procedures they have to implement, and falters when procedures are imposed.

In Baddoo and Hall's study all groups mentioned visible success, yet no evidence arose from our data that this was an issue. The closest our data comes to this is the need for careful explanation for introducing the SQMS. Reward schemes were discussed by one of our interviewees, but were mentioned alongside mottos and badges to give a clear purpose to the group. None of our other interviewees mentioned them. The need for resources was not discussed, neither was the need for a maintainable or easy-to-use process.

4.2 Organisational Change

Our findings can also be related to the literature on organisational change. Introducing a software quality management system into an organisation is about changing the company's culture and the way people work. Writers about organisational culture acknowledge that changing cultures is hard, and there are recognised reasons and conditions for resistance.

Buono & Bowditch (1989, p167) state that "if organisational members can see the the inherent value of a change, they are much more likely to accept and identify with what the organisation is attempting to accomplish." Williams et al. (1993) also suggest that resistance will occur if the need for change is not recognised by those it will affect. Deal & Kennedy (1988) emphasise the importance of peer group consensus. All of these issues link to our finding that tensions were caused when the rationale for introducing SQMSs was not explained, or there was a general lack of consultation with staff.

Another condition likely to cause resistance is when there is increased level of uncertainty, in jobs, status, rewards, etc. This is mentioned by Williams et al. (1993) and by Brown (1995, who

talks explicitly about esteem and status. Deal & Kennedy (1988) emphasise the importance of two-way trust. We found that tensions were caused when developers felt their expertise was undervalued, or when management commitment faltered.

Other tensions we found were at a lower level of detail and were specific to software quality, e.g. rigid versus flexible procedures, staff writing the procedures versus imposition from another body, etc.

5. SUMMARY AND FURTHER WORK

In this paper, we have related stories of the quality effort (SQMS adoption and evolution) in four companies. From our findings, we observed that tensions exist between developers and the quality effort and we divided our observations into issues concerned with the adoption, the evolution, and the day-to-day operation of SQMSs. Although the divisions between these phases are not necessarily clear cut, the divisions serve to indicate that whilst some problems are the same throughout the life of an SQMS, (e.g. imposition creates resentment), others are specific to certain phases (e.g. successful day-to-day operation needs continual commitment).

Our findings so far are in broad agreement with the results of other work in software process improvement and in organisational change, although we provide more detail and specific contextual information for the problems that arise when dealing with SQMSs.

While this analysis has given us some new insights, and confirmed others, we believe that our findings could be enhanced by further analysis and data collection providing more depth to the issues raised.

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