

December 2006

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Recommended Citation

Iversen, Jakob, "Potential for Improvement in Software Development" (2006). *MWAIS 2006 Proceedings*. 13.
<http://aisel.aisnet.org/mwais2006/13>

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Potential for Improvement in Software Development

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ABSTRACT

This article reports the results of a survey among eight software developing organizations, most of which are based in North East Wisconsin. The survey examined how the companies develop software, what they do to improve their development processes, and the respondents' general knowledge of improvement models. The survey results show that while large companies generally are well aware and use the improvement models, smaller companies don't have formal improvement programs and don't have much knowledge of improvement models, such as the Capability Maturity Model.

Keywords

Software development, Software process improvement

INTRODUCTION

Software-developing organizations are still experiencing problems in meeting the demands for rapid development of high-quality software products. One strategy that has emerged over the past decade to improve productivity, quality, and adherence to schedule and budget in software development is *Software Process Improvement* (SPI). This approach uses continuous improvement of a wide range of activities from basic project management disciplines like project planning and tracking to continuous defect prevention and controlled changes of development processes by everybody involved in executing those processes (Aaen, Arent, Mathiassen, and Ngwenyama, 2001; Grady, 1997; Humphrey, 1989).

A significant research effort has been directed at understanding how SPI programs operate (Aaen et al., 2001; Mathiassen, Pries-Heje, and Ngwenyama, 2001; Paulk, 1996), what risks are associated with them (Iversen, Mathiassen, and Nielsen, 2004), and what benefits can be derived (Emam and Briand, 1997; Herbsleb, Carleton, Rozum, Siegel, and Zubrow, 1994). However, most studies have only looked at a very small number of organizations (Diaz and Sligo, 1997; Dion, 1993). Only a few studies have involved a larger number of organizations (Emam, Goldenson, McCurley, and Herbsleb, 1998; Goldenson and Herbsleb, 1995; Herbsleb et al., 1994), and although SPI is applied in a wide range of settings, no studies have attempted to comprehensively evaluate the penetration of SPI practices across the industry. This research seeks to close that gap. By studying a cross-section of organizations in Northeast Wisconsin engaged in software development I have been able to examine what proportion of organizations are engaged in organized improvement activities and whether these activities are based on models such as the Capability Maturity Model (Paulk, Curtis, Chrissis, and Weber, 1993).

The purpose of this project is to understand how software is currently being developed by organizations in the Northeast Wisconsin region and what improvements efforts are in place. To support this goal, several interviews were conducted to answer the following specific questions:

1. *How is software currently being developed?*
2. *What is being done to improve the current processes?*
3. *How aware are software managers in the region of the potential for further improvement?*

RESEARCH METHODOLOGY

Respondents were selected from the membership list of the MIS Advisory Board for the College of Business Administration. This board consists of high-level IT managers in most of the companies with IT activities in the region. The board members represent a large cross section of the IT industry in the region. I invited 15 members to participate via email, and eventually interviewed at seven organizations.

In order to ensure consistency across the interviews but still allow for flexibility I chose to develop an interview guide (Patton, 1990). During each interview, I took notes directly on the interview guide and audio recorded each interview for later analysis. In addition, the web site for each company provided supporting insights about the company.

As a first step in analyzing the data, I wrote a description of each company and their software development and improvement processes as presented through the interviews. Then I completed a table comparing all the companies on several categories: Annual Revenue, Number of employees, Number of IT Employees, Number of software developers, Types of systems developed, Development environments, Development methodology, Level of professionalism, Improvement processes, Improvement budget, Known improvement models, Maturity assessment result, Software metrics, and Metrics process. The comparison table is included in Appendix B.

RESULTS

Several findings emerged from conducting the interviews and analyzing the data. In this section, I will present and support these findings.

Software Process Improvement Doesn't Play Prominent Role

Most of the respondents had heard of SPI and models like CMM, but only two organizations had formalized improvement programs.

Finding: Most companies do not have formal improvement processes

Only two out of seven companies had formal improvement programs, both of which were based on the CMM model. The remaining organizations, treated improvement as an ad hoc activity, which was either left up to individual projects entirely or was treated at staff meetings where managers might encourage developers to adopt new practices.

Unless an improvement effort is supported by senior management and developers, has dedicated resources, and has people in charge who care about improvement, such an effort is very likely to fail (Mathiassen et al., 2001). However, in most of the companies surveyed here, lack of improvement would likely not be considered a failure, as structured improvement programs for most of the organizations was not even considered as an option.

Finding: Large companies are more likely to have formal improvement processes

The two largest companies in the study, Kimberly-Clark and SBC, are an order of magnitude larger than the third largest company, both in terms of total employees, IT employees, and revenue. These two organizations are the only ones with formal improvement processes and dedicated resources for improvement. While small companies can certainly run successful improvement programs (Brodman and Johnson, 1994; Kautz, 1998; Kelly and Culleton, 1999), this finding is in line with the roots of the CMM, which was originally developed to support large defense contractors and also supports one of the most common criticisms of the model (Jones, 1995).

Finding: Companies that do not have formal improvement programs know very little about CMM and other models.

The interviews revealed clearly that most organizations have very little real knowledge of the various models that are available to assist organizations in conducting improvement efforts. While some interviewees had heard of the CMM model, only those who actually used it had any real idea of what the model was and how it could be used.

Adopting a maturity model such as CMM to guide improvement work can be a large and complex undertaking (Aaen et al., 2001), since following such models is likely to lead to significant changes to large parts of the organization. Some of these changes may be quite disruptive. However, there is mounting evidence that even in small organizations, there are strong positive benefits associated with structured improvement programs (Kautz, 1998).

Finding: Metrics collection and usage is very low

While most of the companies interviewed said they collected metrics, this mostly amounted to just recording time spent on individual tasks. Only the two large companies had any systematic metrics collection in place. This finding is consistent with the adoption of improvement programs. Metrics programs are at least as difficult to sustain successfully as are software process improvement programs. Most SPI programs also involve some emphasis on measurement, although it often doesn't play a major role until an organization has reached a certain maturity level (e.g. level 4 in CMM). This is very evident even between the two organizations with an SPI program. Kimberly-Clark is moving towards level 4 and has an extensive set of

metrics, focused on measuring earned-value for each project. On the other hand, SBC, which is at level 2 has a smaller and simpler set of quality assurance metrics. These metrics efforts help Kimberly-Clark and SBC inform their improvement programs.

Perception Vs. Reality

Finding: Companies are confident they work professionally

The interviewees expressed great confidence in their organization's ability to develop software. However, there was great variability in the basis for these statements. The larger companies based their confidence on their formalized processes and improvement programs, whereas the smaller companies felt certain that too much method would only be a bureaucratic hindrance to do real work. For instance, at JJ Keller, the process was described by the following quotes:

"I think [the process] is more on the professional side. Again, depending on the size of the project, we'll tilt it more toward the ad-hoc. But I don't believe we're chaotic – not in constant crisis mode. But it's not very formal."

"One of the things we struggle with is the formal paperwork that has to be completed, 'does that become the project?' versus just making the change and getting out and getting it implemented"

Oracular, the consulting outfit often works methodically, but also is under pressure from customers to get systems up and running:

"We try to go for the structured, methodical, stepping through the process ... But if someone just dropped \$400,000 on software, the last thing they want is to hear that you have to go through four weeks of requirements gathering and the software isn't going to be installed until you architect everything – they want to see that software up on the server by the end of the week."

Room for Improvement

Finding: Most companies believe they can do better

While they were certain that they did a good job, most interviewees also recognized that there were areas that could be improved. During the interview, each respondent was presented with the full list of key process areas from CMMI (CMMI Product Team, 2002). This list has 22 process areas that a software-developing organization can be evaluated on according to the CMMI model. Based only on the titles and a brief description, all respondents were able to classify the list into strong and weak areas for the organization. While this in no way constituted a maturity assessment (Nielsen and Pries-Heje, 2001), it still illustrated that while none of the respondents considered their development efforts to be chaotic or ad hoc, they still found ample room for improvement when going through the list.

CONCLUSION

Based on this study, it is clear that efforts to improve the software development field through software process improvement have failed to reach many small development organizations. In these organizations, managers are largely unaware of the methods for improving processes and their associated benefits and challenges. In order to improve the field, a much larger emphasis must be placed on educating smaller organizations.

Furthermore, it is unclear whether the current models and their presentation are amenable to most small organizations. It is unrealistic to expect organizations with only a few software developers to hire expensive consultants or attend multi-day seminars in exotic locations to learn about the latest developments in improvement methodologies. While it is valuable that the entire text of the CMMI model is available online, it isn't feasible for practitioners to study and understand this model and adapt it to their organization without external assistance. This information needs to be brought closer to home and be delivered through pre-existing organizations and publications that managers in these organizations are attuned to.

This research also raises several questions to pursue in future research. With only seven companies, it is natural to expand the data collection to include more companies. With companies largely in the local area, it may also be relevant to determine whether the economic and business climate of the region has influenced the findings. It would also be highly relevant to examine what information resources IT professionals in small organizations use to further their understanding of the field. What is the content and aim of those information sources? By using these sources, are managers able to be adequately informed about current developments in the field.

It would also be interesting to find out what advantages and benefits Kimberly-Clark and SBC have realized through their SPI programs, and whether the smaller companies would be able to realize similar benefits. It is possible that the larger companies have problems that are significantly different from smaller companies, such as differences in coordination, that the experiences cannot be realistically compared.

One early goal of this research was to be able to establish a Software Process Improvement Network (SPIN) (Institute, 2005) in the area to allow for exchange of experiences with software process improvement. Given that only one of the companies in the area¹ has an ongoing SPI project, it appears that this is something that area businesses have not focused on. This may on the one hand mean that there is good potential for making improvements. On the other hand, it may be difficult to engage organizations in the rigors of SPI since there is so little focus and knowledge of SPI among software developing companies in the area.

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¹ The closest development center for SBCs Billing Group is in Milwaukee and the SPI group is in Chicago.

APPENDIX B. OVERVIEW OF COMPANIES INTERVIEWED

	<i>Oracular</i>	<i>J.J. Keller</i>	<i>SECURA</i>	<i>Oshkosh Truck</i>	<i>Oshkosh B'Gosh</i>	<i>Kimberly-Clark</i>	<i>SBC</i>
<i>Annual Revenue</i>	??	??	\$300 million (direct written premiums)	\$1.9 billion	\$417.3 million	\$14.3 billion	\$41 billion
<i>Company descr./industry</i>	Independent consulting firm	Assists companies with safety and compliance	Insurance	Heavy-duty truck manufacturing	Clothing	Personal hygiene products	Telecom
<i># Employees</i>	100	950	450	6,000	4,690	62,000 worldwide, 24,000 North America	167,000 worldwide,
<i># IT Employees</i>	2 (operations)	52	75	85	39	1100 worldwide, 600 North America	13,000
<i># SW developers</i>	85	22	41	20	16	300 (Greg manages 80 people)	9,000 (3,000 in Billing)
<i>Types of systems developed</i>	ERP, web systems (and many others).	Supply chain, services, some web based. Develops for both internal and customer use.	Administrative back-office. Web system for agents. All internal use.	COTS, ERP, Front-ends	Back-office administrative, COTS	Administrative. Back-office. All internal.	Administrative
<i>Development methodology</i>	Own in-house methodology (waterfall). Often uses client methodology. Has electronic templates for documents.	Based on work requests describing ROI. Projects > 200 hrs need req. document and scope. Sometimes using MS Project on larger projects., and Excel to track projects.	In-house methodology, project dependent. Waterfall.	No defined methodology. Looking at defining one.	Standard manual describing the process – waterfall.	Standard methodology. Methodology team delivers templates for different project types. Templates online. Integrates with PM tool (Niku).	Standard methodology. Waterfall model. Standardizing vocabulary. Written manuals.
<i>Improvement processes</i>	Nothing structured	Informal at staff meetings.	Individual projects.	Mgmt. suggests standards to put in place.	'Practice makes perfect'	Dedicated methodology team	Focus on standardization of disparate business units
<i>Improvement budget</i>	Respondent didn't know	N/A	Respondent didn't know	Respondent didn't know	N/A	1.5% of development budget	1.6% (dedicated resources in Billing)
<i>Known models (bold: in use)</i>	ISO 9000, PSP, TSP, Malcolm Baldrige, ADA compliance.	ISO 9000, Malcolm Baldrige. Best practice SAP implementation, ASAP, ISO 14000.	CMM, ISO 9000, Malcolm Baldrige, Outside agencies.	MethodOne (Arthur Anderson)	CMM, ISO9000, Malcolm Baldrige, Financial audits	CMM	CMM
<i>Software metrics</i>	No	Time spent Estimates	Schedule, budget, and customer expectations.	No	Time	Earned-Value. Moving to quality metrics (reliability, #errors)	SQA metrics
<i>Metrics process</i>	N/A	Time accounting system	Developers report time in online tool based on tasks.	N/A	Collected through PM tool.		Varies by source