Assessing Software Process Maturity and Discipline in the English-Speaking Caribbean

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Assessing Software Process Maturity and Discipline in the English-Speaking Caribbean

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ABSTRACT

The information systems (IS) development community has focused extensively on software process improvement (SPI) programs to address the persistence of low-quality software and the perception of a software crisis. It has employed formal assessment instruments such as the capability maturity model (CMM) to gauge IS process competence and provide the impetus for software process improvement initiatives. Research findings have confirmed that an SPI focus is a necessary (though not sufficient) condition for the production of successful systems. However, most of this research has occurred in the developed world, much fewer in developing countries, and even less in the English-speaking Caribbean (ESC). The insights gained from SPI research in developed countries may not be applicable to these countries, and CMM programs are not affordable in their current arrangement. In this study we propose simplifying modifications to the CMM structure and instrument to make it more amenable to the ESC context.

Keywords

IS quality, Software Process Improvement, Capability Maturity Model, IS in developing countries.

INTRODUCTION

A recurring theme in the information systems (IS) literature in the past several years is the failure within the IS community to fully exploit the innovations and advances in information technology (IT) to consistently produce high-quality business applications. One of the responses of the IS development community to this and other IS quality concerns (Krishnan and Kellner, 1999) is an extensive focus on software process improvement (SPI) programs to establish the required process predictability necessary for producing high-quality IS (Humphrey, 1998). The SPI trend has been to employ formal process assessment instruments such as the capability maturity model (CMM) – developed by the software engineering institute (SEI) of Carnegie Mellon University under the sponsorship of the US Department of Defense – to gauge IS process competence and provide a baseline for planning software improvement initiatives (SEI, 2002).

Most of the research that has evaluated the impact of SPI on software quality concerns organizations in developed countries and a few involves developing countries (Horvat, Rozman and Gyorkos, 2000; Richardson, 2001) but there is no evidence of such studies in the English-speaking Caribbean (ESC). The results have typically confirmed that an SPI focus is a necessary (though not sufficient) condition for the production of high-quality systems (Ravichandran and Rai, 2000); however, these insights may not be entirely applicable to developing countries, with their distinct cultures and business practices.

We conducted a quick survey of randomly selected Jamaican companies which revealed that these organizations had no awareness of the capability of their software delivery processes; they neither engaged in software process assessments nor focused on formal SPI practices. Davison, Vogel, Harris and Jones (2000) asserted that developing countries need to ensure that they are neither isolated from world trends nor disenfranchised from active and autonomous participation in IS developments. This is quite applicable to firms in the ESC due to the new global competitiveness, foreign exchange challenges, and generally tighter budget constraints, which leave far less capacity to recover from poor quality software than larger corporations in the developed world because of economies of scale.

Perhaps ESC companies are not aware of CMM and/or SPI programs; however, software process assessment instruments such as the CMM and full-blown SPI programs are too cumbersome, time-consuming, and costly in their current form for use in smaller organizations (Davison et al., 2000). In this study we examine the structure of the CMM and its applicability to smaller organizations, such as those in Jamaica and other ESC countries, in order to effect simplifying modifications. The objective is to increase the odds of the adoption and application of the CMM in this context. We intend to offer these
revisions to researchers and practitioners in the Caribbean region and other developing countries with similar characteristics. In the process we intend to develop a research model from the revised framework and to test it in future research.

Although, in larger organizations, CMM has been succeeded by the Capability Maturity Model Integration (CMMI), the consolidation of several CMMs, we selected the original software engineering CMM (SW-CMM), because of its popularity. Persse and Wiley (2001) claimed that it is the leading software quality improvement standard in North America. Our smaller target enterprises would be better served by the SW-CMM’s relative simplicity and its exclusive focus on the software process. In the rest of the paper we briefly review the relevant SPI and CMM literature, examine the characteristics of large and small enterprises, propose a modified CMM model for ESC organizations, and offer our conclusions.

SOFTWARE PROCESS IMPROVEMENT AND THE CMM

The major presumption of software process improvement (SPI) efforts, that IS outcomes are largely determined by the effectiveness of the development process, has been substantiated in IS research (Ravichandran et al., 2000). Such improvement programs have focused on (1) understanding and assessing the effectiveness of a firm’s systems development practices (2) using the assessment to identify areas for improvement and developing prioritized implementation goals (3) establishing implementation plans for achieving process consistency and predictability, and (4) instituting a culture that is conducive to continuous improvement (Humphrey, 1998).

The CMM is not only an assessment instrument; it is a framework that describes the key elements of an effective software process, projecting an evolutionary improvement path that includes five maturity levels on a continuum from an ad hoc and immature process to a fully mature and disciplined one (KPMG, 2006). Maturity has to do with the degree of discipline applied to a software process as reflected in the effectiveness with which it is defined, managed, measured, and controlled (Paulk, Curtis, Chrissis and Webber, 1993a). The underlying premise of this model is that continuous improvement can occur only through focused and sustained effort towards building a process infrastructure of effective software engineering and managed practices (Parzinger and Nath, 2000).

Figure 1 presents this framework. It denotes that each CMM Level is supported by key process areas (KPAs) which define several software improvement goals. Similarly, each KPA describes the practices that are essential for accomplishing its goals. These practices are categorized by common features that detail the specific activities that are required to institutionalize the practice (Wiegers, 1996).

CMM IN ESC ENTERPRISES

The CMM, however, was intended to be applied in large organizations (Haase, 1996; Leung, 1999; Wang, 2003), typically in developed countries (Davison et al., 2000). Many of these organizations have reaped benefits such as improvements in product quality, project cycle time, development cost, staff productivity and morale, and customer satisfaction (Dooley, Subra and Anderson, 2001; Herbsleb, Zubrow, Goldenson, Hayes and Paulk, 1997; Johnson and Brodman, 1996; Krishnan et al., 1999). However, the “cost” of obtaining such improvements includes high expenditures, significant investment of time, and some disruption (Buchman and Bramble, 1995).
The rationale for SPI initiatives applies with equal validity to small and large organizations; according to Humphrey (2002) if performance is not measured it will not improve. However, credible evidence suggests that CMM benefits that accrue to large organizations may not be realizable by small enterprises. The evidence suggests that small enterprises (1) experience difficulty in applying CMM and adapting it for small projects (Davison et al., 2000; Haase, 1996; Herrera Ramirez, 2003; Horvat et al., 2000; Johnson and Brodman, 1997; Leung, 1999; Richardson, 2001; Richardson, 2002; Wang, 2003); (2) find some CMM practices irrelevant and others hard to implement (Herbsleb et al., 1997); and (3) cannot afford the steep initial investment of human and financial resources and time (Wang, 2003) or the high implementation expenditure (Saiedian and Kurara, 1995). The combined CMM documents exceed five hundred text-based pages which makes it difficult to understand and assimilate (Ingalsbe, Shoemaker and Jovanovic, 2001). The payback period is also quite long as organizations typically take eighteen to thirty months to advance one full maturity level (Hayes and Zubrow, 1996). Furthermore, small organizations have a lower capacity to absorb these conditions and to recover from failed SPI projects than their larger counterparts, and they lack the economies of scale to fund such projects through low cost capital and develop internal resources and core competencies (Lawler, 1997).

ESC enterprises are subject to all these negative impacts and additional challenges identified in other developed countries, such as (1) resource poverty in finance, labor, equipment, and material (Thong, Yap and Raman, 1996); (2) highly centralized structures, with CEOs making most of the critical decisions (Vreede, Jones and Mgaya, 1999); (3) cultural aversion to change and low productivity (Herrera et al., 2003); (4) the unavailability of IS specialists (Thong et al., 1996); and (5) reliance on imported IT products and solutions (Bhatnagar, 2000). These enterprises also experience other problems including foreign exchange shortages, low economic growth, scarcity of technical personnel due to migration - the IMF indicated that the Caribbean region loses 70% of its workforce annually (Jamaica Daily Gleaner, 2006). These problems may prohibit the adoption of the full-blown CMM.

We have therefore recommended simplifying modifications to the CMM in order to increase the odds of adoption by ESC organizations. These modifications embrace the suggestions of Herrara et al., (2003) to reduce the high resource requirement and Richardson (2002) to focus on the most important software processes and ensure speedier return on investment. It is acknowledged that SPI structures adopted by an organization must be suited to the organization’s culture and social systems (Curtis, Hefley and Miller, 1995; Perry, Staudenmayer and Votta, 1994). Thus we also take into account the fact that ESC enterprises have little experience with SPI innovations; however, they have long embraced project management principles. These organizations may be in the equivalent region of CMM Levels 1 and 2.

Our proposed model will therefore include CMM levels 1 through 3. A clear inference from the limited survey of Jamaican organizations (and presumably other ESC enterprises) is that none employed the equivalent practices of a CMM Level 3 designee. Hence a reasonable short term objective would be to target progression to level 3 and, if necessary, gradually introduce more advanced practices from those key process areas.

<table>
<thead>
<tr>
<th>Major Areas</th>
<th># of KPA</th>
<th># of Questions</th>
<th># of KPA</th>
<th># of Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimizing</td>
<td>3</td>
<td>21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Managed</td>
<td>2</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Defined</td>
<td>7</td>
<td>45</td>
<td>5</td>
<td>39</td>
</tr>
<tr>
<td>Repeatable</td>
<td>6</td>
<td>44</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>Initial</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
<td><strong>124</strong></td>
<td><strong>9</strong></td>
<td><strong>75</strong></td>
</tr>
</tbody>
</table>

**Figure 2. The Modified CMM Framework**
Figure 2 denotes the simplifying modifications that resulted from the reduction of the number of maturity levels and the elimination of associated KPAs (and their corresponding questions) that seemed inapplicable in the ESC context. These KPAs were eliminated either because they were deemed more suited to large projects or because of possible cultural aversion to such practices in the ESC. In the structural components of the modified framework on the left, we have omitted “Common Features,” from the original model, which for our purposes would merely represent a classification scheme for “Key Practices;” an unnecessary complication for too little benefit. The effect of the total modifications we have made are illustrated in the tabulation on the right, which depicts the number of KPAs per level and their corresponding number of questions in the original and modified instruments. Table 1 then elaborates on the KPAs retained in the modified framework and describes their SPI aims.

<table>
<thead>
<tr>
<th>Key Process Areas</th>
<th>Aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Organizational Process Focus</td>
<td>Establish the organizational responsibilities for software process activities</td>
</tr>
<tr>
<td>3.2 Organizational Process Definition</td>
<td>Develop and maintain a set of software process assets that improves process performance across the projects</td>
</tr>
<tr>
<td>3.3 Training</td>
<td>Develop skills and knowledge of individuals so they can perform their roles</td>
</tr>
<tr>
<td>3.4 Software Process Management</td>
<td>Perform a well defined engineering process; integrate the software engineering and management activities into a coherent, defined software process</td>
</tr>
<tr>
<td>3.5 Process Modification</td>
<td>Modify process structure to fit project complexity</td>
</tr>
<tr>
<td>2.1 Software Requirement Management</td>
<td>Capture and manage requirements</td>
</tr>
<tr>
<td>2.2 Software Project Management</td>
<td>Provide planning, management structure and practices to successfully execute project</td>
</tr>
<tr>
<td>2.3 Software Quality Assurance</td>
<td>Establish quality criteria and metric for project deliverables</td>
</tr>
<tr>
<td>2.4 Software Configuration Management</td>
<td>Establish and maintain the integrity of the products of the software project throughout the project’s software life cycle</td>
</tr>
<tr>
<td>1.0 No KPAs for level 1</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Key Process Areas for Modified CMM

TOWARDS THE DEVELOPMENT OF A RESEARCH MODEL

In addition to the capability assessment role, we intend to use the modified CMM instrument for SPI research in ESC organizations. The nine SPI practices embodied in the modified KPAs will serve as independent variables and the characteristics of the ISO/IEC 9126-1 quality model (ISO/IEC 9126-1, 2001), the dependent variables. The ISO/IEC 9126-1 quality model is one of the popular frameworks for assessing the quality attributes of software. This model is shown in Figure 3. We have also eliminated one ISO/IEC quality characteristics - portability - which may not be a useful indicator of product quality for the relatively smaller systems in ESC organizations.

CONCLUSION

Small organizations in developing countries such as those in Jamaica and other ESC nations are as much in need of high-quality information systems as larger ones in the developed world. The latter have typically embraced SPI programs to assist in structuring their software processes to improve the product; smaller enterprises have not. This is because of the cost and complexities of initiatives such as the CMM that are used in SPI programs. We have therefore modified the CMM and its instrument to simplify it for use in Caribbean organizations and developed a research model to test the validity of the approach.
In future research we intend to compare the effectiveness of the modified CMM framework in comparison to the original model and validate and refine the proposed research model, which we plan to use to evaluate the effects of process capability on IS products in ESC organizations. We hope to contribute useful insights to practitioners and researchers in this region and other developing countries with similar problems. Beyond the immediate context of SPI and CMM, our work should help to provide answers to interesting questions such as the magnitude of the impact of particular software improvement practices on specific product quality characteristics, which could have importance beyond the boundaries of ESC organizations.

REFERENCES


