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Exploring the relationship between organizational culture and software process improvement deployment

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ABSTRACT

We explored the relationship between organizational culture and deployment of software process improvement (SPI) approaches using a competing values framework. Our results indicated that the organizational culture had an influence on SPI deployment, primarily made possible by a hierarchic culture with its emphasis on procedures, order, and stability. Clan culture, with its emphasis on human development, commitment to others, and participation, appears to be a necessary condition in creating skills development and sharing SPI knowledge in the process of its deployment. Software Engineering Program Group leaders should ensure that internal values are in place to enhance SPI deployment.

1. Introduction

In recent years, software process improvement (SPI) has emerged as the dominant approach for delivering improvements to the software product in software development organizations. Its intent is to enhance software product quality, increase productivity, and reduce the cycle time for product development. A number of advances have been made in the development of SPI approaches such as ISO 9000, the Capability Maturity Model (CMM) and its newer versions: the Capability Maturity Model Integration (CMMI), and Software Process Improvement and Capability dEtermination (SPICE), which focus on defining and measuring processes and practices to achieve quality software. ISO 9000 certification and CMMI are used by software companies all over the world. They guide the process improvement throughout the project in a division, or part or the entire organization.

CMMI helps adopters to integrate traditionally separate organizational functions, set process improvement goals and priorities; it also provides guidance for implementing quality processes and a reference model for appraising current processes. CMMI provides a *staged* representation with five levels of software process maturity ranging from *initial* (processes poorly controlled and reactive) to *optimizing* (focused on continuous process improvement) [11].

Despite the widespread adoption of SPI, there is still insufficient quantitative evidence of how software products have been improved by its deployment [3,4,6,16] and there is still a great deal of variability in the success of SPI initiatives [5,23]. A recent review of 322 papers on SPI [7] indicated that the field was dominated by one approach (CMM), and heavily biased towards how SPI practitioners can carry out SPI initiatives. Surveys indicated, however, that the SPI field lacked theoretical frameworks.

SPI attempts to change how software professionals think and act in their everyday organizational activities. Therefore, its activities can result in organizational changes. Ravichandran and Rai [21] found that organizations face major hurdles in the implementing SPI and that these are more organizational than technological in nature. Several researchers [1,18] have also indicated that SPI does not deal effectively with the social aspects of organizations. Thus, it needs a managerial focus rather than a technical one.

Hofstede regarded organizational culture as the collection of values, beliefs and norms shared by its members and reflected in its practices and goals. This can affect SPI deployment. Results of several studies, e.g. [2,8,10], have also suggested that organizational culture has a significant effect on both the successful implementation and the use of IT. Therefore, we decided to examine SPI approaches, specifically CMMI, to ascertain the influence that organizational culture has on SPI deployment.

2. Background

SPI involves understanding existing processes and changing these processes to improve product quality and reduce cost and development time.

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2.1. Deployment of software process improvement approaches

The deployment of SPI involves the post-implementation stages of the innovation diffusion process, when the innovation is being incorporated into the organization. It is necessary to focus on the deployment because the SPI may not be used effectively or may not have the intended consequences. The assessment of the deployment adopted by us included three items, as discussed next.

2.1.1. Perceived SPI support for software development

This can be linked to user's understanding of the capabilities and corresponding values to the organization [12]. The *production technology* in our study was defined as: the impact on the ability of a user in generating planning and design decisions and thus artifacts or products. The *co-ordination technology* was defined as: functionality that enabled or supported the interactions of multiple agents in the execution of a planning or design task; it consists of control and cooperative functionality. The *control technology* was defined as: the method of enabling the user to plan for and enforce rules, policies or priorities that will govern or restrict the team members during the process. The *cooperative technology* was defined as: the way of enabling the user to exchange information with others in order to affect the concept, process, or product of the team.

2.1.2. Perceived SPI impact on the quality of the software product and development process

Examining product and process outcomes can reveal each of their impacts on quality. In addition, quality processes are a necessary prerequisite for delivering quality products and satisfying customer needs. Therefore, we concentrated on two dimensions: *product quality* (the overall evaluation of the product produced by the process) and development process quality [20]. *Process quality* in our study is defined as the degree to which the process is designed to promote consensus among participants in software development, operate within established resource parameters, and reduce waste and redundancy. The perceived impact of the deployment of SPI can be linked to the probable or actual consequences of its adoption.

2.1.3. The degree of SPI use

There has been little research confirming the actual value of using SPI. Our study concentrated on two dimensions of SPI use: *horizontal* (the degree of penetration of SPI use measured as the percentage of software developers and projects using SPI knowledge) and *vertical* (the maximum intensity of SPI use within the organization).

2.2. Organizational culture

An organization's culture is its set of shared ideas and values that serve as a means of accomplishing its mission. As such, it can and does play an important role in many facets of the organization. The values define *what* is important to a group. They answer the question: Why people behave the way they do?

Different approaches have been used to study how organizational values affect its culture. The national and organizational cultures represent the most popular approaches. They both define the values that distinguish one group from another. The most popular conceptualization of national culture has been Hofstede's well-known taxonomy of using the dimensions of *power distance*, *uncertainty avoidance*, *individualism*, *masculinity, and Confucian dynamism* or *long-term Orientation* [24]. These allow national-level analyses and allow country or regional comparisons. At the organizational level, the competing values framework (CVF) is most popular. It allows of organizational cultural taxonomies has been to enable the differentiation of comparison of organizations along the dominant values of each organization's behavior.

Fig. 1. Competing values framework of organizational culture.

The CVF is characterized by a two-dimensional space that reflects different value orientations, as shown in Fig. 1. The first dimension in this framework, the flexibility-control axis, shows the degree to which the organization emphasizes change or stability. A *flexibility orientation* reflects flexibility and spontaneity, while a *control orientation* reflects stability, control and order. The second dimension in this framework, the internal–external axis, addresses the organization's choice to focus on activities occurring internally and those occurring outside the organization. An internal orientation reflects maintaining and improving the organization, while an external orientation reflects a competition, adaptation, and interaction with the outside environment.

Thus four types of organizational culture appear: clan (which emphasizes flexibility, change and a focus on the internal organization), adhocracy (which also emphasizes flexibility, but it is externally focused, primarily on growth, resource acquisition, creativity and adaptation), hierarchic (which is externally focused, but is control oriented, dealing with productivity and achievement of well-defined objectives response to external competition.), and market (which emphasizes stability but focuses on the internal organization, its uniformity, co-ordination, internal efficiency and a close adherence to rules and regulations). Though the framework is divided into named quadrants with distinct characteristics, no organization is likely to reflect only one value system. Instead, one would expect to find combinations of values in one company, with some more dominant than others.

Good fit between the values embedded in the software development process and the overall organization's values lead to a more successful implementation. In a content analysis of longitudinal data from three SPI initiatives, Ngwenyama and Nielsen [17] found that cultural assumptions embedded in SPI methodologies could conflict with the cultural assumptions of developers, leading to difficulties in implementing process improvements.

We used the competing values framework in our analysis of the relationship between organizational culture and SPI deployment. It focuses on values as its core constituents of organizational culture, successfully reflects the conflicting demands of the organizational context, and has been applied to the study of organizational issues ranging from culture to leadership, being accepted as determining both the type and strength of cultures prevalent in an organization.

2.3. The competing values framework in the context of SPI deployment

Little research has specifically examined the framework as it relates to SPI deployment, except for Ngwenyama and Nielsen, who applied it to the content analysis of the cultural assumptions of the CMM and concluded that the design ideal of CMM reflected the *market* culture, but it becomes more *hierarchic* at the higher levels of maturity.