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Abstract

Although nearly everyone agrees that the collection and analysis of metrics is highly beneficial to software development and maintenance organizations, this process remains difficult for many of those organizations. The purpose of this paper is to describe a practical set of metrics that are focused on customer satisfaction and that are easily understood by both customer and developer organizations. The goals and concepts related to these metrics are presented in a framework designed to establish compliance mapping with the Software Engineering Institute's (SEI) Capability Maturity Model (CMM®) for software.

Introduction

The systematic collection and analysis of appropriate metrics can be an invaluable component of a rigorous feedback and control process whereby software development and maintenance organizations are able to verify that performance levels are within the bounds of established customer expectations. Metrics programs, however, have been notoriously difficult to implement in many organizations and, in many cases, have not progressed beyond simple measurements of schedule, cost, and level of effort. While these basic measurements provide some project management guidance, they are often insufficient in providing strong evidence of customer satisfaction.

The software Capability Maturity Model (SW-CMM®) developed by the Software Engineering Institute (SEI) requires the basic metrics set of schedule, level of effort, size, and critical computer resources just to reach CMM® Level 2. Part of the rationale behind this set of metrics is that measurement baselines need to be established for individual projects so improvement goals can be established for each project in these areas. At CMM® Level 3, the Software Engineering Process Group (SEPG) is systematically analyzing this data, which now resides in an organizational database, to design and implement organization-wide improvement plans that target these specific areas, e.g. increased schedule control and predictability.

While these measurements and these improvement efforts are certainly translatable back to customer satisfaction, schedule issues are only one quality area in which customers now have high quality expectations. The CMM® Level 4 Key Process Areas of Quantitative Process Management and Software Quality Management drive software development and maintenance organizations to more fully identify and then meet customer expectations of quality. The data collected and analyzed by higher maturity organizations are frequently utilized to educate and fully inform the customer on standard control limits, identifying variations away from these control limits, and courses of corrective action for when these variations occur. As a result these metrics are highly influenced by customer expectations of quality in many areas.

This paper presents a set of metrics that can be gathered while organizations are at Levels 2 and 3 of the CMM® but that are also highly useful for Level 4 efforts. These metrics are focused on maintaining control over customer expectations by providing both developer and customer organizations with an ongoing report of contract compliance.

Background

There has been a good amount of recent discussion on the practical implementation and use of metrics as organizations attempt to gain a quantitative understanding of their software projects. Daskalantonakis (1992) provides a multidimensional view of metrics that encompasses usability, categories, users, user needs, and levels of metrics in the context of a widespread and successful organizational metrics program. His conclusion is that metrics can only show problems and that it is the actions taken as a result of analyzing the measurement data that produces results. Also, Schneidwind (1992) proposes a comprehensive metrics validation methodology to integrate quality factors, metrics, and quality functions. Criteria such as consistency, predictability, and repeatability are identified as critical to the success of a metrics program.

Metrics programs are currently receiving increased attention as many organizations attempt to achieve Level 4 in the CMM® (Chatmon & Holden, 1999; Felschow, et al, 1999; Florence, 1999; Harvey, 1999; Natwick, 1999; Purcell, 1999). These authors all describe current efforts at implementing metrics programs within their organizations. Common themes include identifying the business value of the metrics, establishing quality goals and insuring that the data provide consistent information.

The following sections of this paper present components of a metrics program that is in place at a large

IT consulting organization that emphasizes customer-focused quality.

Project Control and Reporting Process

The Project Control and Reporting Process (PCRP) defines a set of standards that identify critical measurement points before, during and after a project. The PCRP standards are focused on assuring the stage is set for on time, on budget delivery of a quality product with pre-established acceptance criteria.

At a high level, the PCRP standards define:

Project Initiation: Establish the project management environment during Project Initiation. Control points include the statement of work, project plan and risk assessment profile.

Project Execution: Monitor and control the project during execution through weekly status reporting, weekly client status meetings, change control, acceptance process, project summary display (PSD), and project plan updates.

Post Project: Close out the project by finalizing and archiving the Project Notebook and other key assets used to manage the project.

Adherence to the PCRP standards is verified on a quarterly basis, through a formal auditing process. Results are documented on a compliance assessment form, called the PCRP Report Card. The report card provides a consistent means to identify and assess strengths and weaknesses across all levels of the organization, so that additional training or support can be provided where necessary. Each standard is rated by the auditor on a scale of 1 (poor/ unacceptable) to 4 (excellent/fully meets requirements).

Project Status Display

The Project Status Display (PSD) enables project managers to track and report project status at a deliverable level. The PSD is maintained with an Excel workbook, consisting of the following worksheets:

- Project & Billing information
- Planned resources, billing rates and weekly hours
- Actual resources, billing rates, actual and estimate-to-complete hours.

The Project Status Summary (PSS) contains the planned start and end dates, effort and cost estimates and actuals for each deliverable defined in the statement of work and the project plan Summary Sheet which contains graphical and tabular summary of the project's value and actual cost, as well as the project's variance analysis and change control notes.

PSD updates are required on a weekly basis, and are reviewed by senior management monthly. Significant variations between planned and actual performance must be addressed by project management through a formal action plan.

Quality of Service Surveys

Quality of Service surveys are distributed quarterly to individuals in customer business units. The QSR consists of a standard set of questions designed to assess what went well and what did not during the specified period, so that best practices and opportunities for improvement from a customer perspective can be identified and addressed. End Users are asked to rate the quality of service provided on a scale of 1 (poor/ unacceptable) to 5 (excellent/exceeds expectations).

Typical questions include:

- To what extent were expectations met?
- How well were requirements met?
- What is your satisfaction with the professionalism of the team?
- To what extent were you kept informed of the status of your request?
- Was your request fulfilled properly the first time?

Service Level Agreement Metrics

The Service Level Agreement (SLA) is an essential tool for managing service-based projects. It defines the scope and objectives of the project in terms of services that will be provided to the customer, the volume of work products that will be delivered, and acceptance criteria for responsiveness and quality of deliverables. The SLA assigns priorities to the services provided, and establishes baseline service standards and commitments. It becomes the reporting vehicle for performance measurement and provides the opportunity to identify service level improvements throughout the project. Below are suggested minimum metric components of a SLA.

Activity: Production Support
Cost: # of hours; % of effort
Quality -- Cycle Time: Average Time to Respond; Average Time to Resumption of Business
Quality -- Volume: # of calls; Hours of Operation

Activity: User Support
Cost: # of hours; % of effort
Quality -- Cycle Time: Average Time to Respond on shift/off shift; Average Time to Resumption of Business
Quality -- Volume: # of calls; Hours of Operation

Activity: Maintenance Requests
Cost: # of hours; % of effort
Quality -- Cycle Time: % Complete by Due Date
Quality -- Volume: # of Requests Completed; # of Defects per Request

Activity: Enhancement Requests
Cost: # of hours; % of effort
Quality -- Cycle Time: % Complete by Due Date

Quality -- Volume: # of Requests Completed; # of Defects per Request

Activity: Development Requests
Cost: # of hours; % of effort
Quality -- Cycle Time: % Complete by Due Date
Quality -- Volume: # of Requests Completed; # of Defects per Request

Activity: Management Control
Cost: # of hours; % of effort

Software Quality Assurance Audits

SQA audits primarily focus on compliance to defined processes. To provide maximum business value, processes which will be included in the audit schedule are mutually agreed to by SQA and project management. Non-compliance issues identified during an audit are analyzed to determine whether:

- any steps in the process were skipped
- any steps not defined in the process were performed
- the order of execution was changed

Analysis of these points provides a solid basis for determining whether process improvements are indicated, and appropriate recommendations can be made to the Software Engineering Process Group (SEPG).

Other SQA responsibilities include tracking, trending and analysis of:

- Defects identified through peer reviews (# of defects, type, severity, SDLC phase) as a means of providing management with insight into areas where process improvements may be indicated, or additional training for the team is needed.
- Test defects (# of defects, type, severity)
- Post-implementation rework (# of items returned, type, origination)

Evaluating Metrics

No metric is useful unless the organization can identify the business value it provides. Frequently cited indicators of business value for metrics are (Humphrey, 1989; Paulk, 1999):

- Is the metric a good indicator of how well the process is performing, e.g., an indicator of efficiency or effectiveness?
- Can the values for this metric be predictably changed by changing the process or how the process is implemented?
- Can the metric be consistently reproduced by different people?
- Can data be collected and analyzed such that you can predict and/or control process performance?
- Is the data relatively easy and cost-effective to obtain?
- Is the metric one that the customer thinks is an important indicator or process and/or product quality, e.g., an indicator of reliability?
- Is the metric one that the customer requires be reported?
- Is the metric one that the end user thinks is an important indicator of process and/or product quality, e.g., an indicator of usability?
- Is the metric one that senior management thinks is an important indicator of process and/or product quality?
- Is the metric one the organization requires to be reported, i.e., is it one of the common, standard measures defined for the organization?
- Is the metric one that the project manager thinks is an important indicator of process and/or product quality, e.g.,. an indicator of progress?

Conclusion

Metrics have little value if they are not aligned with the business objectives of the organization at large and are useful and consistent on the project level. In addition, customer satisfaction plays an increasingly larger role in quality measures. As organizations attempt to progress up the CMM® maturity levels, they must insure that they are capturing the useful metrics, analyzing them in a consistent manner and then taking appropriate actions as a result of the analyzed data. The metrics framework presented in this paper illustrates how one large IT consulting organization is using metrics to provide both internal and customer-focused feedback on core operating procedures. It is also clear that this metric framework meets many if not all of the evaluation criteria specified in the previous section.

References

References available upon request.