UNIVERSITY OF GOTHENBURG

# Complementing views in Software Process Improvement

An Assumption Analysis of SPICE from an Organizational Culture Perspective

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**Bachelor of Applied Information Technology Thesis**

# Complementing views in Software Process Improvement: An Assumption Analysis of SPICE from an Organizational Culture Perspective

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**The Software Process Improvement and Capability Determination (SPICE) model is emerging approach for software process improvement (SPI). ISO SPICE is creating standards for handling software processes and trying to improve with the existing approaches. It is well known that SPI models have lower success rates. This is because the models have different organizational cultures within the core assumptions. We assume that SPICE has an almost similar structure to CMM, and therefore, it will have lower rate of success in the future. So we believe that SPICE can also benefit from having complete understanding of the organization cultures. Further, CMM model contained many organizational cultures in the core assumption which are creating problems for successful implementation. The SPICE model is also known as ISO 15504, used worldwide as a standard framework for the process implementation and assessment. In this research, we analyze the SPICE model and identify organizational cultures that exist within it and suggest what type of organizations will benefit from it. This might be helpful to future researchers trying to implement SPI model that supports all the organizational cultural types.**

*Index Terms*— **Software Process Improvement and Capability Determination (SPICE), Organizational Culture, Software Engineering, Software Process Improvement**

## I. INTRODUCTION

INCREASING competition in the software market requires more than just hiring smart people and implementing or adapting the latest technology. Software process improvement is another way and most organizations are acclimatizing to improve their business and successfully achieve the targeted goals. In organizations, whether they are small or large, Software process improvement requires special concerns due to human resources and material constraints (Gleison 2007).

SPI models such as CMM/CMMI (Capability Maturity Model) (Paulk et al. 1993), European Boot Strap (Kuvaja et al. 1994) and SPICE, are becoming available and some of them are adapted by various organizations to improve software processes. However, the levels of success are varying and majority has failed. We believe that the organizational cultures embedded in SPI models have major effects. Scott (n.d.) argues that "*One of the significant forces that affect the success of your process improvement efforts is the culture of your organization".* So it becomes important to study the organization culture and following the SPI model according to that culture. Several SPI models are adapted by different organizations according to their best suite but still those organizations failed to reach the level they want. Ngwenyama and Nielsen (2003) have reviewed CMM from an organizational culture perspective for software process improvement. They highlighted CMM from social aspects of organizations. This paper is motivated from Nielsen's paper where we chose to analyze the organizational culture from SPICE perspective for Software process Improvement.

SPICE is an international framework for software processes developed jointly by ISO (International Organization for Standardization) and the IEC (International Electro technical Commission). SPICE comprises of guidelines to implement project assessment. The standards start with a description to reference model, assessment process, tools that can be used for assessment process and a discussion factors heading the assessment to the success path. SPICE's two dimensional reference model defines process dimensions and process capability dimensions for software process assessment. According to Khaled et al (1995) the reference model is *"a cleaner way of expressing the envisioned, high-level description of the goals and fundamental activities that are essential to good software engineering practices and their assessment criteria"*. The difference from CMM to SPICE is that CMM has one dimension reference model, whereas SPICE has two. Further, CMM focuses on an Organization's capability, whereas SPICE's mainly focus is on single process capability. This has a big impression on software process assessment and becomes interesting to address similar approach (Ngwenyama & Nielsen 2003). ISO 15 504 consists of nine parts, but we decided to use Part 1, part 2, part 5 and part 7 for this research. These parts provide guidelines from performing an assessment to guide for use in process assessment. The remaining parts of the ISO 15504 were read partially but have not been used as main sources. Part 5 consists of assessment model and indicator guidelines, which is used most in this research.

The research presented here can help researcher to reconceptualize the SPICE model in order to different

cultures hidden in the SPICE model and what steps will be needed to perform SPI in specific culture. The research also helps the organization how they can overcome process improvement problems and what solution strategies they should follow. In addition it focuses on complementing views within SPICE framework and can be extended to competing values. This paper starts with discussing organization culture and their characteristics with competing values framework. It continues with describing the research methods that are used to analyze SPICE papers. Next, research findings will be discussed including four organizational cultures, which will be described in the organizational culture section. Finally, in the conclusion section, we will sum all findings followed by a few guidance for organizations.

## II. THEORETICAL BACKGROUND

### A. Organizational Culture

Organizational culture is not just deep; it is wide and complex (Schein 2004). The concept of the organization body of literature is still developing and there is not any international set of formula for that (Ngwenyama & Nielsen 2003). Even Schein (2004) mentioned that he often found it easy to agree with his colleagues that organizational culture exists, and that it is important in its effects, but when they tried to define it, they usually ended up with different ideas of what it was. In addition, culture is a big subject, and it can support connections between technology adoption and organizational growth (Cameron & Quinn 1999). According to Schein (2004), the culture is formally defined as "*A pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well*

*enough to be considered valid and, therefore, to be taught to new members as the correct way you perceive, think, and feel in relation to those problems*". In addition, it is important to define culture in order to talk about specific organizations, especially those people who are dealing with the change and software process improvement. Generally, culture will help us to understand how it is developed, created, embedded, manipulated, managed and changed (Schein 2004).

Cooke (2004, p. 2) highlighted that Organizational Culture characterized as "*The glue that holds organizations together*" (Goffee & Jones 1996) and "*it isn't just one aspect of the game, it is the game*" (Gerstner & Louis 2002).

In addition, Quinn and McGrath's (1985) view of organizational cultures is rooted in both anthropology and sociology as shown in the figure 1. Therefore, in order to define organizational culture, both human and society perspective should be studied. He categorized organizational culture into four types (Quinn & McGrath 1985, p. 327):

- Rational culture known as Market
- Ideological culture known as Adhocracy
- Consensual culture known as Clan
- Hierarchical culture known as hierarchy

Schein (2004) distinguishes four types of characteristics in organizational cultures: structural stability, depth, breadth and patterning or integration. Behind his theory (Schein 2004, pp.14-15), stability stands for the level of structure of stability in a group, depth is an unconscious part of a group that is not easy to define, breadth is about a group's
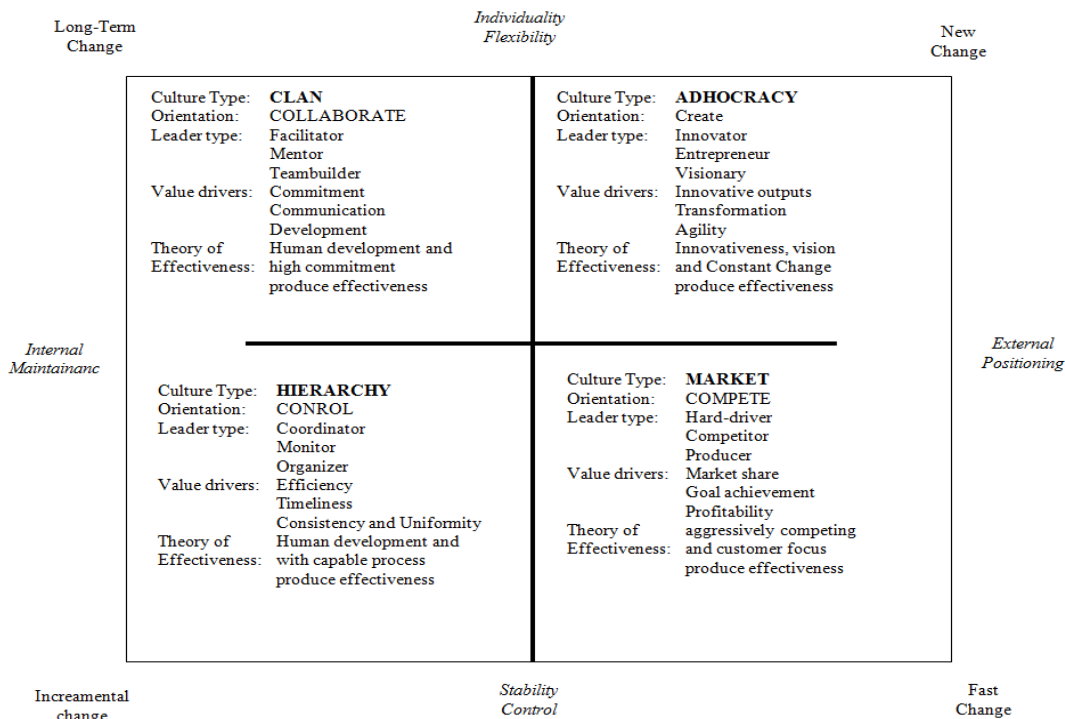


Figure 1: The Competing Values Framework (Quinn et. al. 2006)

functioning and patterning is integration of the elements that hold together with various parts, which are in deeper level. Schein (1994, pp. 25-30) also defined that there are three levels in culture as follows:

- Artifacts – visible organizational structures and Processes
- Espoused beliefs and values – strategies, goals and philosophies
- Underlying assumptions – unconscious, taken-for-granted beliefs, perceptions, thoughts and feeling

### B. SPICE

According to ISO 15504, the model is a framework providing "… *assessment of the Software processes. The framework can be used by the organizations involved in planning, monitoring, controlling and improving the acquisition, supply, development, operation, evolution and support of Software*" (ISO 15504-1:1998, p. 4). Organizations willing to improve product quality must have proven consistent and reliable methods for assessing the state of its process and ways of using the results as part of a coherent improvement program. To satisfy the end user expectation, organization should maximize their responsiveness to the customer and market requirements. SPICE is ISO standardized process assessment approach, which will make the process assessment open and lead to a common understanding of the use of process assessment and improvement including capability evaluation (ISO 15504-1:1998, p. 5). The ISO/IEC TR 15504-2 provides a reference model which describes processes that an organization may perform to acquire; supply, develop, operate, evolve and support software and process attributes that characterize the capability of those processes (ISO 15504-2:1998, p.5). The reference model is two dimensions i.e. process dimension and process capability dimension. The process dimension describes the set of purpose statements whereas the process capability characterizes the level of capability that an organization has achieved for a particular process.

Process dimensions consist of three life cycle processes; Primary Life Cycle Processes, Supporting Life Cycle Processes and Organizational Life Cycle Processes as depicted in Table 3. The process capability dimension is a six level model (ISO 15504-2:1998, pp. 3-7) from level 0 to level 5, incorporating nine process attributes. In order to achieve the higher level, all attributes of the lower levels have to be satisfied fully and the actual level that organization wants to achieve should be satisfied at a larger extent.

1) *Level 0: Incomplete*
The purpose of the process is unclear and no success will be gained to attain the purpose. The output of the process is very few or may be unidentifiable.

2) *Level 1: Performed*
The process is implemented and achieves its process purpose. The achievement may not be rigorously planned or tracked. The agreement within the organization will be made upon action performance. The work product will be identified resulting in understanding of the process purpose. The capability of this process is measured using 1.1) Process performance process attribute.

3) *Level 2: Managed*
The process is managed and work products are established, controlled and maintained. The product should meet defined standards and requirements. In performed level, the achievement is not rigorous, which becomes clear in Managed level. The work product is being delivered within defined time scale and resource needs. The process attributes used to measure this level are 2.1) Performance Management and 2.2) Work product management.

4) *Level 3: Established*
Good software engineering principles are applied and performance and management of the process are achieved. Achievement of the process arrives at the document process. The main difference from *managed* level is the process of the established level is to use a defined process capable to achieve the process outcomes. This level is measured using 3.1) Process definition 3.2) Process deployment.

5) *Level 4: Predictable*
In order to achieve the defined process goals, the process is performed in a consistent way within given control limits. Constant practice and performance of the process help to predict and manage the performance and provide the process capability. The distinction of this level from established level is consistent performance of the process within defined limits to get to the goal.

6) *Level 5: Optimizing*
After consistently performing the process during the predictable goals, the quality of work products is quantitatively known. Using this information, the process is optimized to meet the current and future business goals and needs. Result analysis and quantitative feedback of the process obtained to monitor and improve the process. Process attributes that are measuring this level are 5.1) Process innovation 5.2) Process optimization.

### III. RESEARCH METHOD

Our primary goal is to investigate and analyze organizational cultures that are embedded in SPICE. Most of them were easy to identify by reading ISO 15504 parts but there was too much information to cover in short time and in addition, we were interested in finding

| Primary life cycle process | Customer-Supplier | *"…Consists of Processes that directly impact the customer, support development and transition of the software to the customer."* |
| | Engineering | *"…Consists of processes that directly specify, implement or maintain the software product, its relation to the system and customer documentation"* |
| Supporting life cycle process | Support | *"…Consists of processes which may be employed by any of the other processes including other supporting processes."* |
| Organizational life cycle processes | Management | *"…Consists of the processes which contain practices of generic nature which may be used by anyone who manages any type of project or processes within a software life cycle."* |
| | Organization | *"…Consists of processes that establishes the business goals of the organization and develop process, product and resource assets which, when used by the projects in the organization will help the organization achieve its business goals."* |

**Table 1: Process dimensions: Three life Cycle**

complementary values. In order to find and use them efficiently, we needed to look at those key values and use a content analyzer tool. This process is quite similar to Ngwenyama and Nielsen's (2003) research paper. In this section, we will discuss our research methods and framework for analysis.

### A. Framework for Analysis

In this research, organizational cultures which are embedded in SPICE will be identified using specific attributes, values and symbols. These factors were first defined by (Quinn 1985). Later on, Ngwenyama and Nielsen (2003) have extended the attributes and values further more for their study. We used their extended version of those factors. However, since we used their defined key values; our result would be different depending on the ISO 15504 content, and therefore, key words and strategies are modified in order to cope with the situation. The key words and attributes are shown in the table 2.

We have encountered two problems. First, searched key words were not enough and also it was leaving off some essential elements of SPICE. Therefore, my colleague read through whole ISO 15504 parts and highlighted the important facts for later usage. In addition, extra materials are searched and used, for instance: SPICE book by (Khaled 1998).

Defining and searching for organizational culture is hard, and in reality, there are a lot of different views of it. Even, Ngwenyama and Nielsen (2003) mentioned that organizational culture is not static, but it is dynamic. Despite the existence of those many views, Quinn and McGrath (1985) and Schein's (2004) view will be followed in this research. The organizational culture is categorized as Rational, Developmental, Consensual and Hierarchical; therefore, these types of cultures will be looked through ISO 15504, and then analyzed using visible organizational structures and processes, strategies, goals, philosophies, and underlying assumptions, which are mentioned by Schein (2004).

According to Quinn and McGrath (1985), the organizational cultures are described as:

- **Consensual:** Organization focuses on collaboration and team work. These types of organization tend to have a friendly working environment where people share everything to each other as an extended family.
- **Ideological:** Everything is about growth and development. Here, people stick their heads together to create, share, work and take risks. People focus on creativity, entrepreneurship and adaptability such as open source development. Good examples of these types of organizations are PHP, Linux and MySQL.
- **Hierarchy:** The whole thing is based on execution of regulation. Therefore, these types of organizations have tide regulations and are highly structured such as government and military.
- **Rational:** Organization concentrates on defined goals, objectives and people's expertise. In order to track the goals, these types of organization need control, and everything is agreed on contractual agreements.

The main goal of SPICE's capability level is adapting the process and then improving the process to meet the fundamental goals and business objectives consistently.

Level five is where an organization is fully comfortable with the processes and organizations are achieving the target by constantly monitoring the process.

### B. Method of Analysis

This paper will use qualitative type of design. According to Creswell (2009, p.4), the qualitative research is all about discovering and understanding the meaning of individuals and groups to a social and human problem. Thus, this research paper will explore values in the empirical materials using content analysis approach.

| Culture / Aspect | Hierarchical | Rational | Consensual | Ideological |
|---|---|---|---|---|
| Organizational orientation | Stability and control | Productivity and efficiency | Cohesion and morale | Flexibility, adaptability and readiness |
| Organizational objectives | Execution of regulation | Pursuit of objectives | Group maintenance | Growth and development |
| Organizational structure | Routine tasks and technology; formal rules and policies | Complex tasks; Responsibilities based on expertise | Complex tasks; Collaborative work groups | Complex tasks; Collaborative work groups |
| Base of Power | Knowledge of organizational rules & procedures | Competence | Ability to cultivate relationships | Values |
| Decision making | Top-down pronouncements | Goal-centered, systematic and analytical | Participatory, deliberative | Organic, intuitive |
| Leadership style | Dominance, conservative, cautious | Rational achiever, goal oriented | Team builder; concerned, supportive | Idealistic, risk, oriented, empowering |
| Compliance | Measurement, Determine, Monitoring and control | Contractual agreement | Commitment to process | Commitment to values |
| Evaluation of members | Adherence to rules | Level of productivity | Quality if relationships | Intensity of effort |
| Orientation to change | Resistance (orientated to maintaining the status quo) | Open to goal driven change | Open to change | Change is embraced as part of growth |

**Table 2: Key values in Organizational Culture (Nielsen 2003)**

Bryman and Bell (2003) mentioned that content analysis is an approach for analyzing documents and texts that seek to quantify content in terms of group and in a systematic and replicable manner.

This research paper comes closer to Ethnographic content analysis, which is a term suggested by (Aitheide 1996) to refer to documents that point out the role of the investigator in constructing meaning of texts, also known as "qualitative content analysis" (Bryman & Bell 2003). This is an extension of "textual approach", which deals with public documentation and collects the essential elements for further analysis. This method will create two different types of data (Gephart 1988) as shown below:

1. Naturally occurrence retrospective and archival qualitative data.
2. Self-generated texts including field notes that are describing inquiry events.

For this analysis, ISO 15504 is selected to be studied. ISO 15504 is the international standardization for SPICE, published in 1998, and has nine parts of different type of documents:

- Part 1: Concepts and introductory guide

- Part 2: A reference model for processes and process capability
- Part 3: Performing an assessment
- Part 4: Guide to performing assessments
- Part 5: An assessment model and indicator guidance
- Part 6: Guide to competency of assessors
- Part 7: Guide for use in process improvement
- Part 8: Guide for use in determining supplier process capability
- Part 9: Vocabulary

Most of the parts of ISO 15504 were updated and those newer versions were available, but we have decided to stick with the version 1.0. The main reasons for this were that the old version was stable, had many documents and real world examples.

We had two options to choose from and the first option was to use Nvivo 7. However, this version of the software does not support the PDF files. In fact, we needed a newer version of the software which is Nvivo 8. The software tool helped us a lot to analyze much information in short time. We used specific defined keys to search through a total of 346 pages.

The analysis consists of four main stages:

1. **Key words** – Defining, collecting and grouping key words.
2. **Search -** Exhaustive searching using collected key words.
3. **Define -** Defining the importance of the found information and group them according to four organizational cultures.
4. **Analysis –** Use defined text to unlock the secrets of the SPICE model.

Primarily, we looked at key words which are used by Quinn and McGrath (2003), and all the key words were reasonable and useful. However, some of them had to be changed in regard to our research topic. In addition, Ngwenyama and Nielsen's (2003) defined key words are added to our key word collection depending on their usefulness.

Next, the content analysis tool used and processed as following:

1. SPICE parts were obtained in PDF[1] files and they are imported to the Nvivo tool. But we had problems reading some of the .pdf files. Therefore, those .pdf files were converted into .doc files and loaded up to the NVIVO 8 without modification.
2. Key words categorized into smaller groups such as "flexibility adaptability readiness change easy".
3. We searched the key words through SPICE documents and selected paragraphs which the key word in it have collected in new nodes[2], chosen '"Broader paragraph" mode, which will take a whole paragraph.
4. All the found paragraphs are coded and grouped depending on their importance. For instance: We have taken "goal" from the table 2, and afterwards we search the word through SPICE parts. Therefore, we found 34 paragraphs that have the word. Then, added those essential parts into either Consensual, Ideological, Hierarchical and Rational nodes.
5. A new key term defined, in order to find organizational culture characteristics such as measurement and determine, and all the processes.
6. All previous tasks were repeated until there is nothing left to search for. Example of the search terms and findings are shown in the table 3.

Through this exhaustive search, we discovered that three types of organizational culture exist within SPICE. In the next section, all the findings will be discussed more

detailed.

## IV. RESEARCH FINDINGS

In this section, SPICE will be explained more detailed and its findings that are related to our four organizational cultures will be divided into four sections depending on their importance such as The Hierarchical, The Ideological, The Rational and The Consensual.

### A. *The Hierarchical ideal*

SPICE provides documents, which can be used to manage phases of software production like planning, managing, monitoring and controlling. The Reference model is a starting point for performing software process capability, which allows reporting the results using common rating scale (ISO 15504-5:1998, p.2). The improvement gains are sustained by maintaining a new and improved level of performance until stability has been reached (ISO 15504-7:1998, p.6). During level 1 and level 2 of the process capability dimension, the process implementation is agreed and specific standards and requirements of the process are defined. The base practice (ORG.3.BP9) of the third life cycle (Organizational life cycle) show to "*define the teams which will be needed to perform the work of the project, defining the structure and operating rules for team, required knowledge and skills*" (ISO 15504-5:1998, p.43). The hierarchical culture's aspect of organizational structure is to route the task and technology and define organizational rules and procedures (Quinn et al. 1985, pp. 315-334). This process is undertaken by a human resource management team and applied to people working under them, i.e. control the people in a ladder way.

The process capability level has control attributes and measurement attributes to support the hierarchical culture. The ISO 15 504-1 paper says that process attributes are an expression of process capabilities grouped into process capability levels and each capability level displays a steady development in the management and control of the processes, so the assessment model is a roadmap to increase the capability (ISO 15504-1:1998, p.5). Tharp (n.d.) in his paper says "*Effective leaders in hierarchical culture…can organize coordinate and monitor people and processes".* In order to implement the updated process improvement program plan, one of the main tasks is to monitor the process improvement projects (ISO 15504-7:1998, p.12). The process improvement project should be monitored by the management against the process improvement plan, in order to ensure task progresses and stability control, using data collection and expanding resources to analyze collected data which will generate results for future process improvement projects (ISO 15504-7:1998, p.13). The process capability levels (level 5: Optimizing) support the hierarchical culture with:
*"Performance of the process is optimized to meet current and future business needs, and the process achieves repeatability in meeting its defined business goals.*

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[1] PDF file, portable document reader
[2] Node is used for storing selected information in Nvivo

| | Aspect | Search Terms and Frequency | Found texts from source documents (not all text displayed here) |
|---|---|---|---|
| **O r g a n i z a t i o n a l** | Orientation | Stability and Control (55), efficiency and productivity (10), Flexibility and adaptability (3) | Evolving process capability is expressed in terms of process attributes, which are in turn grouped into a series of capability levels. Each capability level represents an incremental evolution in the management and control of the processes, so that the assessment models provide a road map for increasing capability (ISO 15504-1:1998, p. 4). |
| | Objectives | Regulation (14), Objectives (79), Group maintenance (52), Growth and Development (109) | Mandé worked with all executives to build their awareness of the possibilities for growth and profitability in Movie Views, and help them to see their part in the future of the company. She knew a software process improvement program was instrumental in improving the quality of their products: it was not enough to concentrate solely on finding defective products before the customer saw them. Working with groups of employees to understand the problems, a simple qualitative software process goal was defined (ISO 15504-7:1998, p. 28). |
| | Structure | Roles and Policies (72), Expertise and skills (2), Collaborative work (0), complex tasks (32), responsibilities (2) | The maturity of the supplier-sponsor relationship (the level of trust between the organization and sponsor); <br> • the needs of the sponsor; <br> • the expertise and ability of the assessor(s). (ISO 15504-4:1998, p. 18). |
| | Base of Power | Knowledge and procedures (37), Competence (31), Cultivate (20), Values (11) | Targets for improvement should be quantified for each priority area. These may be either target values for process effectiveness, or target capability profiles, or combinations of the two. They should be set in the light of the organization's needs, using the approach outlined in 7.3. This will typically require the iteration of a number of steps until a set of targets has been identified which meets the organization's needs, which can be objectively measured, and which can reasonably be achieved (ISO 15504-7:1998, p. 11). |
| | Decision making | Pronouncement (0), Goal (34), Participatory and deliberative (0), Monitor (53) | The effectiveness and efficiency of the organization's processes with respect to business goal achievement will be improved on an ongoing basis (ISO 15504-2:1998, p. 21). |
| | Leadership style | Dominance and Cautious (0), Goal (34), Team builder and supportive (19), risk and empowering (49) | New process The purpose of the Risk management process is to identify and mitigate the project risks continuously throughout the life cycle of a project. The process involves establishing a focus on monitoring of risks at both the project and organizational levels (ISO 15504-2:1998, p. 19). |
| | Compliance | Monitoring and Control (53), Agreement (32), Process (100+), Values(11), Measurement (302) | The defined process is performed consistently in practice within defined control limits, to achieve its defined process goals. Detailed measures of performance are collected and analyzed. This leads to a quantitative understanding of process capability and an improved ability to predict and manage performance. Performance is quantitatively managed. The quality of work products is quantitatively known. The primary distinction from the Established Level is that the defined process is now performed consistently within defined limits to achieve its process outcomes (ISO 15504-2:1998, p. 4). |
| | Orientation to change | Resistance (4), Goal (34), Change (60) | Assessors should be persistent in carrying out the duties that are expected of them. They should be able to resolve any conflicts and handle any resistance that they may experience from assessment participants (ISO 15504-6:1998, p. 5). |

**Table 3: Example of Search and Findings**

Quantitative process effectiveness and efficiency goals (targets) for performance are established, based on the business goals of the organization. Continuous process monitoring against these goals is enabled by obtaining quantitative feedback and improvement is achieved by analysis of the results" (ISO 15504-6:1998, p. 6).

The point of reference is in the direction of monitoring, organizing, stabilizing and controlling the process. Hierarchical culture is defined by stability and control and also internal focus and integration. Leaders play an important role in hierarchical culture. Effective leader in this culture organizes and monitors the people in a process and establish coordination among them. The people within the organization are made aware of the rules and trained so that they know how to survive in a highly regulated environment.

SPICE support monitoring and controlling attribute of the hierarchy culture with:

"*The documented assessment process should define the process for all required supporting activities, such as document control, quality assurance, project management, as well as for the key activities associated with the documented assessment process itself. This might be in the form of guidance material, procedures, standards etc., how competent assessors are to attain the required competencies to use the documented assessment process correctly, for example training courses and experience levels. The documented assessment process should provide all necessary guidance including guidance on all activities to be performed in conducting an assessment as described in ISO TR 15 504-3.*"(ISO 15504-4:1998, p. 8).

At Level 2 (Managed) *"The process delivers work products according to specified procedures and is planned and tracked. Work products conform to specified standards and requirements. The primary distinction from the Performed Level is that the performance of the process now delivers work products that fulfill expressed quality requirements within defined timescales and resource needs"* (ISO 15504-5:1998, p. 5). Again, this level outlines Specific regulations that are set to achieve the defined process level. The fascination of rules in SPICE strongly reflects the hierarchical culture. The detailed description of goals, regulations and requirement verification establish a tough connection between hierarchical culture and SPICE.

Primary life cycle processes consist of two process categories (table I), in which some of the key features of the Engineering process categories supporting hierarchical culture ideal are 1) ENG 1.1 System requirement analysis and Design process 2) ENG 1.2 Software Requirement analysis process and from an organizational life cycle process, the supporting process categories are 1) Management process categories and 2) Organization process Categories. The following quote exported from ISO 15504-5 5.3.1.1 Management process point out how hierarchical culture put in practice during a management process and what are the basic process practices and the outcome of the successful implementation of this process. The main purpose of the management process is: *"...to organize, monitor and control the initiation and performance of any processes or functions within the organization to achieve their goals and the business goals of the organization in an effective manner. As a result of successful implementation of the [Management] process... "(*ISO 15504-5:1998, p. 43) will highlight the activities, tasks and resource, infrastructure to successfully achieve the purpose of the process or functions. The review of the performance monitor and analysis of the resulted work product will be reviewed and action will be taken to modify the performance of the process when performance deviated from the identified activities fails to achieve the identified goals. In short, the management process is a goal oriented and performed consistently until the defined goals are achieved.

Four cultures described on (University 2010, *p.* 3) phrases that, "*Successful managers in hierarchy environment know how to keep the organization running smoothly with few surprises.*" An organization process category and Organizational alignment process, have a specific purpose supporting hierarchy culture: "*the purpose of the Organizational alignment process is to ensure that the individuals in the organization share a common vision, culture and understanding of the business goals to empower them to function effectively...as a result of the successful implementation of this process...*" all employees will be aware of the business goals and mission with the ability to understand their role to achieve the goal. In order to successfully implement this process the strategic vision should be developed and deployed. Some quality policies should be defined and team with surprise will be built and empowered by providing the incentives.

The third organization process 5.3.2.6) ORG 3, *Human Resource Management process* (ISO 15504-5:1998, p. 42), provide organizations the individuals based on their skills and knowledge and let the employees to perform their roles. This process will identify the groups and individuals based on the requirement of the project or organization and training will be provided to the selected groups or individuals to improve their skills. The interaction of the groups and individuals are supported during this process; however, the performance of the groups will be monitored using objective criteria and providing feedbacks.

During an organization process 5.3.2.7) ORG 4, Infrastructure process the stability and reliability are maintained important for hierarchical cultures. "*The purpose of the infrastructure process is to maintain a stable and reliable infrastructure that is needed to support the performance or any other process. The infrastructure may include hardware, software, methods, tools techniques, standards and facilities for development, operation or maintenance. As a result of successfully implementation of this process:*
*- An infrastructure will be established that is consistent with and supportive of the applicable process procedures,*

*standards, tools and techniques.*
*- The infrastructure will meet all requirements for functionality, performance, safety, security, availability, space, equipment, cost, time and data integrity"* (ISO 15504-5:1998, p. 43)*.*

## A. The Ideological ideal

Development culture is about innovation. There are very few elements found supporting the Development culture in SPICE papers. The organizational alignment process of the Organizational Life Cycle process (Table 1) explains that "*the purpose of the organizational alignment process is to ensure that the individuals in the organization share a common vision, culture and understanding of the business goals to empower them to function effectively*" (ISO 15504-5:1998, p. 38). Further, as a base practice of the organizational alignment process, paper says that "*Create teams and empower them to work with an integrated product perspective with primary goal of customer satisfaction*" (ISO 15504-5:1998, p. 38). Some of the activities of the Organizational life cycle are related to the Development culture, but they are not fully supporting this specific culture. As mentioned before, the organization needs to empower the business goals, people should work in a team and communicate and share different ideas. Suggesting new ideas and forcing other people to work on it is driving towards the development culture. Bruce says that "*Adhocracy organizations value flexibility, adaptability and thrive in what have earlier been viewed as unmanageable chaos*" (Tharp, p. 6). Adhocracy culture is risk oriented. During capability level 5, Optimizing process, the management practice continues improvement process and during process attribute 5.2 (*Continuous improvement attribute)*, the practice explains following resource and infrastructure characteristics (ISO 15504-5:1998, p. 90).

1) Use benchmark and industrial database
2) Innovation mechanism
3) Early identification of new technology

SPICE is Supporting innovation mechanism and so the development culture. However, SPICE highlights some of the pre-requirements to get to this level. Among them, the main requirements are new vision of the business and process goals should be identified and analyzed and corrective actions are analyzed associated with process improvement needs.

The processes mentioned above are under the control of a senior manager, and he, who will make the final decision about the new ideas or innovation or group work. This means that the work group functions in the drawn periphery but are free to discuss, show and work on their innovative idea. There were no other aspects found in SPICE that is supporting the development culture. The SPICE model is leading more towards to hierarchy level as we analyzed it deep.

According to Quinn and McGrath (1985), the ideological organization's objective is growth and developmental but in our defined key words nothing really found because SPICE is all about monitoring and controlling the activities. The examples of our categorized searched results are shown in the figure 2. F_D stands for idealogical culture and results were null. In addition, we did not find anything useful using the software tool. However, those findings which are mentioned before were found by close reading of the paper.

## B. The Rational Ideal

A couple of week investigations revealed that SPICE clearly has a deep connection with rational culture. In fact, some of SPICE parts showed that SPICE look for productivity and efficiency of the organization based on goal oriented approach.

There are six capability determination levels and each of them supports different organizational culture depending on their characteristics. The first and fourth capability levels of SPICE have some relations to the rational culture. According to ISO 15504, the first capability level is unplanned and untracked and its success depends on individual knowledge and effort. This comes to more rational culture; as Quinn and McGrath (1985) stated that rational organization's power based on competence and expertise of the individuals. The fourth capability level is defined that defined process will be executed consistently, in order to meet the defined goals. Having pursuit of objectives within an organization is also a rational culture type (Quinn & McGrath 1985). However, the level four isn't just based on objectives, and it also seeks for execution of regulation and control, as ISO 15504 stated that performance and processes are quantitatively managed which is more about controlling and monitoring. Stability and control are for hierarchical organizational culture

| F_C | 3 | 7 |
| --- | --- | --- |
| F_D | 0 | 0 |
| F_H | 5 | 36 |
| F_R | 7 | 34 |

**Figure 2: example of created nodes**

(Quinn & McGrath 1985). Therefore, the fourth capability level is mixed with Hierarchical culture.

The rational organizational structure is also noticed in the ISO 15504. SPICE contains at least five activities of planning, data collection, validation, process rating, and reporting. Therefore, all processes must be documented and these activities will be carried out with a team that has at least one expert in it (ISO 15504-1:1998, p. 4). The assumption of the organizational culture of SPICE is more likely rational culture, according to Quinn and McGrath, the rational culture is more about complex tasks to solve, responsibilities and dependent upon experts. To conclude, the way of handling the activities is more or less controlled; however, handling teams and tasks more sound like based on experts which support the concept of the rational organizations culture. Speaking of individuals' responsibilities, there are many cases encountered and are explicitly shown that responsibilities are based on expertise. Accordingly, having responsibilities on expertise is one of the elements of the rational culture. The list of paragraphs that is supporting the rational cultures is:

*"Collecting data….The expertise and ability of the assessor(s)"* (ISO 15504-4:1998, p. 18)

*"Implement activities. Implement activities and tasks by assigning clear responsibilities to individuals"* (ISO 15504-5:1998, p. 34)

*"Those implementing the actions and those affected by them should be involved, or be consulted, while developing the plan and in evaluating alternatives, in order to draw on their expertise and to enlist their cooperation. "* (ISO 15504-7:1998, p. 13)

*"Allocate responsibilities. Identify the specific individuals and groups contributing to, and impacted by, the project, allocate them their specific responsibilities, and ensure that the commitments are understood and accepted, funded and achievable"* (ISO 15504-5:1998, p. 35)

While studying SPICE, we have met a few ways of goal seeking activities and processes. It was most common to have business goals and trying to achieve those. According to ISO 15504, the capability level five optimizes a process involves piloting innovative technologies and changing processes to meet defined goals and objectives. Generally, the level five is fully supporting the rational culture and based on the goal oriented approach to the activities and tasks.

*"any addition information to be collected during the assessment to support process improvement or process capability determination e.g. specific data (or metrics) that is needed to quantify the organization's ability to meet*

*particular business goal"* (ISO 15504-3:1998, p. 3).

*"The effectiveness and efficiency of the organization's processes with respect to business goal achievement will be improved on an ongoing basis."* (ISO 15504-2:1998, p. 21)

*"The organization's process capability will be assessed periodically to determine the extent to which process implementation is effective in achieving the organization's goals."* (ISO 15504-2:1998, p. 21)

The quality management could be the key reason to have a lot of goal oriented findings and, which make connections stronger with rational culture. Therefore, having quality management means that they will have specific goals to meet and try to achieve those.

*"For each quality goal, identify quality control and assurance activities which will help achieve and monitor that quality goal, both at the project and organizational level."* (ISO 15504-5:1998, p. 36)

*"Build and empower teams. Create teams and empower them to work with an integrated product perspective with a primary goal of customers satisfaction"* (ISO 15504-5:1998, p. 38)

*"The software process goal is aim or objective of all or part of the software process. A software process goal should be defined, wherever possible, such that a single software process metric can be used to judge the degree to which goal is achieved."* (ISO 15504-7:1998, p. 24)

In the ISO 15504, various goals are mentioned as a few of them as follows:

- Software process goal
- Quality management goal
- Customer satisfaction goal
- In the capability level five, all tasks and activities will have specific goals to achieve

Decision making in SPICE, were more or less based on goal centered, systematic and analytical approaches.

*"Manage all changes made to the customer requirements against the customer requirements baseline to ensure enhancements resulting from changing technology and customer needs are identified and that those who affected by the changes are able to assess the impact and risks and initiate appropriate change control and mitigation actions."* (ISO 15504-5:1998, p. 15)

*"Product and process measures will be collected to monitor the extent to which the defined goals are met"* (ISO 15504-2:1998, p. 25)

The study shows that there are more contractual agreements than the monitoring and control. According to Quinn and McGrath (1985), the rational culture tends to be based on the contractual agreement. In fact, in the ISO 15504, there are many coincidences as following:

*"Obtain agreement across teams on the customer requirements, obtaining the appropriate sign-offs by representatives of all teams and parties contractually bound to work to these requirements."* (ISO 15504-5:1998, p. 15)

*"Maintain project team interactions. Obtain and maintain agreement on the implementation of interactions between teams"* (ISO 15504-5:1998, p. 43)

The idea of the rational culture is achieving customer satisfaction and focused on transactions with customer supplier and regulators. The primary and supporting life cycle strongly supports these cultures. The primary life cycle consists of the processes starting with an acquisition process to obtain the product or the service to satisfy the customer needs, and end with system testing and maintenance.

### C. The Consensual Ideal

Quinn and McGrath (1985) mentioned that consensual organizational culture exists when objectives and structures of organization are based on the group collaboration and maintenance. There haven't been many records of consensual organization during our investigation with SPICE; however, there are some traces that just good enough to show that consensual organizational culture is present in SPICE.

Group maintenance of organizational objective had spotted on a human resource management process in SPICE. According to Cameron and Quinn (1999), consensual culture is affected by moral and development of a human resource. Therefore, it is a good idea to look at the development of the human resource in SPICE.

The ORG.3 Human resource management process has six specific guidelines. The first guidance rather concerned about the monitoring and controlling, which leads to the hierarchical organizational culture.

*"The roles and skill required for the operations of the organization and the project will be identified through timely review of the organizational and project requirements"* (ISO 15504-2:1998, p. 22)

*"Objective criteria will be defined against which group and individual performance can be monitored to provide performance feedback and to enhance performance"* (ISO 15504-2:1998, p. 22)

The second and third guidelines are more about individual's skills and performance. According to Quinn and McGrath (1985), rational organizational culture is characterized by goal centered decisions, responsibilities based on expertise and competence. Therefore, there are more about rational organizational culture.

*"Training will be identified and conducted ensure that all individuals have the skills required to perform their assignments, using mechanisms such as training strategies and materials"* (ISO 15504-2:1998, p. 22)

*"Individuals with the required skills and competencies will be identified and recruited using mechanisms such as procedures, or they will be trained as appropriate to perform the organizational and project roles"* (ISO 15504-2:1998, p. 22)

The fourth and fifth guidelines are what we are looking for; consensual organizational culture based on group maintenance and their relationship (Quinn & McGrath 1985), which would require effective information sharing between group members and with other groups. These facts are absorbed with followings texts:

*"Effective interaction between individuals and groups will be supported"* (ISO 15504-2:1998, p. 22)

*"The work force will have the skills to share information and coordinate their activities efficiently"* (ISO 15504-2:1998, p. 22)

According to ISO 15504-2 (1998), individuals who possess knowledge and skills, work effectively and collaborative. Having such people are important in a consensual organization and in fact, it is the attribute of the frame work. In addition, this property is linked to organizational structure. We have discussed and concluded about rational organizational culture in previous section. Introducing human resource management, forces us to believe that SPICE supports consensual culture more than the rational culture in human resource.

*"Maintain project team interactions. Obtain and maintain agreement on the implementation of interactions between teams"* (ISO 15504-5:1998, p. 43).

## V. CONCLUSION

Our result shows that SPICE contains several major organizational cultural attributes in their core assumption. According to Ngwenyama and Nielsen (2003), CMM is rational flexible learning organization and has several major organizational cultures in their core assumptions. And it was not surprising to find out that SPICE model has the similar results with CMM from organizational culture perspective. In this section, we will discuss our findings more detailed and its benefits to the organizations.

Documentation is one of the keys for success in SPICE and without it; there will be no maintaining and sustaining the SPI. In addition, documentation is not just for supporting activities but more about having control and monitoring tasks, which tie SPICE more to Hierarchical culture. In fact, when capability determination level goes lower to higher, it requires more documentation and controlling. Therefore, the last two levels exist just for monitoring and controlling, in order to sustain the SPI. For instance: according to ISO 15504, the fifth capability determination level iterates until defined goals are met. In order to go to the next iteration, it needs the previous iteration's process that has been well documented. Therefore, the next iteration is based on the previous iteration's documentation.

Compliance is followed by contractual agreement. SPICE suggests having contractual agreements between groups, individuals, customers and organization. Consequently, having the contractual agreement will contradict with the hierarchical culture where everything is based upon controlling and monitoring. Therefore, both hierarchical and rational organizations will suffer from it.

SPICE needs cautious and effective leaders, in order to monitor and control SPI. In a hierarchical organization, the leaders tend to be: Micromanagement, procedural rigidity, Over-regulation and Ironbound tradition (Quinn at al. 2006). Therefore, cautious and effective leaders are required in the SPICE and hierarchical organization will benefit from it.

SPICE model noticeably had a goal oriented approach in the capability determination level. In fact, the fifth and sixth levels have the goal oriented approach mixed with controlling and monitoring. SPICE requires skilled workers and it is suggested to change current workers either by training or hiring. Therefore, rational organizations will benefit for having the goal oriented approach and skilled crews. However, the rational organizations will suffer from a lack of control.

Having a collaborative environment is important in SPICE and this environment is created due to human resource management, and its methods and suggestions are more or less about maintaining relationships between crews. It is suggested by ISO 15504 that each group member is supposed to share information to each other and there has to be a global database that everyone can access. From this, consensual organizations will benefit.

In summary, SPICE supports Hierarchical, Rational and Consensual organizations. However, it is not guaranteed that these types of organizations will succeed 100%. This is because SPICE model has contradictions of organizational cultures within its core assumption. For instance: When the capability determination level goes from lower to higher, it needs more monitoring, controlling and goal orientation. In fact, the higher level of capability determination has characteristics of both Hierarchical and Rational organizational cultures.

In this research, we looked at organizational cultures that are embedded in SPICE assumed that this study will help organizations in a number of ways. However, our study shows that SPICE is for mixed characteristics of different cultures. According to Cameron and Quinn (1999), organizations usually end up with having different characteristics. In other words, most of the organizations are a mix of different cultures. Therefore, it is a good idea to identify the competing values in SPICE.

This research area should be studied more, and it would be interesting to apply competing values frame work on all those SPI models and come up with documentation or frameworks for the different organizations. From this, organizations could profit a lot more and there will be more success in implementing SPI models.

## ACKNOWLEDGMENT

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