SOFTWARE QUALITY MANAGEMENT AND ORGANIZATIONAL FIT

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ABSTRACT:

This paper describes some of the findings, of an ongoing ethnographic study of a computer operations section in an Information Technology Centre. The study finds that after an initial period of staff acceptance of prescribed quality management procedures, certain features of organizational culture, structure and power, work against continued conformance. Procedures will be modified, firstly to resolve any inconsistencies between the prescribed procedures and strongly held beliefs and values about work practices and organization, and secondly to reduce or eliminate perceived threats. The paper argues that software quality management is based on a unitarian approach to organization, which ignores the plurality of beliefs and work contexts which exist in an organization, and which assumes that organizational features can be managed and changed in predictable ways. This paper suggests that a pluralist approach to organizational analysis helps to reveal the nature and extent of changes required to the quality management system and the requirements for implementing changes.

INTRODUCTION

Although the importance of software quality, as a strategic and competitive tool is now widely accepted, the achievement of improvements in quality is still problematical. Many of the 'hard' problems, the development of tools and systems, seem to have been solved, but the 'soft' problems of values, attitudes, and organization remain, so that the implementation of software quality systems has not been so successful. A new approach to these problems has been developed by the Total Quality Movement, which views quality as a philosophy of management, and sees the organization as a series of interrelated processes which can be assessed for their effectiveness in contributing to quality management. In the software quality arena, considerable effort is being invested in the definition and assessment of software processes. (Humphrey and Sweet 1987)
The purpose of the study discussed in this paper is to gain an understanding of how and why actual software quality practices differ from the policies and procedures prescribed by management in a particular organizational context. The findings discussed relate to the acceptance of change, and the features of organizational culture, structure and power which affect the implementation of prescribed procedures.

THE STUDY

Research Setting

The research setting and methods of this study are reported fully in Davies and Nielsen (1992). A brief summary is presented here.
The organization selected for the field study, the Operations Section of an Information Technology Centre (ITC) in the Division of Information Services of an Australian University, was chosen for ease of access and because of the pivotal role it appeared to play in the ITC. The Operations Section maintains a Help Desk, is involved in multi-skilling, organizes work schedules, coordinates much of the documentation which deals with system development and use, deals with internal system problems and system failures and is generally the interface between the users and the other sections of the ITC. The field study focuses on the configuration management practices of the section. These practices were chosen because in the author's experience the implementation of such procedures has often been problematic, and because configuration management occupies an important place in the development of a quality management system. According to the Capability Maturity Model proposed by Humphrey (1990), configuration management processes are required for an organization to move from the initial to the repeatable and defined levels of process maturity. Ultimately, at the level of process and work systems, it is suggested that configuration management can provide a continuous source of information on software development practices in an organization. "According to the SEI [Software Engineering Institute], an important criterion for assessment of an organization's software maturity level is the degree to which its software development process is defined (and, therefore, documented)." (Hopkins and Jernow 1990, p 125)

The discipline of configuration management is currently undergoing some redefinition in relation to its role in system development (Olsen 1993). However, it is generally agreed that configuration management has four primary goals: to identify and define the items in a system (identification), to control changes to these items (change control), to record and report the status of these items (configuration status accounting), and to audit the items to verify completeness and conformance to specifications (Buckley 1993, Whitgift 1991).This paper focuses specifically on configuration identification and change control, which were continuing concerns of the Operations Section during the period of the study.

Research Methods

The research methods used in the study are ethnographic, including participant observation, unstructured interviews, attendance at regular Section meetings, diary recordings, and analysis of documentation. The study commenced in 1991 with an intense two month period of 'shadowing' one member of the section.

The interpretive perspective is used, to enable the author to gain an understanding of the meaning of work practices within their organizational context - how people make sense of their everyday practices in relation to their goals and their working situation. This sense making is crucial to the understanding of what is meant by quality, and also to how it can be achieved in ways that do not conflict with other beliefs and values. The particular interpretive approach used by the author is that of critical hermeneutics, the interpretation of the text produced by people in their work contexts, and of the texts produced by the author in the act of interpretation. (Thompson 1981) Thus the interpretation is seen as a recursive act, which is potentially infinite. This recursiveness is also important to the ongoing nature of meaning construction, which continually reacts to and creates change in the sense making environment.

It is expected that this approach will contribute more to an understanding of why quality management systems are not successfully implemented, than the acontextual view of much of the positivist research currently undertaken in the software quality arena. Alhough there is the problem of generalization in such research, which can only be overcome by further research and the development of a larger body of knowledge about the organizational contexts of software quality management practices.

The specific approach to interpretation taken in this study is based on the intertexuality relationships between texts and contexts. Themes, such as issues and problems, are identified by lexical and syntactic foregrounding which continues across a number of texts. This continuation is explained by the notion of cohesion in text, which shows the links from one specific textual unit to other units (con-texts) and to the wider situational and cultural contexts (Halliday and Hasan 1985).

Research Findings

The author's identification and interpretation of themes was challenged and modified by feedback sessions between the author and the staff of the Operations Section and these differences in interpretations became further texts to be studied. The themes which are discussed in this paper are concerned specifically with the problems of establishing satisfactory configuration management practices and associated documentation. To explore the possible meanings of these themes we need to consider the features of the situational context of the field study and to place these in the wider context of organizational culture, structure and power. The significance of this for the implementation of software quality management practices is also discussed.

The theoretical outcomes of this study so far are that initially staff may accept the quality management procedures, but that ultimately these procedures will be modified by staff, even when ownership of the procedures appears to have been accomplished. The reasons for these modifications being made are, first to resolve any inconsistencies between the prescribed procedures and strongly held beliefs and values about work practices and organization, and secondly to reduce or eliminate perceived threats. The gap that arises between prescribed procedures and actual work practices results from a unitarian perspective on organizational culture, structure and power which ignores the plurality of beliefs and work contexts which exist in an organization.

The practical outcomes of the study are a greater understanding of the different perspectives on organization within ITC, and of the organizational features which work against the acceptance of prescribed practices. If this understanding can be confirmed and shared by ITC management, then the chances of successfully implementing software quality management systems may be improved.

THE CONTEXT OF CHANGE

Resistance to Change

The implementation of software quality management systems means the introduction of significant changes to the way an organization or group of people operates. The way that changes are handled by management and staff is an important feature of the organizational context.

During the period 1992-1993, the General Manager of the ITC initiated work on the implementation of practices conforming to the Australian Standard for Software Quality Management (AS3563) with the objective of gaining official certification. Most of the staff of the Operations Section were involved in the formulation of section policies and procedures, as well as vision statements and strategic plans for other sections in the Division. During this time a sequence of events was seen to recur several times. One or more members of staff would be involved with management in the formulation of an objective and a consequent set of procedures to enable the objective to be carried out. (For example, a new procedure for recording software change requests was proposed, so that information could be collected about the frequency and nature of these requests, as well as the time required to make the changes.) The objective and the procedures would be discussed and agreed on or modified at Section meetings and would be documented for future reference. Many of these procedures were such that they would need to be carried out very frequently, on a daily, or at least weekly, basis. After some period of time the procedures would be raised again at a Section meeting, and in many cases the procedures would have been changed significantly or ignored in the interim. There would be disagreement amongst staff about the importance, correctness or usefulness of the procedures and after further discussion over one or more meetings, a new set of procedures would be put into place. These changes were often not documented and were rarely communicated to management. There were very few occasions during this two year period in which officially instituted procedures were accepted and maintained without modification, or where management were involved in discussions about subsequent modifications.

Acceptance of Change

The way that changes were handled in this organization can be considered in relation to the literature on the way that people react to attempts to introduce change. Acceptance of change is usually characterised as taking one of three forms - compliance, identification or internalization (e.g Handy 1985). Compliance means that change is accepted quickly, but unwillingly, because the recipient is given no choice. In other words, some source of power - money, status, etc., is exchanged for the recipient's compliance. The recipient may be prepared to accept the change without the exchange offered. However the use of power denies the recipient this choice, so compliance is the only response which the employee can offer. Such acceptance requires the manager to continually check and monitor the employee and to offer further rewards. Commitment to the change by the employee remains low.

Identification, as a form of acceptance occurs when staff admire or identify with the source of the change, be it an individual or a group. Where managers are close to their employees and have considerable personal power they may obtain this kind of acceptance readily. However it requires the continued presence of the initiator of the change. If the group disbands or the initiator leaves, commitment to the change may disappear. The last type of acceptance is internalization, where an individual accepts the change as their own idea. This creates a high level of commitment and is self-maintaining, however it takes great effort to obtain and requires granting the member of staff considerable independence. The information systems literature which deals with the impact of systems on organizations indicates that the internalisation of change through 'ownership' is essential for successful implementation (Knight 1989, Land 1987).

In this study, members of the Section were fully involved in formulating the original changes. The verbal and written language used by management and staff during these negotiations showed that participants were attempting to achieve changes in a way that was acceptable to everyone, and the Operators appeared to have internalised these changes. It would therefore seem reasonable to conclude that monitoring by management was not required. However, since the implementation of most of these changes was shortlived, another explanation must be sought.

What is also significant in this study is that there were often considerable differences between the official procedures which were not accepted and the procedures which were finally implemented. An understanding of the nature of these differences and the reasons for them occurring, may be looked for in the analysis of the Operators discourse within the organizational context, discussed in the next sections of this paper.

ORGANIZATIONAL CULTURE

Perspectives on Organizational Culture

Before discussing the organizational culture as a context for the development of configuration and documentation practices, it is important to refer briefly to some of the assumptions about culture, which are found in the literature of quality management. The assumption that organizational culture can be changed and managed lies behind much of the literature. Such an assumption is called 'integrationist' (Meyerson and Martin 1987), and its adoption, either implicitly or explicitly, is consistent with the notion that culture is something an organization *has*, that it is a set of variables which can be manipulated to achieve desired objectives. According to this view, the effective implementation of quality management practices can be achieved by the sharing of vision and values across the organization. There is an emphasis on achieving common objectives and the idea of ambiguity or subcultures is disregarded. "Quality as an organizational truth is the outstanding emotive force which can unify everyone within the organization" (Lascelles and Dale 1988).

Over a two year period there were a number of interventions into the practices of the Operations Section, and the author was able to observe the effects of these actions. There have been no significant empirical studies of how quality management interventions affect organizational culture and so far there is no evidence that change does occur except at the surface level (Dale and Cooper 1992). This study supports this, in that no effects were observed, except in the creation of some artefacts (such as procedure manuals) for official use. Indeed most of the interventions were adapted to be consistent with strongly held beliefs and values, for example about the amount of autonomy professional staff should have. So that although the staff accepted in principle the new practice, it was implemented in such a way that the 'new' system was virtually the same as the system it was intended to replace.

Different perspectives on organizational culture are provided by the differentiation and fragmentation views (Martin and Meyerson 1988) which recognize that different and sometimes incompatible beliefs and values exist within organizations, and that these are not always easy to identify. So that interventions into the organizational culture may have no effect, or that the effects may be unpredictable. This study supports these latter views, by showing that differences continued to exist between management and the staff of different sections, in spite of the considerable effort to involve staff in the development of software quality policies and procedures.

These three different perspectives on organizational culture are strongly related to the unitarian, pluralist and radical frames of reference for considering organizational power, proposed by Burrell and Morgan (1979). These are referred to again in Section 5 of this paper.

The Importance of Organizational Subcultures

The fragmentation view of organizational culture is supported by the following incident. A major intervention occurred when a requirement was made for a common depository for all written documentation, relating to a new system to support the Help Desk Service. General problems experienced in compiling documentation have been discussed in a previous paper (Davies and Nielsen 1992). In this case, the need for visibility of system development was considered urgent by management as the Help Desk was under considerable criticism and the new system was expected to alleviate some of these problems. Staff from several sections were involved in the development of the system, and so a procedure for change control was proposed so that all staff would be aware of which version of the documentation was the current one. The most difficult stage of development was expected to be that of information requirements analysis, and it was at this stage that the change control procedure broke down.

Because of the difficulty of having staff meet face to face, much of the discussion occurred on email. However, informal work groups were formed, whose documentation was not able to be managed under the new change control system. Ultimately a prototype was developed which satisfied the most urgent requirements of the Help Desk staff, but which did not include the functions which were intended to supply information to management about the efficiency and effectiveness of the service. The development of the 'official' system which included these reporting functions was delayed indefinitely, and when changes to the prototype were proposed it was after the systems programmer who had undertaken most of the development work had left the organization and it was found that there was no extant documentation of the requirements. An analysis of the discourse that occurred during this incident showed that the objectives of the various groups were irreconcilable. Consequently the informal work group was used to avoid disclosing officially some of the concerns which the different sections had with the proposed system. These objectives reflected the different values of management and staff and their different notions of how quality should be achieved. These differences were not resolved by the consultation processes used during the development of the change control system.

In particular, a conflict persisted between the quality control perspective, which requires staff to recognise the need for continuous group inspection, and the perspective of the professional computer specialist who expects to be judged on the basis of results rather than on compliance with specific procedures. Professionally educated personnel

generally expect a high degree of discretion and control in their work. They expect some autonomy in the way they organize their work practices and less outside supervision than people who have received less education. Development staff expressed great impatience with procedures for change control which would slow down the pace of their work, and which intimated that they were unable to perform high quality work without outside supervision. Computer Support staff valued most highly their responsiveness to client needs, and would not sacrifice this responsiveness to the putative long term benefits of a new system. The Operations Section who were charged with coordinating and controlling the new documentation procedures suffered considerable stress during this period, because of the conflicting demands of management and the other Sections. However they were half hearted in their attempts to maintain control, showing their strong commitment to the values held by the staff in the Support and Systems Development Sections. As one Operator expressed it "If you're filing change reports, and the telephone's ringing and there's a customer at the Help Desk, I know what I'd do first."

ORGANIZATIONAL STRUCTURE

Official and Emergent Structures

Another explanation for the differences between prescribed and actual work practices can be sought in the way that control is maintained over and within groups. Within the ITC there are some conflicts between official control mechanisms and actual organizational structures. The overall structure resembles a bureaucracy and the official systems in place to support this structure are vertical in design. However, the actual organizational structures in some sections in ITC are more organic in form, adapting and changing according to the various projects in hand. This adaptive structure adopted by the Operations Section is discussed below. Although the Operations Section had very clearly defined responsibilities and official authority in relation to documentation and configuration management it had no real authority. That is, the Section did not feel empowered to use this authority considering its relationship with the other sections and its own mode of operation. In relation to the project for the development of the Help Desk system, the status of the Operations staff was generally lower than that of other sections. (In other projects, such as systems maintenance, it had a far higher status). It was therefore difficult for Operations staff to convincingly argue for the adoption of the new procedures.

In addition Operations staff felt uneasy providing information to management which might result in criticism being directed at the staff who had produced it. In an organic style organization documentation is produced and used mainly for communication and education. In a bureaucratic type of organization this same documentation may be used for evaluation, review and performance assessment. Staff are unlikely to be accurate in documenting activities which reveal problems in performance, if this information may affect their chances of promotion. This confusion over the purpose of software quality practices is likely to affect their successful implementation.

Organizational Performance and Organizational Structure

Change - whether it be the slightest deviation from an established procedure or the orderly progression from one stage of development to the next, will have some effects on the way that work is carried out in an organization. The motivation for organizational change is to improve the performance of the organization, in relation to, for example, the production of quality software. The proposed change will be based on certain assumptions about the relationship between organization and performance, and notions of what constitutes 'good' organization. An explanation for the difficulties experienced by the Operations Section in their attempts to comply with official procedures may be found in the conflict between different models of 'good' organization, held by the Operations staff, individual section managers and ITC management.

The Operations staff appear to be torn between a consistency and a contingent approach to organization for quality management. The consistency approach is shown by their reluctance to institute any formal changes, such as the change control system, which are inconsistent with firmly held beliefs about what is important in their work. The initial acceptance of procedures initiated by management seems to derive from their desire to show respect for their opinions, and their understanding or the political realities of the organization. But as inconsistencies become evident, the new procedures are modified without any communication to management.

However, the Section also takes a contingency approach by continually reorganizing on a short-term basis to cope with the frequent changes in technology, complicated work schedules, and most especially customer demands. Because this organic approach is not supported by any management resources, such reorganization occurs in an ad hoc manner and damages any mutual reinforcement provided by the organization. Indeed, it is often referred to by staff of other sections as an inability by Operations to organize themselves properly. For example, the Section has great difficulty in organizing staff meetings because they are concerned that the standard of service will drop if inexpert staff from other sections are used as stand-ins. The Operations staff face daily conflict between their need to meet as a group to communicate and discuss important changes, and their desire to maintain service. Thus, the

contingent approach used by the section does not derive from any management philosophy but from the Section's desire to remain responsive to urgent customer requirements. This approach is not supported by management.
For the management of ITC, a 'model' approach appears to be in use, reinforced by the government requirement for universities to demonstrate their commitment to quality management. In some sections, staff have greater control over their workload, and more stability in their work schedules and practices. The best ways of operating to implement quality practices, objectives and procedures are worked out over longer periods of time. However, this is often achieved at a cost to the Operations Section, who are most affected by the deployment of staff to such temporary arrangements as working parties on quality management.
These different approaches to organization reflect different views of 'quality'; even though the notion of quality is defined and specified in official documents, the exact meaning of quality is constructed quite differently by different groups according to features of their work context and their shared values and beliefs. Since the Operations staff have the greatest role in the production and coordination of documentation, the incongruencies in ideas about how best to achieve quality between the different sections is expected to have long term effects on the ability to implement properly documented quality management practices.
Each of these approaches entails problems for software quality management. The 'model' approach seems to underlie many software quality notions such as standards, 'best practice', etc. But a well identified problem with organizations attempting to emulate such models to achieve quality improvements, is that each organization varies so greatly in terms of size, history, market and so on, that the model may be inappropriate. The 'consistency' approach may entail the organization maintaining structures and practices inappropriate to external and internal contingencies. The Operations Section seems to be in this situation, ignoring long-term strategic considerations in order to maintain the current order. However their use of the 'contingency' approach aggravates the situation, as it prevents them from maintaining stability in work practices and puts them at odds with the management.

ORGANIZATIONAL POWER

Perspectives on power

The integrationist approach to organizational culture, discussed earlier, is similar to the unitarian approach to organizational power which characterises much of the discussion of software quality management. From the unitarian viewpoint, software quality management is proposed as a rational and technical process which should become a common objective for all members of an organization. Conflict is viewed as dysfunctional, and able to be removed through appropriate managerial actions. However, the experience of the author in this field study was that the configuration management processes which were introduced to facilitate communication between sections and between staff and their clients, were a source of unease for staff in the Operations Section. This was in spite of the involvement of staff in formulating these processes. The rationality of management discourse was not challenged by staff at the time of formulating new procedures, but management authority was undermined by changes which were made by staff to protect themselves from the consequences of adopting the new procedures. This reaction by staff may be explained by viewing organizational power from a pluralist or radical point of view.
The radical perspective views the organization as a political battleground where "rival forces strive for the achievement of largely incompatible ends" (Morgan 1986). Power according to this perspective is distributed unequally, conflict is often latent, and will ultimately result in radical change. The radical perspective provides little hope for quality improvement under present circumstances, since such a quality management programme is viewed as an instrument for management control.(Boje and Winsor 1993)
The pluralist perspective recognizes the diversity of interests within an organization and the inevitability of conflict, which can be used positively or negatively. It also proposes that power derives from a number of sources and that individuals can draw from these sources. For example, the professional knowledge of the Operations staff could be used to influence management policy.

Configuration Identification

One process which occupied considerable time at section meetings was that of establishing systems for identifying and naming configuration items. Identification as a configuration management activity involves the creation of new names, since each configuration item (software, hardware, process) must be identified as unique. Many of these names will form part of an artificial language, which will require a key for decoding (for example, HLS/DEX3.2-EC3.1: key HLS = Mnemonic for system/programme; DEX =Module(subsystem); 3 = baseline; .2 = version; EC = error correction (type of change; 3 = sequential number of approved change; .1 = version of change). Other names will be formed from everyday words and phrases. Both types of names should be descriptive, in that if the rules of the language are understood, the item that the name refers to should be unambiguously recalled. Thus identification

is prerequisite for one of the major functions of configuration management, that is, to be able to communicate the current state of any software product to the development team and to clients, during the development process.
However, the ability to create names in this way has political consequences: what can be identified can be used for control, unless its real significance can be hidden. The search for appropriate names may be viewed as a rational attempt to understand the nature of change in software development, and to develop a classificatory scheme which will appropriately reflect the reality of change. However, such a scheme also creates a knowledge structure and presents it for scrutiny to the outside world. This structure may have a constraining effect on future practices and therefore may be conceived of in threatening terms. This is strongly demonstrated in the problem of establishing the terminology for describing types of change; error correction, enhancement, etc. During the meetings on how to record software change requests, discussion of what change is and how it should be categorised soon broke down and was replaced by a search for names that were acceptable to the group. However the operators did show awareness that the names chosen could have meaning for other staff. Hence the criteria for acceptability of names was discussed. These criteria derived more from the impression that the Operations staff thought the name might make on other staff, than from its applicability to the phenomenon to which it was meant to apply.
A persistent approach to Identification took the form of 'hiding'. For example, names were sought for routines, such as tests, that were not performed any more, but which the Operators did not like to ignore in case someone official remembered instituting the practice and looked for evidence that it still existed.

Identification and Control

A preoccupation of staff in many meetings was the question of how to deal with the 'merging' of previously separate systems and practices. This discussion often revealed that the current usages in the identification of systems and practices were deemed unsatisfactory by some staff - they did not want their current names to be revealed to staff from other sections. Some effort was applied to finding new names for these items. Effort was also expended on finding names for practices and systems that so far had remained nameless or had unique identification but no descriptive identification.
Several reasons for the preoccupation with identification emerged from the discussions at meetings. Firstly, the prospective reorganization of work groups led to a feeling of going public and therefore the need to tidy up the shop, and to put on a good face. A desire was also expressed to maintain current practices as far as possible and to be in the strongest, most invulnerable position, before the reorganization occurred - to have everything sewn up. The Operations staff did not explicitly discuss the idea that the classification of changes to configuration items might have an impact on the way the section was able to control its own work, or that it might affect management perceptions of their efficiency. However, the solutions proposed by Operations staff to the problems of classifying changes and recording the status of changes showed that these were major concerns.
Much of this discourse was at odds with rational notions of configuration control by making configuration items invisible to the uninitiated, and of enabling clients to understand the status of the system development project. However, when the identification activity is viewed as an instrument of management control, it is likely to be used by operational and production staff to conceal the nature of some of their activities.

CONCLUSION

The tensions between prescription and practice, the lack of a common understanding of what is meant by 'quality' within an organization, and the barriers presented by traditional structures and divisions between management and operational staff are all problems which will make the implementation of quality management practices difficult in the organization studied. These problems, or similar ones are reported in the literature and are experienced by practitioners and consultants to such an extent that there have been a number of attacks on the quality movement in the software development and other industries (e.g. Boje and Winsor 1993).
These problems have been partly explained in this paper by examining their situatedness in organization. Firstly, the introduction of software quality management requires change of some form or other. In the literature of organizational change, considerable emphasis has been put on managing the process of change, to involve those affected by the change in the process of design and implementation, so that they come to 'own' the change. However this paper argues that unless the organizational context supports this approach, this will be just as ineffectual as more authoritarian approaches. The prescribed practices will appear to have been accepted, but non-prescribed practices will emerge which enable staff to maintain a reasonable working environment which is consistent with their beliefs and values. This will make it difficult for an organization to achieve any improvements in quality.
Secondly, actual work practices will differ from prescribed practices in a way that reflects features of the organizational context. Procedures which are inconsistent with the beliefs and values of staff will be modified, to reduce inconsistencies. Conflicting organizational structures will require changes to systems to accommodate

different work practices. Lastly, the power which the users of the quality management system perceive they possess, and the potential threat which the system presents to them will result in changes to the system, which allow the staff to maintain autonomy and avoid unwanted control.

Thirdly, software quality management is based on a unitarian approach to organizational culture, power and structure which assumes that these organizational features can be managed and changed in predictable ways. However, this paper shows that a pluralist approach can identify problems in software quality management practices. It is suggested that organizational analysis should be carried out prior to the formulation of new procedures which are intended to improve software quality. Such analysis would help identify the nature and extent of changes required to the system and/or the organization, and would allow staff to make better informed decisions about how to carry out the changes.

This paper has focussed on the effect of organizational context on prescribed quality management procedures. However, the author does not mean to deny the interactive nature of the effect, and analysis will be carried out of the impact that new procedures have had on the organization. As well, an examination of the importance of individuals and of the role of management has not yet been concluded.

Remarkable progress has been made in research into the "hard aspects" of software quality. To achieve results in quality improvement a similar effort needs to be made in investigating the 'soft aspects' of software quality. More empirical research is needed to develop a thorough understanding of the organizational contexts of software quality, in a range of national and organizational settings.

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