

Knowledge Management and Organizational Culture in a Software Organization – a Case Study

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Abstract — *Software development activities are usually knowledge intensive. Knowledge management is essential to foster improvements and innovation on software development processes. Organizational Culture (OC) is a key factor that impacts the success of knowledge management, since it influences the way employees learn and share knowledge in the organization. The Competing Values Framework (CVF) was proposed to support the definition of organization's cultural outline. CVF aims to diagnose and facilitate Organizational Culture changes. Previous researches presented a theoretical model to correlate knowledge management to the CVF. However, the existing literature does not present evidences of this correlation. The goal of this work is to identify whether this correlation exists or not in the context of a software organization by means of a case study. We performed a comparison between the values obtained and those presented in the theoretical model. The comparison output enabled us to verify that the case study results diverged from the theoretical ones. Therefore, it was not possible to observe the theoretical model's propositions on the investigated software development organization.*

Keywords — **knowledge management, organizational culture, competing values framework.**

I. INTRODUCTION

Software development organizations have to keep their level of knowledge along with its own capacity to create and use this knowledge. These are their main abilities to innovate and to keep a competitive advantage [1]. Software engineering knowledge is dynamic and depends on technology, organizational culture and the changing needs of organization's software development practices [2]. In order to evolve their knowledge, software development organizations can focus on Knowledge Management (KM) practices to share important knowledge among their members [3]. Thus, they have to foster knowledge usage and experience exchange in order to improve its software development practices [4].

According to Mehta [5], the key factors that contribute to effective KM are human and technical. Human behavior is the key to success or failure of KM activities, as KM involves an emphasis on organizational culture, teamwork, promotion of learning, and sharing of skills and experience [6].

The Organizational Culture (OC) affects the way that organization members learn, acquire and share knowledge [7]. Rubenstein-Montano *et al.* [8] recommend that KM practices must be compatible with the Organizational Culture.

The literature presents a theoretical model [9][10] that correlates the KM cycle (SECI – Socialization, Externalization, Combination, and Internalization model) [11] and the OC by means of the Competing Values Framework (CVF) [12]. However, no empirical evidences about this correlation were found so far. Thus, our goal is to empirically investigate this relationship. We conducted a case study on a software development organization that encourages KM practices.

The rest of this paper is organized as follows: in Section II we present the background of knowledge management and CVF model. In Section III, the research method defined to our case study is presented. In Section IV we discuss the results of the case study. And, finally, in Section V the reached conclusions and the future studies are presented.

II. BACKGROUND

Knowledge management goal is on the acquisition of new knowledge, on how to handle existing knowledge in ways to make it possible to use it in the future, on how to store and spread them, and on providing applicable strategies for new contexts [6]. According to Nonaka and Takeuchi [11], knowledge may be classified in two types: tacit and explicit. The tacit knowledge is subjective and based on human experience, perception and individual values. In addition, the explicit knowledge is considered objective and transmittable by formal and systematic languages.

The dynamic interaction between tacit and explicit knowledge leads to a knowledge conversion model known as SECI (Socialization, Externalization, Combination and Internalization). The SECI model focus on creating, exploring and maintaining knowledge [11]: a) *Socialization* is the experience of sharing process, in which a person's tacit knowledge is spread to another by observation, cooperation or behavior imitation; b) *Externalization* transforms tacit knowledge into explicit knowledge and it is important on creation processes, because ideas and concepts are formulated; c) *Combination* generates new explicit knowledge by combining different explicit knowledge; d) *Internalization* is

the process that converts explicit knowledge into tacit knowledge, also known as the individual learning process.

The Organization Culture is essential to encourage interactions between individuals and to facilitate the knowledge flow [13]. The Competing Values Framework (CVF) is one of the most influential and used models on Organizational Culture research due to its reliability and effectiveness [12].

CVF aims to diagnose and trigger the changes in the Organizational Culture changes while they organizations grow and experience external environment pressure [12]. Four dominant culture types emerge from the CVF model [12]: clan, adhocracy, market, and hierarchy (see TABLE I).

TABLE I - CVF model cultures from Cameron and Quinn [12]

#	CVF Cultural Types
1	The Clan Culture seeks flexibility and focuses on its internal environment. It is a family organization where teamwork is encouraged. Leaders are considered mentors, as loyalty, tradition, and commitment are emphasized.
2	The Adhocracy Culture seeks flexibility and focuses on its external environment. This culture is grounded on the innovation and entrepreneurship. Leaders must be innovative, entrepreneurial, visionary.
3	The Market Culture, denoted as the rational goal perspective, is characterized by values that highlight predictability and external focus. Leaders are demanding, competitive, and produce results.
4	The Hierarchy Culture, referred to as the internal process perspective, is characterized by values that highlight predictability, control and internal focus. Managers maintain control through standard operating procedures and policies.

Based on the identification of the four CVF cultural types, Cameron and Quinn [12] developed and validated the Organizational Culture Assessment Instrument (OCAI). This instrument utilizes a questionnaire to verify and establish an OC profile. By using OCAI it is possible to identify the current organizational profile, as well as the preferred or desired one.

Gray and Densten [9] and Rai [10] proposed a theoretical model that integrates the CVF and the SECI model. According to Gray and Densten [9], this integration offers an opportunity to clarify and acknowledge the impact of OC on the organizational knowledge treatment process. The authors conclude that [9] [10]: a) Organizations of *clan culture* are likely to focus on *knowledge socialization*; b) Organizations of *adhocracy culture* are likely to focus on *knowledge externalization*; c) Organizations of *market culture* are likely to focus on *knowledge combination*; and, d) Organizations of *hierarchy culture* are likely to focus on *knowledge internalization*.

III. RESEARCH METHOD AND STUDY SETTINGS

The goal of this paper is to investigate the relationship between SECI Model [11] and the Organizational Culture by means of CVF [12] in a software development organization. To achieve this objective, a case study was conducted in two successive steps: a) investigation of the Knowledge Management practices in use by the software organization; and b) investigation of the Organization Cultural profile.

Case studies are important to better understand the causes behind a given problem and its consequences [14]. According to Flyvbjerg [14], predictive and universal theories cannot be found in studies of human issues. Therefore, the context-dependent knowledge obtained via case study becomes more valuable than the theoretical knowledge (contextually-

independent).

Our case study took place in an organization that develops software in Manaus, Brazil. This organization is a technological institute for research and development projects (R&D) in software and hardware, technological training, social responsibility, sustainability and biotechnology. With more than 200 employees, this organization needs to manage knowledge and promote effective learning related to the relevant aspects of its activities. This organization values KM, including KM-specific activities in its software development process.

A. Knowledge Management Practices Investigation

The purpose of this step was to identify the KM practices in the software organization and correlate these practices with SECI model of Nonaka and Takeuchi [11]. To identify the practices, we conducted semi-structured interviews and we made observations of the lessons learned meetings.

An interview guide was developed to help managing the interview process. The questionnaire focused on investigating how KM and Organizational Learning take place in the organization. We interviewed 17 employees from the investigated organization. These employees worked in projects running process improvements. The roles of the interviewed employees included developers, quality analysts, test analysts, project coordinators and team leaders. Thus, they were more involved with learning issues and KM in the organization.

The practices were identified by means of qualitative analysis of the collected data. A researcher conducted the analysis and the results were checked and discussed with a second researcher.

B. Organizational Profile Investigation

The main goal of the second stage of our study, performed after identification of KM practices, was to investigate the cultural profile of the software organization. A questionnaire based on OCAI [12] was applied.

The OCAI questionnaire consists of six items (dominant characteristics; organizational leadership; management of employees; organization glue; strategic emphases; and, criteria of success.) Each item has four alternatives related to the four organization cultures (Clan, Adhocracy, Market, Hierarchy). For each of these four alternatives it is necessary to divide 100 points, according to similarity between the alternative and the organization. As more points one alternative has, more similar to the organization this alternative is.

Cameron and Quinn [12] claim that the organization's key people should respond to the OCAI questionnaire. Therefore, we invited employees that held positions as managers, project leaders, project coordination assistants, and project coordinators to participate in this stage of the study. Furthermore, they were chosen because of their deep knowledge about the organization. The population of employees that hold these roles in the organization is 49 employees (4 managers, 33 project leaders, 10 coordination and 2 coordination assistants). A total of 29 employees participated in the study: 1 manager, 2 coordination and 26 project leaders. After collecting the data, the cultural profiles were produced as described by Cameron and Quinn [12].

IV. OUR RESULTS

A. Identifying Knowledge Management Practices

We identified the KM practices adopted in the organization distributing them according to SECI model [11]. We observed and identified 12 practices in our case study. This investigation of the KM practices step occurred during a Software Process Improvement initiative. It is important to notice that a particular practice may belong to more than one quadrant of the SECI model. TABLE II depicts some examples of practices adopted and their relationships with the SECI model. In addition, the total amount of practices of each quadrant of SECI model is presented.

TABLE II. KM practice samples and SECI quadrant totals.

	Socialization	Externalization	Combination	Internalization
Process Wiki		•		•
Trainings	•			
Lessons Learned		•	•	•
⋮	⋮	⋮	⋮	⋮
Total	5 (28%)	4 (22%)	1 (6%)	8 (44%)

Most of the organizational practices (44%) focused on the knowledge internalization. Thus, the organization employs its efforts in making the explicit knowledge become tacit, supporting the learning process. One example of the **internalization** practice identified is employee's integration, which occurs after new employees are hired, when those new employees obtain knowledge about the organization's software development process. Thus, the knowledge internalization occurs when the organization's explicit knowledge (stored on wiki pages) is presented to help the new employees to learn it.

Focusing on the tacit and explicit knowledge interactions, the practices related to knowledge **socialization** summed 28%, e.g.: training and interacting with more experienced employees. Process Wiki pages and Intranet use are examples of practices related to **externalization**, which occurs when the employees' tacit knowledge is stored and becomes explicit and freely available to any employee that has access.

Only one practice related to **combination** was identified. During "lessons learned" practice execution, combination occurs when lessons related to issues that need to be improved in the next development cycles are solved. Knowledge obtained from the solutions is incorporated into existing lessons learned in organization's knowledge database.

B. Investigation of Organization's Profile

OCAI questionnaire application enables organizations to analyze its own cultural profile, as well as, to analyze in a stratified way each of the six dimensions that compose the instrument, which are: a) dominant characteristics; b) organizational leadership; c) management of employees; d) organization glue; e) strategic emphases; f) criteria of success.

From the 29 questionnaires filled by the participants, only 23 were considered valid. The analysis of each dimension of the current cultural profile and how employees would like it to be eventually in the future (preferred profile) is shown in TABLE III. Regarding the *Dominant Characteristics*, the organization is more focused on the market culture type, meaning that the organization focuses on results and its employees are competitive and focus on the achievement of established goals. However, regarding to the preferred profile, these employees want the organization to be a dynamic and entrepreneurial place, where they may feel encouraged to take risks, in other words, the adhocracy culture.

Concerning *Organizational Leadership* and *Organization Glue* dimensions, the organization is related to the market culture type. In this type of scenario, the leadership style is aggressive and result-oriented. The employees prefer a profile related to Clan, in which leaders act as mentors, facilitating and encouraging employees' development. Finally, we found that employees are satisfied with the results of the *Management of Employees* dimension. This dimension is related to teamwork, consensus and participation. In this dimension the current and preferred cultural profile were the same (i.e. clan profile).

Regarding the *Strategic Emphases* dimension, we verified that the Adhocracy profile is predominant. In the diagnosis of current profile, we found that the organization emphasizes on acquiring new resources and on creating new challenges. However, employees would like the organization to have a profile more related to Clan, emphasizing human development, levels of trust, openness and participation.

The organization defines success based on efficiency (*Criteria of Success*). The noticed critical points are reliable deliveries, well-prepared schedule and a low-cost production. Preferably, the employees also wish that the organization to have a *Criteria of Success* closer to Clan profile.

The graph based on the organization's average cultural profile is presented in Fig. 1. According to Fig. 1, we observe that the most prevalent culture type in the organization is Market. This indicates that this organization is focused on performance and values competitiveness. It is also possible to notice that the organization already tends to Clan culture.

When asked how employees would like the organization to be in the future, the Clan type was preferred. This type of culture is characterized by a friendly working environment, with emphasis on human development and teamwork.

C. Comparison Analysis of the identified KM Practices as the Dominant Organization's Cultural Profile

The results of the two stages of this case study were shown in the previous subsections. These results were important inputs for the primary goal of this work, which is to investigate through practice the relationship between the SECI model [11] and the Organizational Culture through CVF [12].

TABLE III. Results of the organizational profile by size

	Dominant Characteristics		Organizational Leadership		Management of Employees		Organization Glue		Strategic Emphases		Criteria of Success	
	Now	Preferred	Now	Preferred	Now	Preferred	Now	Preferred	Now	Preferred	Now	Preferred
Clan	27,27	29,09	23,32	40,68	35,00	39,55	27,27	35,91	25,00	37,73	28,64	40,23
Adhocracy	20,45	36,82	17,59	25,45	20,91	24,32	23,86	32,27	28,18	30,00	15,91	23,41
Market	37,36	26,14	35,00	15,45	23,86	17,73	31,14	20,00	24,32	16,59	22,3	16,59
Hierarchy	14,91	7,95	24,09	18,41	20,23	18,41	17,73	11,82	22,50	15,68	32,73	19,77

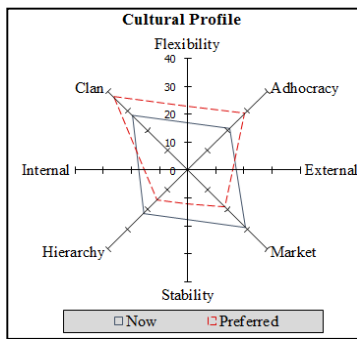


Fig. 1: Organizational Cultural Profile

Gray and Densten [9] and Rai [10] concluded that there are relationships between: Socialization and Culture Clan; Outsourcing and Adhocracy Culture; Combinations and Market Type Culture; Internalization and Hierarchical Culture.

On the findings of Gray and Densten [9] and Rai [10] there is a relationship between the internalization of knowledge and hierarchical culture type. However, this relationship was not observed in our case study: most of KM practices were related to knowledge internalization stage and the predominant culture is Market cultural profile. Gray and Densten [9] and Rai [10] also claim that there is a relationship between combination of knowledge and the cultural market profile. Again, the results obtained do not allow infer this relationship, as we identified only one KM practice related to knowledge combination.

According to our study, 5 (five) practices were identified as part of knowledge socialization step. This shows that, after the knowledge internalization, socialization is also encouraged. The case study results also show that there is a tendency for the clan culture. It is worth remembering that Clan profile core values are participation, loyalty and commitment [12].

V. CONCLUSIONS AND FUTURE WORK

This paper presented a case study that aimed to compare, in practice, the relationship between the KM cycle (SECI) and the organizational culture through the CVF. In order to perform this case study, we collected data related to KM practices adopted on one organization and requested the selected employees to answer an OCAI questionnaire concerning organizational culture.

While comparing this research results with the results proposed by the authors Gray and Densten [9] and Rai [10], we did not find evidences that there is a relationship between quadrants of the SECI model and CVF in the way they proposed.

The results of this case study are limited to the context of the study performed. Flyvbjerg [14] states that context-dependent knowledge is more valuable than theoretical knowledge. Therefore, the results obtained in this study show the importance of investigating the proposed theories in practice. This case study results showed different relationships than those proposed by the theoretical model of Gray and Densten [9] and Rai [10].

We intend to continue investigating, through new experimental studies, the relationship between the SECI model [11] and the Framework CVF [12] in other software

development organizations. In addition, future research should be conducted in order to get answers to the following research questions: "Is it good or bad for the organization to have KM practices centralized in a quadrant of the SECI model (e.g., internalization)?"; "What are the benefits of having a lot of practice of KM in a SECI quadrant and few in other quadrants?"; "Is the relationship between the SECI model and the CVF model similar in other software organizations?".

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