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AN EXAMINATION OF CULTURE PROFILES IN A SOFTWARE ORGANIZATION IMPLEMENTING SPI

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Abstract

The capability maturity model integration (CMMI) has become one of the most preferred approaches to software process improvement (SPI). However, the amount of discontinued or delayed CMMI-driven SPI projects is considerable. In this paper we investigate the culture embedded in the CMMI and compare it with the cultures within an implementing organization in Scandinavia by utilising the competing values framework. We search for congruencies in culture profiles and relate the profiles to assessment results in different business areas of the organization. Our research reveals that in spite of similar culture profiles in the business areas, which are significantly different from the culture profile of the CMMI, there is no apparent association with the level of SPI success. Furthermore, even if CMMI based process descriptions are not adapted to the software organisation's specific culture profile, evidence suggests that SPI success is possible.

Keywords: Capability Maturity Model Integration (CMMI), competing values framework, organizational culture, software process improvement.

1   INTRODUCTION

Over the years software process improvement (SPI) has emerged as the preferred approach to achieving efficient high-quality software development in complex organizations. The research and practicability of SPI has been expressed in many ways through e.g. SPICE (Emam et al., 1998), the European bootstrap model (Kuvaja et al. 1994), the capability maturity model (CMM) (Paulk et al., 1993) and the newer capability maturity model integration (CMMI) (CMMI Product Team, 2001), all contributing to our current knowledge of optimal processes in software development. However, CMM and now CMMI have generated a certain standard as to how demanding customers expect their suppliers to function internally. Nonetheless, in spite of the considerable amount of money spent on process improvements the disappointment rate is evident (Herbsleb et al., 1997) (SEI, 2002). SPI is a complicated issue, and (Mathiassen et al., 2002) underline the implementation issues through several large case companies. Much research questions whether CMM is a sound approach and some are even very critical towards it; see (Hansen et al., 2004; Mathiassen et al., 2005; Nielsen and Nørbjerg, 2001; Aaen, 2002).

(Ngwenyama and Nielsen, 2003) claim that the CMM models (SW-CMM and P-CMM) contain several major organizational culture contradictions between core model assumptions which may pose challenges to an implementing organization. Furthermore, they believe that the CMM could benefit from a comprehensive understanding of organizational design, culture and change, for example by extending the model with a framework of organizational change. However, there is very little research to support this. State of the art research on the topic of culture in SPI points to culture as a factor that influences the adoption and implementation of SPI. Successful implementation and the management of software processes improvement depends on the fit between the values of various subgroups and the values embedded in the new software development process (Dubé and Robey, 1999). Moreover, alignment between the values embedded in a software development process and the organizational culture facilitates implementation (Dubé, 1998). In fact, if the cultural assumptions embedded in an SPI maturity model like the SW-CMM are at odds with the assumptions underlying the organizational culture, the implementation may be in jeopardy (Ngwenyama and Nielsen, 2003). Additionally the application and adoption of such models, e.g. the SW-CMM, promotes certain types of organizational cultures implying a possible conflict between the maturity model being used and the culture of the organization (Boehm, 2000). The cultural assumptions embedded in models like the CMM and CMMI are western in origin which necessitates adaptation to the national culture context of an organization (Phongpaibul and Boehm, 2005). Chances of effecting change through SPI may be increased by building a positive work climate and promoting job satisfaction (Yamamura, 1999). Despite these contributions to our knowledge about culture in SPI, current research has not sufficiently dealt with the impact of cultural incongruity on the level of success. Among other things, existing research does not adequately address the question of the need for cultural congruency between software organizations and SPI models. In this paper we address this research question. We have studied a Scandinavian software organization to determine whether the success or failure of CMMI based SPI is attributable to organizational culture. For the purpose of the empirical investigation, we have used the competing values framework by (Cameron and Quinn, 1999) underlying the theoretical study by (Ngwenyama and Nielsen, 2003).

The paper is organised as follows. In the next section we present the competing values framework and its measurement instrument. Section 3 outlines the research approach based on this framework. In section 4 we describe the case on which our argument is based, and we analyse the case data. Section 5 contains a discussion of our findings, and section 6 concludes the argument.

2   COMPETING VALUES FRAMEWORK

The Competing Values Framework (Quinn et al., 1983) identifies four clusters of opposite types of organizational culture. As the name suggests these opposite sets of basic assumptions, orientations, and core values of organizational cultures are competing. Different indicators of organizational culture can be sorted along two dimensions. One dimension differentiates criteria that emphasize stability, order, and control from criteria that emphasize flexibility, discretion, and dynamism. The other dimension contrasts on the one hand internal orientation, integration, and unity with on the other hand external orientation, differentiation, and rivalry. Each of the four clusters or quadrants formed by these two dimensions represents a culture type labelled clan, adhocracy, market, and hierarchy respectively. These four culture types are theoretical constructs or archetypes, and most organizations contain elements of all of them (Cameron and Quinn, 1999). Only when viewed through the theoretical framework does an organizational culture appear as a mixture of culture types. In reality an organizational culture is specific in nature with concrete characteristics.
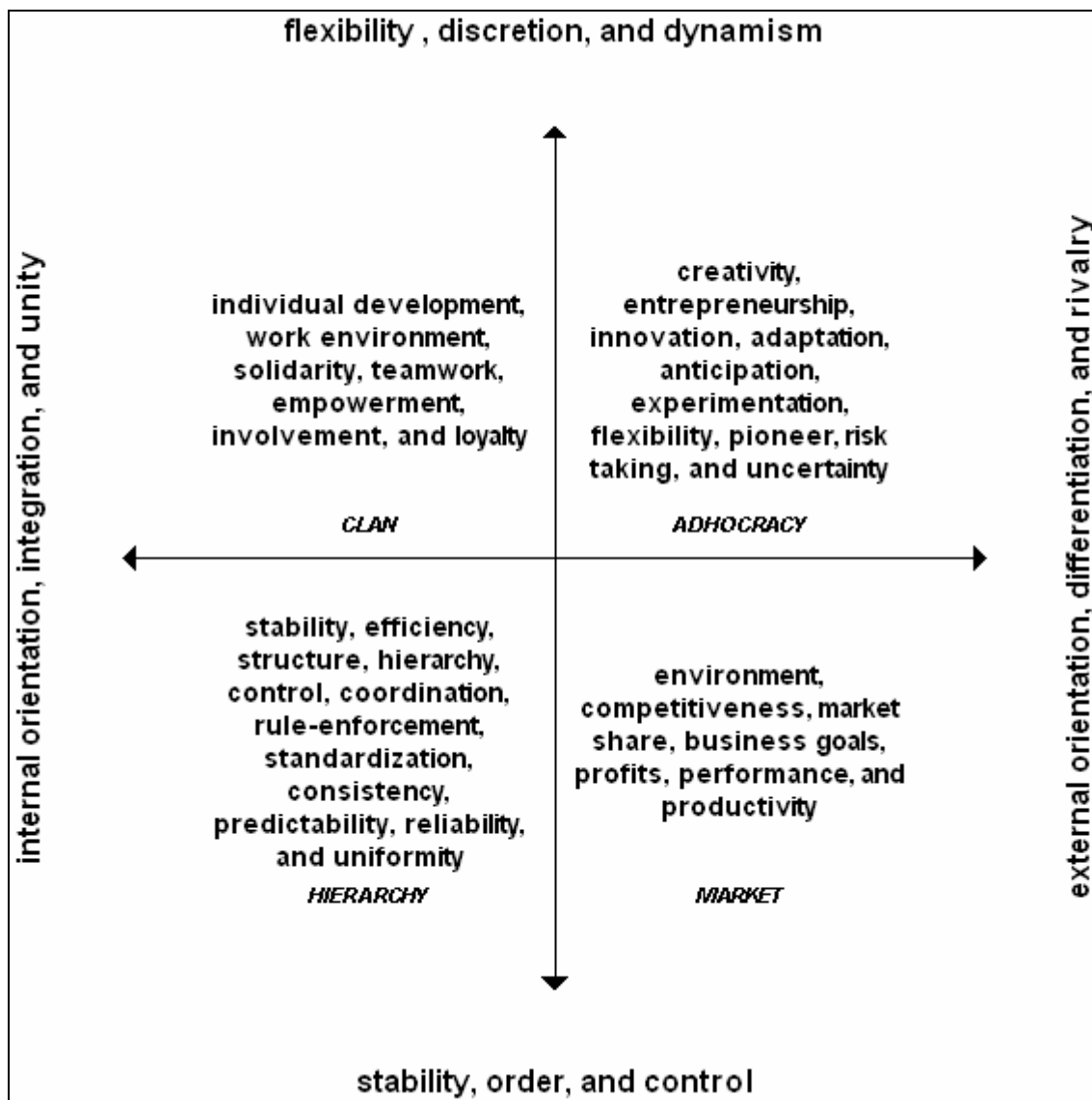

Figure 1.   The Competing Values Framework
Source: Adapted from (Cameron and Quinn, 1999)

Figure 1 illustrates the two-dimensional space that embraces the four culture types. The figure also contains keywords that are used to describe each of these culture types. For example, in a clan culture commitment to employees and their individual development takes center stage. Emphasis is on the work environment, solidarity (internal cohesion) and teamwork, and other keywords that describe this culture type are empowerment, involvement and loyalty.

The widely used measurement instrument based on the competing values framework, the organizational culture assessment instrument (OCAI), has been developed and tested by (Cameron and Quinn, 1999). The OCAI uses a questionnaire to establish a culture profile based on the four culture types. That is, the tool assesses the relative importance of elements of the culture types in an organization. For example, an organization might be dominated by the clan culture type (60%), supported by elements of the adhocracy culture type (30%), but only marginally influenced by the hierarchy and market culture types (5% each). In order to avoid attaching too much importance to the numerical values ascribed to each of the culture types, e.g. by claiming that the organization is x % hierarchical, y % market, z % clan, and w % adhocracy, the percentage points should be interpreted as expressions of tendencies within the organization rather than facts (Cameron and Quinn, 1999).

Using the OCAI presents two advantages to this study. First, it is a non-intrusive and inexpensive (measured by the time used by each respondent to answer the six questions on the questionnaire) way of identifying an organization's culture profile. Second, the usefulness of the tool has been validated in practice. The authors cite empirical validation in numerous organizations (Cameron and Quinn, 1999), and the many instances of the OCAI being used by practitioners and researchers (see for example Al-Khalifa and Aspinwall, 2001; Dastmalchian et al., 2000) lend credibility to this claim of validity. Thus, the tool is useful in providing an approximate picture of an organizational culture (or in this case subcultures) or tendencies within that culture.

3 RESEARCH APPROACH

The investigation was carried out in a large Scandinavian high-tech organization, Systems Inc. (the name of the organization and its business units are anonymized to protect sensitive data). The basic research approach follows the structure of a case study as outlined by (Yin, 1994). The case study is part of a larger collaborative practice research effort (Mathiassen, 2002) undertaken by one of the authors. The collaborative practice research setting has provided access to many sources of empirical data and has given a larger context for our interpretation of the data. We have utilized several data sources and followed four steps in our data collection and analysis:

1. Data selection and collection

2. Algorithmic data processing

3. Data analysis

4. Comparative data analysis across data sources

The fundamental idea underlying the study was to obtain an understanding of the influence on organizational culture by the embedded culture of the CMMI. The procedure for analyzing the CMMI as a text in search for elements of organizational culture was described by (Ngwenyama and Nielsen, 2003). In our study we have extended this procedure to include several data sources:

- The CMMI specification by the Software Engineering Institute

- CMMI based internal (Systems Inc.) standard operating procedures known as Systems Inc. Management System (SMS)

- Systems Inc. internal news: News on Systems Inc.'s intranet spanning a 3-year period

In addition, we have depended on the OCAI and process maturity assessments performed during Systems Inc.'s SPI project as primary data sources. In the following the selection and collection of

data (step 1) from these five sources are presented in greater detail along with the algorithmic data processing (step 2). The data analysis (step 3) and comparative data analysis across data sources (step 4) are presented in section 4.

3.1 The OCAI survey in two business areas

The questionnaire developed by (Cameron and Quinn, 1999), see section 2, was translated from English into the national language of the organization. The questionnaire was distributed to and answered by employees in two different business units. The questionnaire was digitized and the software tool Inquisite was used to facilitate both the data collection and the data analysis. By mid September 2006, the questionnaire was sent to 37 respondents in department 1, Defcom, and 40 respondents in department 2, Aeronaut, with respectively 85% and 55% of the respondents completing the questionnaire. Rather than selecting representative respondents the whole population of all middle managers, project managers, and project participants that had participated in the software process improvement effort were selected. Since we were interested in the effect of organizational subcultures on process implementation efforts, it was deemed appropriate to include only employees who had actually contributed to these efforts. Having collected the data, culture profiles were produced as described by (Cameron and Quinn, 1999), see section 2. One culture profile was generated for each of the two business units.

3.2 The textual analysis of CMMI, SMS, and Systems Inc. internal news

For the purpose of establishing culture profiles of the documents (CMMI, SMS, and Systems Inc. internal news) based on the competing values framework we have performed quantitative textual analyses in a manner similar to that of (Ngwenyama and Nielsen, 2003) in their study of the CMM. To that end we used the software tool ATLAS.ti to perform word counts and frequency analyses on all the documents. The descriptions of each of the four culture types of the Competing Values Framework were analyzed in search for words and phrases that collectively describe the culture types (Cameron and Quinn, 1999: 33-40). The selection of key words and phrases was an iterative process in which culture codes were proposed and validated through discussion. During this process some of the proposed culture codes were discarded while new ones surfaced. Originally some culture codes were too broad (e.g. risk) while others were too specific (e.g. results-orientation) to warrant a search for their occurrence. Afterwards, we searched for occurrences of the selected words and phrases in the CMMI, the SMS, and the Systems Inc. internal news using ATLAS.ti. Since some of the words and phrases were ambiguous and not readily operable in such a search, it was necessary to include synonyms and different combinations of words. Arriving at these synonyms and word combinations was a time-consuming process and involved establishing and discussing more than 250 culture codes. Three examples illustrate the need for these synonyms and word combinations. First, the concept of "employee development" (clan culture) is synonymous with "personal development" and we wanted to make sure that our search included such synonyms. Consequently, we established a list of synonyms for each word or phrase that was part of one of the four culture types. Second, the concept of "risk taking" (adhocracy culture) has not only numerous synonyms, e.g. "taking a risk" and "taking chances", but may also be described as something undesirable which stands in contrast to its positive connotation in the adhocracy culture type. We wanted to make sure that our search only included "risk taking" as desirable behaviour. Therefore, we established a number of compound codes like "risk" not co-occurring in the same sentence with "avoid". Third, different inflexions of the word "predictability" (hierarchy culture) exist. It may for example appear as "predictable", "predict" etc., and we wanted to make sure that our search included such inflexions. Therefore, we used wildcards in our searches, i.e. predict* to encompass them all. Having searched the documents in a rigorous and exhaustive manner for words and phrases that describe the culture types, we performed weighed (taking into account an uneven number of words and phrases for each culture type) distribution analyses to show the prevalence (in percentages) of the four culture types in each of the documents.

Based on these distribution analyses we established a culture profile for each of the documents similar to the OCAI profiles.

3.3   The CMMI Assessments

Software process assessments produce insight into the current state of an organization's software development practices, help prioritize improvement initiatives, and are used to periodically evaluate and re-plan ongoing SPI initiatives (Humphrey 1990; McFeeley 1996; CMMI Product Team 2001). During its SPI project Systems Inc. relied on the Electronic Based Assessment Tool (EBAT) for continuous process maturity assessments (Müller et al., 2007). The tool allows for measurements of a project's degree of CMMI level 2 compliance, and as such EBAT was an integral part of the organization's measurement strategy. The tool was used repeatedly for determining whether systems development practices at the project level were compliant with both required and expected CMMI model components. During the SPI implementation EBAT was used on more than 30 new and ongoing projects. Assessments were performed on average every 3 to 4 months to evaluate the progress of putting new processes into practice. In keeping with (Müller et al., 2007) the operational goal of the SPI project was to reach 75% compliance.

For the purpose of this paper we have used EBAT assessments from three consecutive measurement milestones during the SPI implementation in both Aeronaut and Defcom. Assessments at milestone 1, 2 and 3 were carried out in December/November 2005, March 2006 and May/June 2006 respectively. At each milestone for each business unit an average score was calculated for the degree of CMMI compliance for each process area at level 2. Also, a score for the overall level of compliance across process areas was calculated for each business unit. Not all process areas were included in every assessment. The selection of process areas to be assessed depended on the implementation plans for each business unit. Only process areas that the business unit was implementing at that time were included in the assessment for that milestone.

4   CASE DESCRIPTION AND ANALYSIS

Systems Inc. is a Scandinavian high-tech organization that develops software solutions, systems and products for civilian and military applications used in extreme environments. The fact that human lives and valuable material assets are at stake, makes Systems Inc.'s development activities highly critical and knowledge intensive. Therefore, Systems Inc. is committed to improving its process maturity and systems development capabilities in part through the use of CMMI. The reason for using CMMI has to do with the fact that Systems Inc. is contracting with customers who require their suppliers to be operating at CMMI level 3. Systems Inc. is comprised of autonomous business units two of which are the focus of this paper. One of the business units, Aeronaut, is an organization of 143 people and a global provider of advanced aerospace technology. The other business unit, Defcom, is an organization of 155 people and a global provider of advanced defense technology.

4.1   Overview

The results from the OCAI analysis of the two business units and the textual analysis of the three documents (CMMI, SMS, and Systems Inc. internal news) are shown in Table 1.

	Adhocracy	Clan	Hierarchy	Market
CMMI, v1.1	7%	25%	36%	32%
CMMI, v1.1, ML2	8%	21%	31%	40%
Systems Inc. internal news	24%	28%	21%	27%
Systems Inc. Management System	11%	23%	30%	36%
Aeronaut	18%	23%	31%	28%
Defcom	19%	25%	33%	23%

Table 1.   Culture profiles

Table 1 shows the cultural profiles for CMMI, CMMI level 2, Systems Inc. internal news, SMS, Aeronaut, and Defcom. It is not surprising that the textual analysis of CMMI reveals a high tendency towards the hierarchy culture (36%) and hardly any tendency towards the adhocracy culture (7%). This is consistent with both the CMMI management ideal (Aaen, 2003) and previous analyses of CMM-SW in (Ngwenyama and Nielsen, 2003). Looking at CMMI level 2 in isolation, we see a higher leaning towards the market culture (40%), while the adhocracy culture is nearly identical (8%). Table 1 also shows the results of the textual analysis of the SMS which is dominated by the market culture (36%) and the hierarchy culture (30%). The dominant culture type of Systems Inc. internal news is less obvious, although the clan and market culture types are in the lead (28% and 27% respectively). Both Aeronaut and Defcom show a tendency towards the hierarchy culture (31% and 33% respectively), and the overall profiles for these two business units are very similar. No difference above five percentage points exists.

Looking at Aeronaut, the dominance of the hierarchy culture (31%) indicates that stability, efficiency, and structure take center stage. Almost as dominant is the market culture (28%) that emphasizes environment, competitiveness, and market share. Both culture types stress stability, order, and control (see Figure 1). Defcom, on the other hand, is dominated by the hierarchy and clan culture types which underscore the importance of internal orientation, integration, and unity.

To be able to identify patterns of interest in relation to the differences in culture profiles as they appear in Table 1, Table 2 has been created. It shows the level of incongruity between selected culture profiles.

	Adhocracy	Clan	Hierarchy	Market
Systems Inc. Management System vs. CMMI ML2				
Percentage difference	37,5%	9,5%	-3,2%	-10,0%
Percentage points difference	3	2	-1	-4
Systems Inc. internal news vs. Systems Inc. Management System				
Percentage difference	118,2%	21,7%	-30,0%	-25,0%
Percentage points difference	13	5	-9	-9
Aeronaut vs. Systems Inc. Management System				
Percentage difference	63,6%	0,0%	3,3%	-22,2%
Percentage points difference	7	0	1	-8

Defcom vs. Systems Inc. Management System				
Percentage difference	72,7%	8,7%	10,0%	-36,1%
Percentage points difference	8	2	3	-13
Defcom vs. Aeronaut				
Percentage difference	5,6%	8,7%	6,5%	-17,9%
Percentage points difference	1	2	2	-5

Table 2.   Culture profile differences in percentages and percentage points

The level of incongruity is presented in Table 2 as both a percentage difference and a percentage point difference between culture profiles. The culture profiles are established based on accepted measurement techniques, but the resulting numbers are approximations. They are stochastic variables and should be viewed with reservation. Consequently, we define congruence between two culture profiles using a broad criterion leaving ample room for deviations on the variables: *two culture profiles are congruent if and only if the percentage point difference for each of the four culture types is less than 5 and at the same time their primary and secondary culture types are the same.* Based on this definition we therefore conclude that the SMS is congruent with CMMI level 2 and that all the other culture profiles compared in Table 2 are incongruent. The congruence between SMS and CMMI level 2 was expected, since the SMS was developed as an instantiation of CMMI level 2, and because considerable effort was put into ensuring compliance of the SMS with the process guidelines provided at CMMI level 2.

4.2   Comparison Graphs

Based on the numbers in Table 1 and 2 we are now able to graphically create culture profiles and compare the results. We will only compare incongruent culture profiles. Additionally, since the SMS and CMMI level 2 are congruent, we will only compare the business units' culture profiles with that of the SMS.
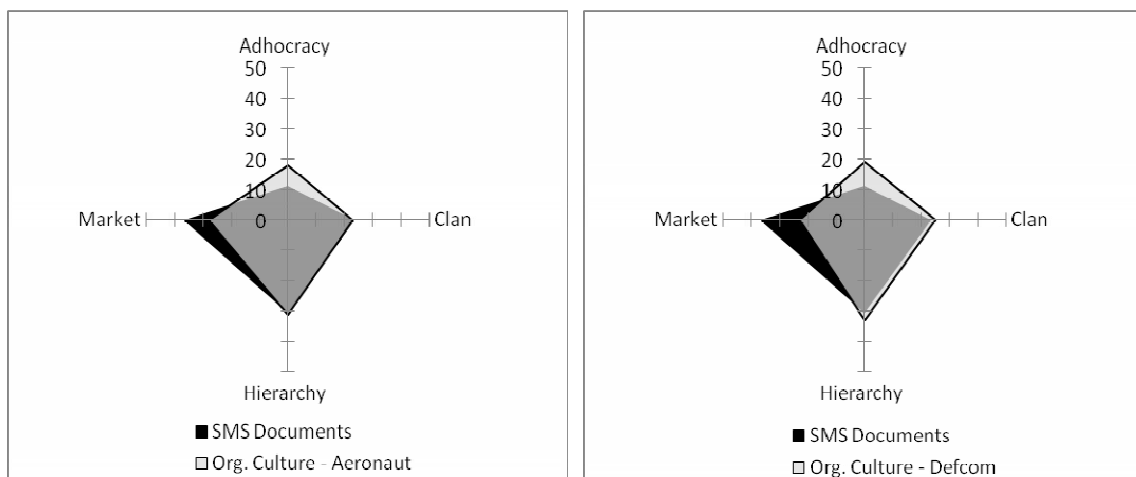

Figure 2.   Organizational Cultures vs. SMS Documents

Figure 2 shows on the left hand side a comparison of the SMS and Aeronaut profiles, and on the right hand side a comparison of the SMS and Defcom profiles. The primary culture type of the SMS is the market culture, and in comparison to the Aeronaut and Defcom profiles this is where the largest difference exists (8 and 13 percentage points). However, whereas the two business units score lower on market culture, the adhocracy culture type is more pronounced for both Aeronaut and Defcom compared to the SMS (7 and 8 percentage points). Other differences are negligible.

The culture profiles of the two business units are much alike as seen in Figure 3, but they are incongruent according to our definition.
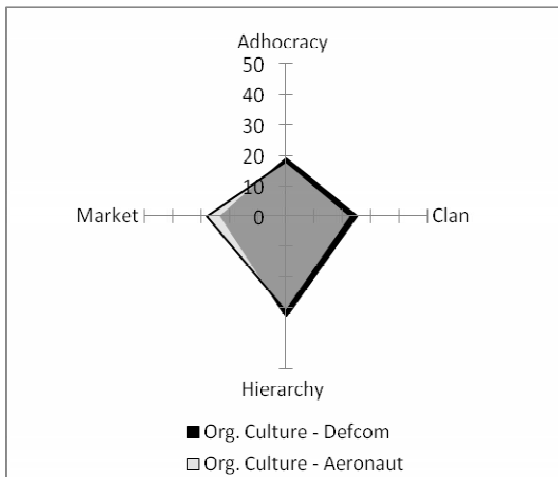

Figure 3.   *Organizational Culture Profile of Defcom vs. Aeronaut*

Figure 3 reveals small yet significant differences. The primary culture type of both Aeronaut and Defcom is the hierarchy culture (31% and 33% respectively). The market culture accounts for the largest difference (5 percentage points) between the two business units.

The culture profiles of the SMS and the Systems Inc. internal news are also incongruent. An in-depth analysis of this incongruity and the contents of the Systems Inc. internal news has revealed that very few news clips deal with the SPI project. The Systems Inc. internal news are the responsibility of the communications department, and their content mediation (selection, creation, and editing of content) seemingly promotes a different culture profile than those of the business units. It is, however, outside the scope of this study to investigate the reason for this incongruity.

4.3   Assessment results

The process maturity and degree of CMMI level 2 compliance of the two business units was assessed three times during the SPI implementation. The assessment results for each of the three milestones are documented in Table 3. The number of projects that participated in and were assessed during the SPI implementation changed over time reflecting management's prioritization of the SPI project. Although Aeronaut had as many as eight projects participating in the project at one time, only two projects remained at the end. Defcom started out with five participating projects, but ended up with six projects.

Business Unit	Assessment Milestones		
	Milestone 1(Dec/Nov 2005)	Milestone 2 (Mar 2006)	Milestone 3 (Jun/May2006)
Aeronaut	--- • PP: 71% • PMC: 62% --- --- --- • CM: 75% *Average: 69,3%*	• REQM: 57% • PP: 68% • PMC: 54% • SAM: 62% • MA: 46% • PPQA: 53% • CM: 68% *Average: 58,3%*	• REQM: 66% • PP: 74% • PMC: 69% • SAM: 69% --- • PPQA: 58% • CM: 68% *Average: 67,3%*
Defcom	--- • PP: 74% • PMC: 64% --- --- --- --- *Average: 69,0%*	• REQM: 71% • PP: 76% • PMC: 66% • SAM: 68% • MA: 35% • PPQA: 68% • CM: 75% *Average: 65,6%*	• REQM: 76% • PP: 78% • PMC: 76% • SAM: 77% --- • PPQA: 75% • CM: 81% *Average: 77,2%*

Table 3.   Assessment Results for Aeronaut and Defcom

The abbreviations in the table represent the seven process areas in CMMI level 2: Requirements Management (REQM), Project Planning (PP), Project Monitoring and Control (PMC), Supplier Agreement Management (SAM), Measurements and Analysis (MA), Process and Product Quality Assurance (PPQA), and Configuration Management (CM).

The average scores for the two business unit show that the degree of CMMI level 2 compliance and the rate of implementation is persistently higher in Defcom than in Aeronaut (except for milestone 1). At the third milestone Defcom was above the threshold of 75% in all process areas whereas none of Aeronaut' process areas were compliant. The degree of CMMI compliance is an indicator of speed and status of the SPI implementation at different points in time. Based on the goal of 75% compliance we are able to conclude that Defcom was successful in achieving this goal while Aeronaut was not.

5   DISCUSSION

It is possible to establish culture profiles of the CMMI and the subset of the model describing CMMI level 2. Our analysis supports previous studies showing the dominance of the hierarchical and market culture types (Hansen et al., 2004; Ngwenyama and Nielsen, 2003). Previous studies sceptical of the underlying management ideals of the CMMI and its predecessor the SW-CMM arrive at similar conclusions (Bach, 1994; Bach, 1995; Bollinger and McGowan, 1991; Brodman and Johnson, 2000). It is of interest to both managers and researchers of systems development organizations whether congruence between the culture profiles of the CMMI and the organization doing SPI is a prerequisite for successfully reaching maturity level 2 or higher. Although previous studies are based on the implicit assumption that congruence is necessary, our findings do not support such a conclusion. The argument is presented below.

SPI at Systems Inc. focused on updating and ensuring adherence to internal process descriptions and standard operating procedures (the SMS). Our analysis of the SMS shows it to be congruent with

CMMI level 2 which comes as no surprise since it was updated during the SPI project to ensure compliance with the CMMI. The updates were spurred by desire for a future evaluation of the maturity of the organization by means of a formal appraisal. The congruence between the SMS and CMMI culture profiles suggests that the updating was successful, i.e. the CMMI requirements were interpreted and incorporated into the internal process descriptions and standard operating procedures of the SMS.

However, whereas the CMMI and SMS culture profiles are congruent, the SMS culture profile is incongruent with the culture profiles of both Aeronaut and Defcom. From a theoretical perspective organizational cultures are change resistant, cannot be redesigned, nor can they be deliberately chosen and implemented (Schein, 1985). Consequently, just because Systems Inc. decided to comply with the CMMI, there is little if any reason to expect changes to the organizational subcultures underlying the systems development practices of the organization. In fact, our findings reveal that the implementation of the updated SMS has not brought the organizational subcultures of the two business units into alignment with the culture profiles of the SMS.

Although it may seem reasonable to attribute the lack of congruence between culture profiles to incomplete implementation of CMMI based processes, our findings do not support such a conclusion. To the contrary, internal CMMI assessments showed Defcom to be compliant with CMMI level 2 at milestone 3 (77%). They improved the degree of compliance by 8 percentage points in the course of the implementation. Hence, systems development practices in Defcom were improved and determined to be compliant with the CMMI level 2 requirements, but at the same time the culture profile of the organization was incongruent with that of the CMMI. Defcom was successful in improving organizational maturity despite the incongruity between culture profiles. The finding is therefore that the cultural incongruity has not prevented Defcom from changing existing systems development practices.

This finding questions the generality of previous research findings that emphasize the need for cultural congruence. According to the literature it is important for managers to consider the fit between values embedded in new processes and the specific organizational culture in which they are to be implemented and further to appreciate the values underpinning maturity models and models for software development (Dubé, 1998; Dubé and Robey, 1999; Ngwenyama and Nielsen, 2003). Although our findings do not lead us to reject the importance of culture, we find it interesting whether this proposition holds in all cases, but at the same time we should be cautious with drawing too far-reaching conclusions from our case. There are several possible reasons why we can observe this incongruence in the Systems Inc case. First, the data collection may be too limited in which case more data should be collected in further studies. Second, the OCAI measurement tool may be flawed, but that is unlikely as it has been tested in a large number of studies and its reliability and validity has been studied several times as reported in (Cameron & Quinn, 1999). The OCAI is reliable which means our measurements of the two departments are consistent. The validity is high, i.e., which phenomena are supposed to be measured are actually measured. Third, the textual analysis may be flawed as a measurement instrument. The instrument is reliable in the sense it produces the same results every time it process the same text. We have insufficient data to conclude that it also valid in a statistical sense. Fourth, there can be specific conditions not measured by the OCAI which can explain the successful CMMI implementation. We have indications of this from our interactions with the department, but we have less reliable data on this. All this leads us to conclude that it is an interesting finding that should lead to further studies, because the foundation for a strong conclusion is too weak

Turning out attention to the differences in culture profiles between the two business units, the question remains whether they account for the differences in SPI outcome. The answer is no. The differences in culture profiles point in two directions. First, the hierarchy culture type is the most dominant part of the profiles of both Defcom and Aeronaut. The differences between the two culture profiles are small, i.e. 5 percentage points at most (the market culture type). Second, although the hierarchy culture type dominates both the overall CMMI culture profile and the culture profiles of the two business units, the culture profile of CMMI level 2 (the goal of SPI at Systems Inc.) is dominated by the market culture

type. In fact, Defcom – as the more successful of the two business units in terms of SPI – scores lower on this dimension than Aeronaut. Therefore, it is not possible to establish a link between SPI success and the differences in culture profiles between the two business units. This conclusion raises the question whether the OCAI is useful as a method for identifying subculture differences within the same organization which (Cameron & Quinn, 1999, p. 139) claim it is. According to our analysis, the two business units are almost culturally congruent, yet our observations at the organization indicate that differences exist, but we cannot explain these differences with the data at hand.

Our findings point in the opposite direction of the literature referenced in the introduction. First, (Phongpaibul and Boehm, 2005) emphasize that the assumptions underlying a SPI model must be adapted to fit the characteristics of national cultures. In a similar vein, (Boehm, 2000) argues that conflicts between maturity models and organizational cultures are probable. Examples of such conflicts are described in (Mathiassen et al., 2002). However, our findings question the necessity of bridging the gap between national cultures and the embedded cultures of SPI models in order to ensure success in SPI. Second, (Dubé and Robey, 1999) conclude that there has to be a fit between a subgroups' values and the values embedded in their software development process. Further, (Dubé, 1998) stresses the importance of establishing an alignment between values in the software development process and the underlying organizational culture. Our study cannot confirm these conclusions. The CMMI is North American in origin and Systems Inc. is a high-tech organization with roots in the national culture in a Scandinavian country, and at the level of organizational culture our study reveals differences in culture profiles. Despite these differences, CMMI assessments show one of the business units to be successful in implementing systems development processes based on a culture profile different from that of the organization. This is not to say that there will be no conflicts and struggles during SPI implementation. It is simply to say that cultural incongruity and SPI success seems to happen simultaneously. Third, (Ngwenyama and Nielsen, 2003) claim that the SW-CMM contains internal contradictions in terms of organizational culture which must be resolved to effectively improve software processes. Based on their identification of contradictions within the SW-CMM (Ngwenyama and Nielsen, 2003) conclude that management of CMM based software process improvement is fraught with difficulties. Our study does not challenge this claim. It simply shows that it is not possible to attribute these difficulties to incongruity between organizational cultures and the culture embedded in SPI models alone.

6   CONCLUSION

In this paper we have investigated the culture embedded in the CMMI and compared it with the subcultures of an implementing organization. For this purpose we have used the competing values framework. We have searched for similarities and differences between culture profiles and compared the profiles to SPI implementation outcomes in two business units within the organization. Culture profiles have been established through different techniques. Culture profiles of the two business units have been established by means of the OCAI developed by (Cameron and Quinn, 1999), and a culture profile of the CMMI has been established by means of textual analysis developed by (Ngwenyama and Nielsen, 2003). The outcome of SPI implementation has been evaluated by means of CMMI assessments. Having identified incongruities between culture profiles, we have clarified the implications for research and practice. Based on our analysis we have found that cultural incongruity does not necessarily lead to implementation failure. On the contrary, we have pointed to the possibility of improving systems development practices despite such incongruities. In fact, we have suggested that SPI is possible while maintaining the existing organizational culture.

This study is a first of its kind involving the same framework both in a questionnaire (the OCAI) and an automatic textual analysis – and for software process cultures. While the OCAI have been applied in many studies it is fair to conclude that the instrument for textual analysis has to be improved further to increase its validity. In our study we have used the 5 %-criterion for congruence as an

operationalization of our reading of the culture profiles and in further studies it should be investigated how congruence can be measured in a more statistically sound way.

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