

# Measurement for Process Improvement

*Technical Report Prepared by*

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## **1. BACKGROUND AND INTRODUCTION TO THE PAPER**

Activities in the Practical Software and Systems Measurement (PSM) community since 1998 have formed the basis for this guidance on measurement for process improvement (PI). Teams met during PSM User Conferences and at PSM Technical Working Group Meetings to discuss the needs for measures, tailor existing PSM guidance to suit process improvement, draft new measurement categories, and explain example measures being used in their organizations for handling process improvement.

This paper consolidates the output of those sessions, leveraging the most recently published PSM guidance for software and systems projects for any kind of organization. This material may be used with process improvement efforts of many different types and sizes: individual improvement projects, programs of projects, and small process improvement team activities.

Individuals who are planning a PI project, acting as sponsors of a PI project, or working in the role of measurement experts for an organization or PI project will be able to use this paper as input to their work. The paper includes the following sections and appendices:

- Areas of Measurement for Process Improvement – a brief description of the primary areas of PI work that have needs for measures
- Measuring the Value of Process Improvement – a primary area of measurement needs, to understand the rationale for a process improvement project, and to monitor how well the PI effort meets the goals for the business
- Measuring Readiness for Process Improvement – an area of measurement that examines the organization’s capability for change and for taking on an improvement effort
- Measuring Process Improvement Progress - like any other project, this area of measurement examines the progress of an improvement project against its plan, as well as looking at its progress in meeting overall goals
- References – Books and Web Sites - primary sources used for the paper and referenced by the paper, with web sites that provide information about the concrete benefits of process improvement; provided as a starting point for the reader
- Appendix A – the information categories and major questions addressed by PSM for software and systems projects, provided as a reference that applies to all projects
- Appendix B – the common information categories, measurable concepts, and prospective measures used by PSM for software and systems projects, most of which also apply to PI projects
- Appendix C – Example Cost Benefit Analysis Form , which can be adapted to meet the needs of PI projects
- Appendix D – Example Process Improvement Risk Factors – a set of risks often seen in organizations pursuing process improvement
- Appendix E – Process Improvement Measurement Specifications – list of and specifications for new measures which are useful for PI measurement, being added to the PSM collection

While the paper is expected to be useful to any reader seeking information about best practices for PI measurement, the reader should also be familiar with the PSM guidance for software and systems projects, available in book form or at the PSM web site (see References for details).

## 2. AREAS OF MEASUREMENT FOR PROCESS IMPROVEMENT

The objectives and issues related to process improvement drive the measures required, as shown in Figure 2-1. Measures are generally needed in these areas:

- Anticipated value of the process improvement project, to justify doing the project
- Readiness of the organization for process improvement
- Progress of the process improvement project, examining both progress to performing the planned work (progress to plan) and progress in attaining the anticipated value (or results)

Organizations tend to have common categories of information needs regarding process improvement, with common questions to be answered for these categories of needs. The measures of *value (or results)* that organizations use for business impact and for monitoring progress to their business goals are quite diverse. These measures tend to fit into categories of both “hard” measures like financial return and “soft” measures like improvement to employee morale. *Readiness* measures are useful to ensure the organization is prepared to make improvements, although current use of such measures is relatively rare. Most measures of *progress* to plans for process improvement projects are similar to those used with software and systems projects. [See Appendix A and Appendix B for the common questions addressed and measures used for software and systems projects.]

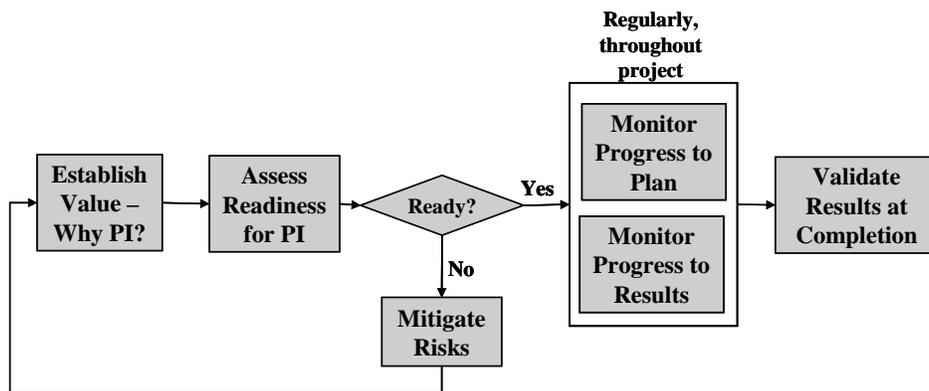


Figure 2-1 The Flow of Measurement Support for Process Improvement Projects

### 2.1 VALUE (RESULTS) OF PROCESS IMPROVEMENT PROJECTS

As with its other project investments, the resulting business value is used by an organization to justify the time and effort to be spent in a process improvement (PI) project. In many organizations, improvement projects are handled through regular portfolio management; therefore, an improvement project needs to have a sound business case to gain and maintain resources. This type of management care ensures that there is organizational commitment to the project for documented business reasons - a key to success for any process improvement effort.

[See an example cost-benefit analysis form in Appendix C; this example might be evolved to build a PI business case.]

The business case used to justify the process improvement project may identify measurable impact in a variety of performance measures – for projects, organizations, and the enterprise as a whole. In addition, there may be measures of value to the process users, often exemplified in adoption or compliance measures that show the new processes are both used and useful. Both impact and adoption measures are used to provide motivation for change, compare results of alternate approaches, ensure ongoing value of the ongoing investment, and meet a variety of other organization-specific needs.

Categories of information, common questions to be answered, and examples of candidate measures are discussed further in the section *Measuring the Value of Process Improvement*. In general, the material in this area is applicable to software and systems projects as well as process improvement projects.

## **2.2 READINESS FOR PROCESS IMPROVEMENT**

While the justification for a PI project may be clearly established, the current business situation, social environment, personnel situation, or some other factors may argue against starting a project at a particular time. The organization's level of alignment and commitment is also key to its readiness for improvement, often exemplified in the involvement of various levels of management. The risks to success may be such that the project should be put on hold until conditions change significantly.

Organization alignment, risks to be addressed, common questions to be answered, and some mechanisms for identifying and analyzing them are discussed further in the section *Measuring Readiness for Process Improvement*.

## **2.3 PROGRESS WITH THE PROCESS IMPROVEMENT PROJECT**

Process improvement programs are performed using one or more projects throughout the duration of the improvement program (which may continue for the lifetime of the organization). The progress of any improvement project against its plan can generally be measured using the PSM guidance for projects and programs. While all of the standard Information Categories apply, some of the questions addressed for software and systems projects need special interpretation for process improvement (PI) projects. Similarly, some of the Measurable Concepts need to be interpreted in the light of special PI project needs. Some of the measures used by software and systems projects apply directly to PI projects, some need to be tailored, and others are not relevant.

The section *Measuring Process Improvement Progress* describes which Information Categories, Measurable Concepts, and Candidate Measures for software and systems projects apply to PI projects, and how they need to be interpreted.

## **2.4 PROGRESS ACHIEVING PROCESS IMPROVEMENT VALUE (RESULTS)**

In addition to monitoring how well the project is handling its planned activities and commitments, it is important to be monitoring progress to the business case, performance baseline, or other business results projected for the project.

The section *Measuring the Value of Process Improvement* describes Information Categories, Measurable Concepts, and Candidate Measures for monitoring progress to showing value in-process, as well as at the end of the process improvement project. It is very useful to have measures providing evidence of positive business impact early in an improvement project, to ensure that the investment is having a useful effect and to provide motivation to continue the project. As business needs change, the improvement project and its associated measures may also need to change; having a way to monitor results in-process helps ensure that the improvement project stays well-aligned with business needs.

## **3. MEASURING THE VALUE OF PROCESS IMPROVEMENT**

This area of measurement focus establishes the business case for the PI project, using the investment costs and the primary business benefits to be achieved. The business case needs to be visible, realistic, and actively monitored throughout the project.

The issues addressed by this information category are those needed to justify and continue investing in a process improvement project, providing data needed to

- compete against other projects for priorities and funding
- decide whether or not to continue the project, once underway
- accumulate historical data for estimates for other projects
- demonstrate having met the objectives

In most cases, a baseline needs to be set, enabling development of reasonable targets for improvement goals. Sometimes that data already exists, but in other cases, the first measurement activity is to understand the environment and collect the initial baseline. Common elements in such a baseline are shown in Figure 3-1.

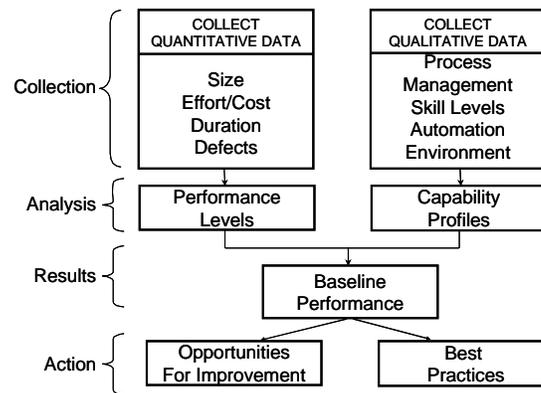


Figure 3-1 Developing a Baseline for Process Improvement (derived from David Consulting Group, Inc. 2004)

### 3.1 PROCESS IMPROVEMENT VALUE (RESULTS) INFORMATION CATEGORIES AND QUESTIONS

While there are many ways to describe costs and benefits of performing a process improvement project (or any other kind of project), at an abstract level the key questions are these:

- What is our current performance?
- What are our performance goals?
- What business benefit will we achieve as an outcome from the project?
- What is the cost of this project?

For PI projects in any organization, the primary cost is the time and effort required for people to perform the improvement work, to deploy the results into the organization, and to learn to use the new process materials. In addition, there are generally investments in tools (and supporting systems), training, measurement (appraisals, assessments of progress), and (internal or external) consulting guidance from subject matter experts.

The benefits from PI projects include outcomes that demonstrate a clear return on investment – added revenue to the organization; new knowledge or capability; improvements to cycle time, product quality, productivity, customer satisfaction, and/or cost. Specific benefits can be identified using questions that generally fall into one of these areas:

- Financial results
- Customer satisfaction
- Internal business processes
- Learning and growth of the organization

The Balanced Scorecard Measurement framework<sup>1</sup>, along with strategy maps, provides a basis for using PSM to generate a useful set of questions and measures to support an organization's goals and strategies.

<sup>1</sup> See Kaplan and Norton books in the References section.

The measurable concepts identified for the Process Improvement Justification information category are these, derived from the Balanced Scorecard:

- Financial – financial goals and benefits from the project
- Customer Satisfaction – satisfying both internal and external customers, generally interested in things like price/performance, mean time to failure, response time to requests, etc.
- Internal Business Processes – improved practices and methods to develop, maintain, and deliver products and services, as well as to manage the people in the organization
- Learning and Growth – improved people-related capabilities of the organization, such as technical skills of the staff, the number of staff, the level of domain knowledge, personnel turnover and morale, etc.

Questions that might be asked about these concepts are provided in Table 3-2 below:

Candidate Questions Being Addressed by Measures		
Information Categories	Measurable Concepts	Questions Addressed
Process Improvement Results	Financial	How much will this project cost? What is the impact of not doing this project? What financial benefit will we achieve? What financial burden will we avoid? What impact will there be to our market share? What impact will there be on the organization assets, e.g., the Total Cost of Ownership of our technology assets? Is the value increasing over time?
	Customer Satisfaction	Will this increase customer satisfaction? Will this reduce the level of required customer support? Will this help us address <specific customer concerns>?
	Internal Business Processes	Will this improve our ability to meet customer goals or needs? Will this improve our time to market? Will this improve our product or service quality? Will this improve organization efficiency? Will this improve organization effectiveness? Will this improve our ability to manage objectively? Will this reduce our cost of quality? Will this increase our predictability?
	Learning and Growth	Will this improve our workforce capability? Will this help us attract or keep talent? Will this help our resource utilization? Will this help our company morale? Will this help employee satisfaction? Will this increase our management capability? Will this improve our employee/manager ratio?

Table 3-2 Candidate Questions Being Addressed by Measures

### 3.2 PROCESS IMPROVEMENT VALUE (RESULTS) ICM TABLE

The information needs in this area can be met by some of the existing PSM measures, but several additional measures are needed, shown in Table 3-3, Information-Concept-Measure Mapping, in bold italic font. The new measures are defined in the individual specifications in Appendix E.

Information - Concept - Measure Mapping		
Information Categories	Measurable Concepts	Prospective Measures
Process Improvement Results	Financial	<ul style="list-style-type: none"> <li>• Cost               <ul style="list-style-type: none"> <li>○ Amount invested (project, inventory and other costs – including personnel effort)</li> <li>○ Opportunity cost (lost revenue or other costs not avoided, by not spending the time or money on this or another effort)</li> <li>○ Savings (e.g. effort costs, capital investments, ongoing support, etc.)</li> </ul> </li> <li>• award fee</li> <li>• <b>revenue</b> from sales, ongoing support, license fees; revenue in order backlog</li> <li>• <b>market share</b> (e.g. % of available market; number of new customers; level of repeat business)</li> <li>• derived measures such as asset value (cost of various assets, adjusted for time held), contribution to asset value; return on net assets; Total Cost of Ownership</li> </ul>
	Customer Satisfaction	<ul style="list-style-type: none"> <li>• satisfaction ratings (e.g. customer survey results)</li> <li>• problem reports (e.g. number of complaints or service calls)</li> <li>• effort (e.g. support hours)</li> <li>• measures of specific customer concerns (e.g. call center response time)</li> </ul>
	Internal Business Processes	<ul style="list-style-type: none"> <li>• aggregation of all standard project measures across the organization of interest (e.g. Schedule and Progress, Resources and Cost, Product Size and Stability, Product Quality, Process Performance, Technology Effectiveness, Customer Satisfaction)</li> <li>• derived measures from project measures (e.g. time to market, <b>cost of quality</b>)</li> <li>• derived measures from process measures (e.g. capability baselines composed of aggregate project measures, process capability – current measure of level of performance to baselines and targets)</li> </ul>
	Learning and Growth	<ul style="list-style-type: none"> <li>• experience level (e.g. # of certifications, degrees, years of experience; domain coverage; technology coverage)</li> <li>• staff level (e.g. current employees, managers; number who have left)</li> <li>• staff turnover</li> <li>• satisfaction ratings (e.g. employee survey)</li> <li>• problem reports (e.g. suggestions in the suggestion box; comments in 1-1 session)</li> </ul>

Table 3-3 Information - Concept - Measure Mapping

### 3.3 EXAMPLE PROCESS IMPROVEMENT VALUE (RESULTS) MEASURE – COST OF QUALITY

While the financial measures used by organizations vary considerably in the entities and attributes used, a measure of Cost of Quality is usually focused on the same data in any organization: the effort (time) data for work done in the organization. This data is also critical to many other measures of progress, so it is likely to be available in some form.

The example shown here reflects a goal of many organizations to reduce the cost of rework (also known as nonconformance). (See the related definitions in the Appendix of measurement specifications.) In many organizations, as much as 40% of its work effort is wasted in reworking products with defects and providing customer support to customers who experience problems because of defects. In addition, when staff are unexpectedly diverted to the rework efforts, they cannot complete current work on time, further aggravating the effect of rework.

The model behind this measure of rework is a variant on Crosby's Cost of Quality model<sup>2</sup>, which has four dimensions of cost:

- Cost of Performance – cost to develop and provide a product or service, focused on those activities that plan and handle the work
- Cost of Prevention – cost to establish and maintain processes for doing the work, training for those who perform the work, and other enablers
- Cost of Appraisal – cost to review products and services under development, to be sure they meet requirements and conform to the processes
- Cost of Nonconformance (Rework) – cost incurred to deal with defects in the product or service, including the rework of the product/retesting/review, etc., as well as the cost for customer support or help desks, payment of penalties and fines, and other costs associated with the effect of defects

In systems and software organizations, most of these costs are directly attributable to effort of the people doing the work of the organization, thus the measure is essentially a productivity measure. When the cost of rework is driven low, staff is available to contribute its effort to the productive work of building and delivering products and services.

In Figure 3-4 below, an organization might be updating its process set to improve its ability to review work in progress, to better estimate and track its work, and to train its people in the processes. Thus, there is likely to be an increase in the effort going into the Cost of Prevention and Cost of Appraisal, which should lead to a reduction in the Cost of Nonconformance (Rework) and an increase in effort available for the Cost of Performance. The chart shows six months of progress, to a target of reducing cost of rework by 5% for the year.

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<sup>2</sup> Crosby, Philip. *Quality is Free*. New York: New American Library, 1979.

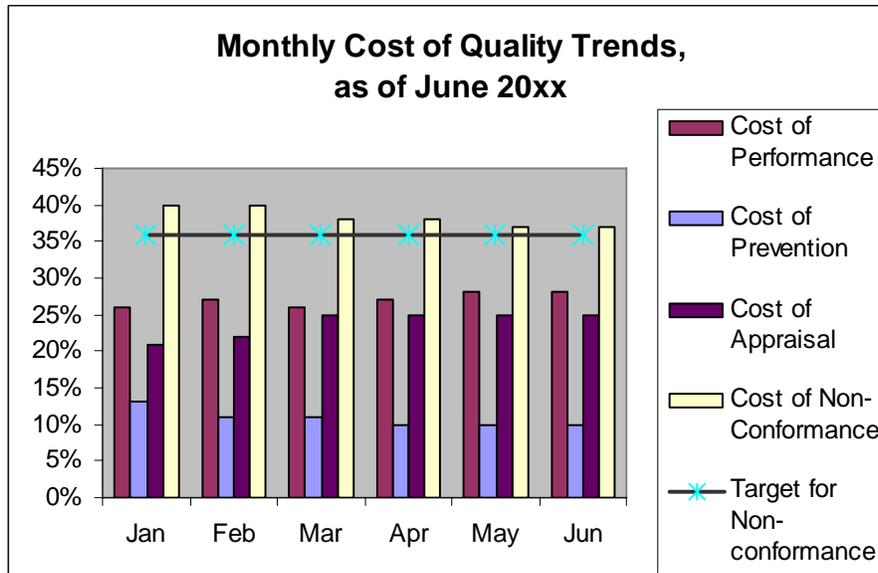


Figure 3-4 Example Results Measure – Cost of Quality Trends

#### 4. MEASURING READINESS FOR PROCESS IMPROVEMENT

Handling the risks to process improvement projects is essential, and readiness measures are useful to establish the level of risk as a project is initiated. Failures of PI projects are expensive not only in the time and effort wasted, but in the loss of motivation for future process improvement in the organization. Organizational change is difficult, and people will strongly resist a new change initiative if they feel they've wasted their time on prior ones, and organizational conditions are still the same.

Measures for this area might be used before, during, or after justification of the project. They may also be helpful when significant organizational changes occur as a PI project is underway. Note that while this information category is critical to process improvement projects, it also applies to systems and software projects as well.

##### 4.1 READINESS INFORMATION CATEGORY AND QUESTIONS

This Information Category is being addressed by the following measurable concepts, to be able to address the questions in the table below.

- **Alignment and Commitment:** how to determine whether or not the project is aligned with the organization goals, objectives, personnel, and culture. This category seeks to determine whether or not the organization is committed to this project with sufficient involvement of management and availability of resources to enable the project to be successful.
- **Process Improvement Capability:** overall organizational capability to undertake this project with strong likelihood of success. Measures cover organization capability for

doing process improvement, for making organization changes, and for establishing current process capability baselines.

These concepts also reflect the content of the Process Improvement Process Area of ISO 15504<sup>3</sup>, one input to the development of this material.

If the measures used for this category identify that the organization is not ready to proceed with an improvement program, the sources of the risks or issues need to be addressed. Otherwise, attempts to implement a process improvement program are likely to fail, wasting time and energy of all involved. Methods to mitigate the risks or issues may be as simple as some training in missing skills, or as extensive as changing the management structure of the organization. The collection of risk factors provided in Appendix D indicates the breadth of sources of potential barriers for a process improvement program, each of which can have multiple remedies.

Candidate Questions Being Addressed by Measures		
Information Categories	Measurable Concepts	Questions Addressed
Process Improvement Readiness	Alignment and Commitment	Is this project consistent with the business goals? Does the level of commitment to the project match the goals of the project? What is the perceived value to each level of the organization? To what extent are there cultural or political barriers to this project?
	Process Improvement Capability	What is the capability of the organization's PI process? What is the capability of the organization to undertake organization change? (other than forced change) What is the organization's track record with respect to successfully implementing prior improvement initiatives? Can we establish a baseline for the performance area addressed by the project?

Table 4-1 Candidate Questions Being Addressed by Measures

#### 4.2 PROCESS IMPROVEMENT READINESS ICM TABLE

The information needs in this area can be met by some of the existing PSM software and systems project measures, but several additional measures are needed, shown in Table 4-1, in bold italic font. Note that these concepts and measures are also very important in the progress monitoring of the project.

New measures shown in bold italic in Table 4-2, below, are defined in the individual specifications in Appendix E. A table of common risks is provided in Appendix D, to use for the measure of *Process Improvement Risk Ratings*.

<sup>3</sup> ISO/IEC 15504: Information Technology - Software Process Assessment, published in 1998 as a series of 9 documents that support software process improvement for the international community; re-published during 2003 through 2005.

Information - Concept - Measure Mapping		
Information Categories	Measurable Concepts	Prospective Measures
Process Improvement Readiness	Alignment and Commitment	<ul style="list-style-type: none"> <li>• Satisfaction Ratings (e.g. on surveys of organization leaders and others)</li> <li>• Resource Availability (staff and budget)</li> <li>• <b>Process Improvement Risk Ratings</b></li> <li>• <b>Human Resources Performance</b></li> <li>• <b>Level of Involvement</b></li> </ul>
	Process Improvement Capability	<ul style="list-style-type: none"> <li>• Reference Model Ratings</li> <li>• Process Audit Findings</li> <li>• Satisfaction Ratings (e.g. using Organizational Change Surveys, surveys of past experiences)</li> <li>• derived measures from process measures (e.g. capability baselines composed of aggregate project measures, process capability – current measure of level of performance to baselines and targets)</li> </ul>

Table 4-2 Information - Concept - Measure Mapping

#### 4.3 EXAMPLE OF PROCESS IMPROVEMENT READINESS MEASURE – LEVEL OF INVOLVEMENT

To know whether or not an organization is ready to deploy a set of processes, a process team might monitor the involvement of the organization management in the activities leading up to the deployment phase. In Figure 4-3 shown here, a program has been underway for a year, and it is facing the deployment of a set of process materials in January of the next year. It appears that the involvement was below target at the start of the year, but it is near the 100% desired now, so that deployment is likely to be successful.

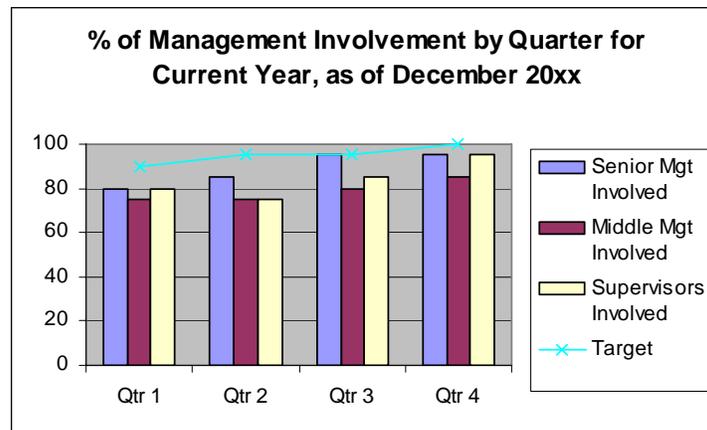


Figure 4-3 Example Management Involvement Measure

See the measurement specifications for this measure, to understand the supporting detail that would be measured.

## 5. MEASURING PROCESS IMPROVEMENT PROGRESS

When monitoring progress, process improvement projects share many characteristics with software and systems projects, thus many of the same information needs exist, and many of the same measures apply. The guidance for measuring progress of PI projects starts from the guidance for software; differences of interpretation are noted in the tables that follow. See Appendices A and B for the tables from which these were derived. In addition to these measures, some of those introduced for determining readiness also apply here; see the category of Alignment and Commitment for those measures.

Note that deliverables of PI projects are generally documented organizational processes and process assets, deployed on navigable servers or web sites. Thus, some of the measurable concepts need to be interpreted in terms of the technology and access *mechanisms used to host* access to the process materials, rather than to the *process deliverables* themselves.

In addition, some of the deliverables of the process improvement project may be software, such as estimation programs and measurement tools. In these cases, the standard measures for developing software can also apply to the process improvement project.

## 5.1 PROCESS IMPROVEMENT PROGRESS INFORMATION CATEGORIES AND QUESTIONS

Process-improvement-specific questions or adaptations to existing questions to be able to address this PI measurement area are indicated in bold, italic font, in Table 5-1, below:

Candidate Questions Being Addressed by Measures		
Information Categories	Measurable Concepts	Questions Addressed
Schedule and Progress Resources and Cost Product Size and Stability Technology Effectiveness Customer Feedback	Concepts from the software table apply	Questions from the software table apply, with minimal interpretation needed
Product Quality	These apply directly: Functional Correctness Usability Reliability	Questions from the software table apply, with minimal interpretation needed Assumption: Reliability applies to the mechanisms used to host the processes
	Maintainability	How much maintenance does the system require? <i>[applies to both the process materials developed and the mechanisms used to host the process materials]</i> How difficult is it to maintain? <i>[applies to the process materials]</i>
	Efficiency	Does the target system make efficient use of system resources? <i>[for the mechanisms used to host the processes]</i> Can the PI activities be performed in an efficient manner? <i>[for the project plan and process materials used to develop the processes]</i>
	Portability	To what extent can the functionality be hosted on different platforms? <i>[for the mechanisms used to host the processes]</i> <i>How easily can the process materials be tailored to meet circumstances of use?</i>
Process Performance	Concepts apply to the process being used for building and maintaining process materials	Questions need to be interpreted in the sense of building and maintaining process materials
<b><i>Process Improvement Readiness</i></b>	<b><i>Alignment and Commitment</i></b>	<b><i>To what extent are there cultural or political barriers to this project?</i></b> <b><i>Does the level of commitment match the goals of the project?</i></b> <b><i>Is the communication about the project adequate?</i></b>

Table 5-1 Candidate Questions Being Addressed by Measures

## 5.2 PROCESS IMPROVEMENT PROGRESS ICM TABLE

New measures (or significant adaptations) needed to address this PI measurement area are indicated in bold, italic font, in Table 5-2, below. These measures are defined in the individual specifications in Appendix E.

Information Categories	Measurable Concepts	Prospective Measures	Adaptations for PI Projects and Process Material
Schedule and Progress	Milestone Completion	Milestone Dates	No change
	Critical Path Performance	Slack Time	No change
	Work Unit Progress	Requirements Traced Requirements Tested Problem Reports Opened Problem Reports Closed Reviews Completed Change Requests Opened Change Requests Resolved Units Designed Units Coded Units Integrated Test Cases Attempted Test Cases Passed Action Items Opened Action Items Completed	Most require no change. <ul style="list-style-type: none"> <li>Units Coded becomes Units Developed</li> </ul> <p>These can be interpreted in terms of pilot tests of process materials.</p> <ul style="list-style-type: none"> <li>Test Cases Attempted</li> <li>Test Cases Passed</li> </ul>
	Incremental Capability	Components Integrated Functions Integrated	No change
Resources and Cost	Personnel Effort	Staff Level Development Effort Experience Level Staff Turnover	No change
	Financial Performance	BCWS, BCWP, ACWP Budget Cost	No change
	Environment and Support Resources	Quantity Needed Quantity Available Time Available Time Used	No change
Product Size and Stability	Physical Size and Stability	Database Size Components Interfaces Lines of Code	Adapt to process implementation units, e.g. process elements, document size, number of steps
	Functional Size and Stability	Requirements Functional Changes Function Points	Adapt to process implementation units, e.g. process elements, document size, number of steps

Information Categories	Measurable Concepts	Prospective Measures	Adaptations for PI Projects
Product Quality	Functional Correctness	Defects Age of Defects Technical Performance Level	No change No change <i>Adapt to address fitness for use [example provided]</i>
	Maintainability	Time to Restore Cyclomatic Complexity	Not applicable Not applicable
	Efficiency	Utilization Throughput Response Time	Not applicable to the process materials, apply to host mechanisms/ systems
	Portability	Standards Compliance	<b>Tailoring Difficulty</b>
	Usability	Operator Errors	No change
	Reliability	Mean-time-to-failure	Not applicable to the process materials, but do apply to mechanisms used to host them
Process Performance	Process Compliance	Reference Model Rating Process Audit Findings	No change Applies with respect to use of standards for process development and maintenance
	Process Efficiency	Productivity Cycle Time	Apply to the processes used for process development and maintenance
	Process Effectiveness	Defects Contained Defects Escaping Rework Effort Rework Components	Apply to the processes used for process development and maintenance
Technology Effectiveness	Technology Suitability	Requirements Coverage	Applies to process standards and to mechanisms used to host the process set
	Technology Volatility	Baseline Changes	Applies to process standards and to mechanisms used to host the process set
Customer Satisfaction	Customer Feedback	Satisfaction Ratings Award Fee	No change Not applicable
	Customer Support	Requests for Support Support Time	No change No change
<b>Process Improvement Readiness</b>	<b>Alignment and Commitment</b>	<b>Process Improvement Risk Ratings</b> <b>Human Resources Performance</b> <b>Level of Involvement</b>	<b>These were defined as part of the Readiness measures and can be tracked here as well.</b>

Table 5-2 Information-Concept-Measure Mapping

### 5.3 EXAMPLE OF PROCESS IMPROVEMENT PROGRESS MEASURE

One of the measures of quality of the products of a process improvement project is the fitness for use of its process materials. The measure of product quality known as Technical Performance Level can be applied to process materials built by a process team, to see that the materials are fit for use. Examples of the data that can be gathered include: level of adoption among users who are candidates for using the material, number of non-compliances while using the material, level of satisfaction with the material, and the amount of tailoring that is needed to use the material.

In this example, we focus on the first two sources of data – adoption rate and number of non-compliances.

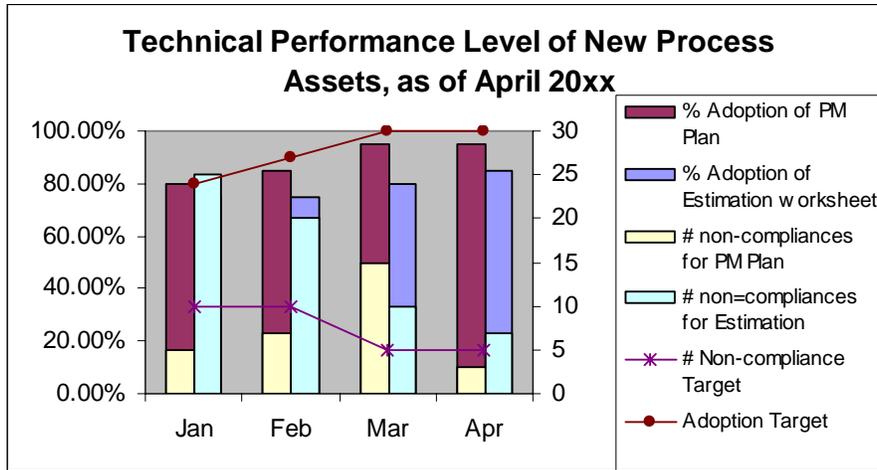


Figure 5. Example Technical Performance Level Measure

## 6. SUMMARY

Measures for process improvement generally need to cover all areas discussed here in some way, providing an understanding of readiness to pursue the improvement effort, tracking progress of the effort, and ensuring achievement of the anticipated results. Specific measures need to be established that best suit the organization and the improvement effort, with adjustments as needed over time.

## REFERENCES – BOOKS AND WEB SITES

*ISO/IEC 15504: Information Technology - Software Process Assessment*, a set of 9 documents, published in 1998, re-published 2003 – 2005.

Kaplan, Robert S., and David P. Norton. *The Balanced Scorecard*. Boston, MA: Harvard Business School Press, 1996.

Kaplan, Robert S., and David P. Norton. *The Strategy-Focused Organization*. Boston, MA: Harvard Business School Press, 2001.

Kaplan, Robert S., and David P. Norton. *Strategy Maps*. Boston, MA: Harvard Business School Press, 2004.

McGarry, John, David Card, Cheryl Jones, Beth Layman, Elizabeth Clark, Joseph Dean, and Fred Hall. *Practical Software Measurement, Objective Information for Decision Makers*. Boston, MA: Addison-Wesley, 2002.

PSM Support Center. *Practical Software and Systems Measurement, Objective Information for Decision Makers*. Version 4.0B, October 2000.

Rather than reproduce information about measurable benefits that are specific to a point in time, we provide links to web sites that have such information. In addition to these, please search for the latest sources using phrases such as “return on investment process improvement,” “ROI process improvement,” or “measures process improvement.”

[www.sei.cmu.edu](http://www.sei.cmu.edu) and their Software Engineering Information Repository (SEIR), located at <http://seir.sei.cmu.edu>

One of the Department of Defense Information and Analysis Centers, the Data and Analysis Center for Software, <http://iac.dtic.mil/dacs/> and their ROI Dashboard <http://www.thedacs.com/databases/roi/>

David Consulting Group, and their recent information about measuring benefits of process improvement, found at their web site [www.davidconsultinggroup.com](http://www.davidconsultinggroup.com)

## APPENDIX A INFORMATION CATEGORIES AND QUESTIONS FROM PSM 5.0<sup>4</sup>

Candidate Questions Being Addressed by Measures		
Information Categories	Measurable Concepts	Questions Addressed
Schedule and Progress	Milestone Completion	Is the project meeting scheduled milestones?
	Critical Path Performance	Are critical tasks or delivery dates slipping?
	Work Unit Progress	How are specific activities and products progressing?
	Incremental Capability	Is capability being delivered as scheduled in incremental builds and releases?
Resources and Cost	Personnel Effort	Is effort being expended according to plan? Is there enough staff with the required skills?
	Financial Performance	Is project spending meeting budget and schedule objectives?
	Environment and Support Resources	Are needed facilities, equipment, and materials available?
Product Size and Stability	Physical Size and Stability	How much are the product's size, content, physical characteristics, or interfaces changing?
	Functional Size and Stability	How much are the requirements and associated functionality changing?
Product Quality	Functional Correctness	Is the product good enough for delivery to the user? Are identified problems being resolved?
	Maintainability	How much maintenance does the system require? How difficult is it to maintain?
	Efficiency	Does the target system make efficient use of system resources?
	Portability	To what extent can the functionality be hosted on different platforms?
	Usability	Is the user interface adequate and appropriate for operations? Are operator errors within acceptable bounds?
	Reliability	How often is service to users interrupted? Are failure rates within acceptable bounds?
Process Performance	Process Compliance	How consistently does the project implement the defined processes?
	Process Efficiency	Are the processes efficient enough to meet current commitments and planned objectives?
	Process Effectiveness	How much additional effort is being expended due to rework?
Technology Effectiveness	Technology Suitability	Can technology meet all allocated requirements, or will additional technology be needed?
	Technology Volatility	Does new technology pose a risk because of too many changes?
Customer Satisfaction	Customer Feedback	How do our customers perceive the performance on this project? Is the project meeting user expectations?
	Customer Support	How quickly are customer support requests being addressed?

<sup>4</sup> Source: McGarry, John, et al., *Practical Software Measurement, Objective Information for Decision Makers* Boston, MA: Addison-Wesley, 2002, p. 43

## APPENDIX B I-C-M TABLE FROM PSM 5.0<sup>5</sup>

Information – Concept – Measure Mapping		
Information Categories	Measurable Concepts	Prospective Measures
Schedule and Progress	Milestone Completion	Milestone Dates
	Critical Path Performance	Slack Time
	Work Unit Progress	Requirements Traced Requirements Tested Problem Reports Opened Problem Reports Closed Reviews Completed Change Requests Opened Change Requests Resolved Units Designed Units Coded Units Integrated Test Cases Attempted Test Cases Passed Action Items Opened Action Items Completed
	Incremental Capability	Components Integrated Functionality Integrated
Resources and Cost	Personnel Effort	Staff Level Development Effort Experience Level Staff Turnover
	Financial Performance	BCWS, BCWP, ACWP Budget Cost
	Environment and Support Resources	Quantity Needed Quantity Available Time Available Time Used
Product Size and Stability	Physical Size and Stability	Database Size Components Interfaces Lines of Code
	Functional Size and Stability	Requirements Functional Changes Function Points

<sup>5</sup> Source: McGarry, John, et.al., *Practical Software Measurement, Objective Information for Decision Makers* Boston, MA: Addison-Wesley, 2002, p. 37.

Information Categories	Measurable Concepts	Prospective Measures
Product Quality	Functional Correctness	Defects Age of Defects Technical Performance Level
	Maintainability	Time to Restore Cyclomatic Complexity
	Efficiency	Utilization Throughput Response Time
	Portability	Standards Compliance
	Usability	Operator Errors
	Reliability	Mean-time-to-failure
Process Performance	Process Compliance	Reference Model Rating Process Audit Findings
	Process Efficiency	Productivity Cycle Time
	Process Effectiveness	Defects Contained Defects Escaping Rework Effort Rework Components
Technology Effectiveness	Technology Suitability	Requirements Coverage
	Technology Volatility	Baseline Changes
Customer Satisfaction	Customer Feedback	Satisfaction Ratings Award Fee
	Customer Support	Requests for Support Support Time

<sup>1</sup> Source: McGarry, John, et.al., *Practical Software Measurement, Objective Information for Decision Makers* Boston, MA: Addison-Wesley, 2002, p. 37.

## APPENDIX C EXAMPLE COST/BENEFIT ANALYSIS FORM

A form like the following might be used to analyze the primary costs and benefits for a project improvement project.

Project Benefits							
Item #	Revenue Benefits	2004	2005	2006	2007	2008	Total all years
1	<item>						\$0
2	<item>						\$0
3	<item>						\$0
<b>Total Revenue Benefits</b>		\$0	\$0	\$0	\$0	\$0	\$0
Item #	Savings Benefits	2004	2005	2006	2007	2008	Total all years
1	<item>						\$0
2	<item>						\$0
3	<item>						\$0
<b>Total Savings Benefits</b>		\$0	\$0	\$0	\$0	\$0	\$0
<b>Total Benefits</b>		\$0	\$0	\$0	\$0	\$0	\$0
Project Costs							
Item #	Costs	2004	2005	2006	2007	2008	Total all years
<b>Capital Investment Amount (000's)</b>							
1	Hardware						\$0
2	Software						\$0
3	Other						\$0
<b>Total Capital Investment</b>		\$0	\$0	\$0	\$0	\$0	\$0
<b>Development Costs</b>							
1	Employee Payroll Expenses						\$0
2	Assessment/benchmark Fees						\$0
3	Consulting Fees						\$0
4	Training						\$0
5	Travel						\$0
6	References, materials						\$0
7	Other						\$0
<b>Total Development Costs</b>		\$0	\$0	\$0	\$0	\$0	\$0
<b>Total Cost of Project</b>		\$0	\$0	\$0	\$0	\$0	\$0
<b>Recurring Operational Costs</b>							
1	Support Employee Expense						\$0
2	Consulting Fees						\$0
3	Maintenance - Hardware						\$0
4	Yearly License Fees - Software						\$0
5	Depreciation						\$0
6	Other						\$0
<b>Total Annual Operational Costs</b>		\$0	\$0	\$0	\$0	\$0	\$0
<b>Other Considerations</b>							
	Cash flow impact						
	Non-financial (soft) costs/benefits						

## APPENDIX D EXAMPLE PROCESS IMPROVEMENT RISK FACTORS

The following table lists examples risk categories (bold labels) and risk factors that threaten process improvement projects. High, Medium, and Low risk cues are indicators of when specific risks may

threaten the project. However, each project needs to state its own specific risks before attempting mitigation; items in the table here are merely examples.

	<b>Risk Factors</b>	<b>Low Risk Cues</b>	<b>Medium Risk Cues</b>	<b>High Risk Cues</b>
	<b>Organization Mission and Goals</b>			
1	Improvement Project Fit to Organization	directly supports organization mission and/or goals	indirectly impacts one or more goals	does not support or relate to organization mission or goals
2	Improvement Project Fit to Business Users or Customers	customer or business user understands impact to them of the project and supports the effort	customer or business user doesn't understand benefit of the project or is uninvolved	customer or business user is openly critical of the project and sees no particular benefit to them
3	Relation to Other Process Improvement Efforts	well defined interfaces; good fit with other programs	unclear how to relate, or aspects of fit yet to be decided	interfaces not well defined or controlled; subject to change
4	Work Flow	little or no change to work flow anticipated	will change some aspect or have small affect on work flow	significantly changes the work flow of organization
	<b>Organization Culture</b>			
5	Attitude Toward Change	variety of changes have occurred, with recent success	organization has tried to change, success varied; people hesitant to try new approaches	organization severely burned by one or more changes; widespread fear of new approaches
6	Experience with Quality Programs	organization has implemented successfully a major quality program, with favorable results	one or more quality programs attempted with limited success; some in organization skeptical, others think the programs a waste of time	one or more quality programs attempted; organization believes efforts were waste of time, actively opposes quality or process improvement
7	Action Orientation	organization is oriented to taking action and solving problems, with the ability to make fundamental changes	some in the organization take action, but there are political struggles to get broad changes made	organization hides behind the politics or insists on long reviews and discussions
8	Use of Measurement and Facts	organization has defined business goals; collects and uses measures regularly	organization has some limited experience with measurement; parts of the organization are quality and fact-oriented	most decisions in the organization are based on politics; no measurable business or improvement goals
9	Patience with Change	management and key leaders in organization willing to spend time socializing the changes	some managers or key technical leaders are impatient and push for quick results	little experience with change; leaders in key positions push for quick results
10	Alignment on Mission and Needs	organization mission and/or vision is established and shared across organization	organization mission and/or vision is in development or being sought	management and individuals disagree on the state of the organization, its mission or vision, and/or need for change
11	Tools Orientation	organization has balanced approach to tools; believes they must support processes and selected methods	some in organization focus on tools as the primary way to improve their efforts	most in organization expect tools to solve their productivity and effectiveness problems
12	Level of "Planfulness"	most of organization uses plans for their work	some evidence of planning, but not all projects follow plans	little evidence that anyone builds or uses plans
13	Use of Training in	orientation and training are	orientation and training	people rarely get training

	<b>Risk Factors</b>	<b>Low Risk Cues</b>	<b>Medium Risk Cues</b>	<b>High Risk Cues</b>
	Organization	regularly provided, to ensure that employees are current with processes and technology for doing their work	are provided when pressure from project problems or competition point out the need for that training	or orientation for their roles, or the organization expects its people to keep up with the industry on their own time
14	Meeting Behavior with Organization Levels	people feel free to discuss any issues with anyone in the organization in the room	people at one level of the organization are comfortable with some people at higher levels of management	people in meetings are honest and open only when only their level of the organization (and perhaps their project) is represented
15	Meeting Practices	sound practices for handling meetings: agendas, action item lists, processes for effective meetings are evident	meetings are rare or people avoid going to meetings because results are generally inconclusive	meetings nonexistent or very common; meeting practices poor; no agendas, no meeting processes, no follow through on actions
16	Organization Roles and Responsibilities	individuals throughout the organization understand their own roles and responsibilities and those of others	individuals understand their own roles and responsibilities, but are unsure who is responsible for work outside their immediate group	many in the organization are unsure of or unaware of who is responsible for many of the activities of the organization
17	Experience with Consultants on Change Programs	were successful in past with other consultants on PI or other change programs	no experience with other consultants, or no bias based on prior experience	had negative experiences in the past with consultants on PI or other change programs
<b>Organization Management</b>				
18	Organization Stability	little or no change in management or structure expected	some management change or reorganization expected	management or organization structure is continually or rapidly changing
19	Executive Involvement	visible and strong support	occasional support, provides help on issues when asked	no visible support; no help on unresolved issues
20	Management Awareness of PI	all levels of management are aware of the PI effort and intent	some levels of management are not yet aware of the PI effort and intent	most levels of management are unaware of the PI effort and intent
21	Management Support	strongly committed to success of project; provides credible and consistent message	some express commitment, but people may question the rationale	little or no visible support of the PI effort
22	Management Teams	management functions as a team, with joint goal setting and decision making; trust each other	some common activities among the management, with sharing of goals and resources	little evidence that the management functions as a team; no mutual respect
23	Middle Management Participation	members of middle management ask questions, offer help on implementation	one or more members of middle management (or project leaders) work with the improvement team on implementation efforts	middle management is totally uninvolved with the PI effort
24	Management Credibility	individuals believe the improvement plan is real, will happen	individuals question the level of concern of management	individuals don't believe management will improve the situation
25	Level of Trust in Management	individuals trust management to be acting in the organization's best	individuals perceive that the organization comes before them, in how	individuals do not trust management to make sound decisions, because

	<b>Risk Factors</b>	<b>Low Risk Cues</b>	<b>Medium Risk Cues</b>	<b>High Risk Cues</b>
		interest, as well as that of the individuals	management makes decisions and runs the organization	of various political reasons
26	Ability to Deal with Personnel Issues	management is able to honestly assess and assist development of their staff	performance reviews are irregular, some done well and others not so well; bad news is not delivered well	problems in personnel performance are ignored, hoping they will go away on their own
27	Degree of Empowerment	people used to taking on responsibility, working in teams	locus of power shifts with types of projects; not all is centered in senior management	senior management controls all important decisions; middle management is very directive
<b>Organization Process Users</b>				
28	Level of Discipline	most of the organization uses defined processes and is able to persist with them through crises	some projects or individuals follow processes regularly	few in the organization use structured processes or have experience in disciplined development
29	Policies and Standards	policies and standards are now defined and enforced	policies and standards are in place, but are weak or not carefully followed	no policies or standards exist, or they are ill-defined and unused
30	Developer Involvement	highly involved with PI project team, provide significant input	play minor roles, moderate impact on system	minimal or no developer involvement; little input
31	Level of Acceptance	developers accept concepts and details of new process; take part in reviews	developers accept most of concepts and details	developers do not accept any concepts or design details of the approach
32	PI Training of Organization	PI training needs are considered; training in progress or plan in place	training needs considered; no training yet or training plan is in development	training requirements not identified or not addressed
33	Percentage of Permanent Staff	most of the organization is composed of permanent staff	a small portion of the organization is temporary or contract staff	a significant portion of the staff is temporary employees, making process change transient
<b>PI Project Parameters</b>				
34	Project Size	small, non-complex, or easily decomposed	medium, moderate complexity, decomposable	large, highly complex, or not decomposable
35	Dedicated PI Staff	1-3% dedicated full-time	several people part time	only a committee effort
36	Budget Size	sufficient budget allocated	questionable budget allocated	doubtful that budget is sufficient
37	Cost Controls for Project	well established, in place	system in place, weak in areas	system lacking or nonexistent
38	Politically Determined Goals or Dates	goals or dates have been set based on analysis of project plan	some goals or dates are management-directed	goals and dates are driven by political reasons
39	Dates in PI Plan	stable commitment dates for milestones	some unclear commitments	no set dates, or no set commitments
40	Schedule Aggressiveness	PI team thinks that schedule is acceptable and can be met	team thinks parts of the plan are too aggressive	team thinks that most of the plan is unlikely to be met
<b>PI Project Deliverables</b>				
41	Requirements Stability	little or no change expected to approved set (baseline)	some change expected against approved set	rapidly changing or no agreed-upon baseline
42	Requirements Complete and	completely specified in PI plan	partially specified in PI plan	some requirements totally undocumented

	<b>Risk Factors</b>	<b>Low Risk Cues</b>	<b>Medium Risk Cues</b>	<b>High Risk Cues</b>
	Clear			
43	Testability/Pilot Possibilities	deliverables easy to pilot or test, plans made	parts of deliverables hard to pilot, or minimal planning being done	most of deliverables hard to pilot, or no plans made
44	Dependencies on Other Efforts	clearly defined dependencies	some elements are well understood and planned; others are not yet comprehended	no clear plan or schedule for how the whole effort will come together
	<b>PI Project Management</b>			
45	Approach	deliverables and process planning and monitoring in place	planning and monitoring need enhancement	weak or nonexistent planning and monitoring
46	Measurable Project Objectives	verifiable, measurable, and reasonable performance objectives for PI project	some performance objectives, measures for PI efforts may be questionable	no established performance requirements or requirements for PI are not measurable
47	Communication Within PI Teams	Project Manager (PM) clearly communicates goals and status within the PI teams	communicates some of the information some of the time	rarely communicates clearly to the team or to PI sponsors who need to be informed of team status
48	Commitment Process	changes to commitments in scope, content, schedule reviewed and approved by all involved	changes to commitments not communicated to all involved	changes to commitments made without review or involvement of the team
49	Experience of Project Manager	PM very experienced with projects involving organization change	PM has moderate experience or has experience with other types of projects	PM has no experience with this type of project or is new to project management
50	Political Skills of Project Manager	PM experienced and able to work with politics in this organization	PM has some experience with politics, but is uncomfortable with aspects of this organization	PM inexperienced with politics of this organization or has failed to address politics in the past
51	Attitude of Project Manager	strongly committed to success	willing to do what it takes	cares very little about project
52	Authority and/or Support of Project Manager	complete support of PI team and of management	support of most of team, with some reservations	no visible support; manager in name only
	<b>PI Development Process</b>			
53	Use of Defined Process by PI Team	project process in place, established, effective, followed	process established, but not followed or is ineffective	no formal process used
54	Management of Dependencies Across PI Teams	PI teams use a process to identify and actively manage dependencies across teams	dependencies and interfaces are identified, but may not be managed	process used by PI teams does not identify and manage cross-team dependencies
55	Early Identification of Defects	peer reviews are incorporated throughout to examine work products	peer reviews are used sporadically	team has set no reviews
56	Change Control for Work Products	formal change control process in place, followed, effective	change control process in place, not followed or is ineffective	no change control process used
57	Defect Tracking	defect tracking defined, consistent, effective	defect tracking process defined, but inconsistently used	no process in place to track defects
58	Pilot Approach	pilot sites (or teams) are	pilots need to be done	only available pilots are

	<b>Risk Factors</b>	<b>Low Risk Cues</b>	<b>Medium Risk Cues</b>	<b>High Risk Cues</b>
		available and interested in working with this project	with several teams, since each can handle only part of the need	uncooperative or in crisis mode already
<b>PI Development Environment</b>				
59	Mentoring Approach	PI team has effective mentoring approach for project teams using results PI deliverables	mentoring provided inconsistently or only by individuals already on the project teams	no mentoring approach considered or used
60	Physical Facilities for PI Teams	little or no modification needed	some modifications needed; some existent	major modifications needed, or facilities nonexistent
61	Hardware and Software Support for PI Teams	stable, no changes expected, capacity is sufficient	some changes under evolution, but controlled	platform under development
62	Amount of Communication to and from Organization	PI team has regular newsletter or other communication to the whole group	people who care to learn more come to the PI team for information	little exchange of information is happening; people generally unaware
63	Consultant Support	useful advice and support at reasonable price and in needed time frame	adequate support at contracted price, reasonable response time	little or no support, high cost, and/or poor response time
64	Consultants Working in Focus Areas of Change	no consultants working in technical or organization areas to be affected by change	there are interactions with consultants providing advice about the areas being changed	consultants working in the areas being changed provide roadblocks or alternate approaches to the work of this project
65	Examples and Reusable Components	examples from similar organizations and/or reusable components are available	examples are available, but from organizations quite different from this one	no examples or reusable components are available to use in this project
<b>PI Project Teams</b>				
66	Staff Availability	organization able to provide staff at committed level of effort	other commitments sometimes interrupt the work on PI	high level of interrupts for planned time on PI project
67	Staff Selection Process	PI staff recruited from those with appropriate set of skills	PI staff recruited from those who volunteer, whether or not skills match needs	PI staff selected from those available for assignment
68	Mix of Staff Skills	good mix of skills - people skills, technical areas	some skills inadequately represented	some skills not represented at all
69	Respect for PI Project Team Members	highly respected members of the organization	some members of the PI effort are respected; some are not	people working on PI are not respected by their peers
70	Experience with Organization Change	extensive experience	some experience	little or no experience
71	Training of PI Teams	training plan in place, training ongoing	training for some areas not available or training planned for future	no training plan or training not readily available
72	Experience as Teams	members of PI team have prior experience with successful teams	some members of PI team have worked in teams before	organization has no successful experience with teams, or this team has no such experience
73	Team Spirit and Attitude	strongly committed to success of project; cooperative	willing to do what it takes to get the job done	little or no commitment to the project; not a cohesive team

	<b>Risk Factors</b>	<b>Low Risk Cues</b>	<b>Medium Risk Cues</b>	<b>High Risk Cues</b>
74	Team Productivity	all milestones being met, deliverables on time, productivity high	milestones being met, some delays in deliverables, productivity acceptable	productivity low, milestones not met, delays in deliverables
75	Personality Fit	PI project members are effective communicators and facilitators	PI project members can get along with others, but are not sought out	PI project members are aloof or unapproachable by members of the organization
76	Expertise with Domain	good background with domain within team	some experience with domain in team or able to call on experts as needed	no expertise in domain in team, no availability of experts
<b>Organization Process Maintenance</b>				
77	Complexity of Deliverables	easy to maintain or unlikely to change	certain aspects difficult to maintain	extremely difficult to maintain
78	Availability of Deliverables	readily accessible, perhaps via network	available by request	most people don't know where to find the PI deliverables
79	Availability of Process Owners	owners for individual processes being developed or changed are in place, experienced, sufficient in number	missing some areas of expertise	significant discipline or expertise missing
		<b>Total Categories</b>	<b>11</b>	
		<b>Total Factors</b>	<b>79</b>	

*Note: these were developed over the last ten years by consultants at TeraQuest Metrics, Inc., which is now part of Borland Software Corporation.*

## APPENDIX E PROCESS IMPROVEMENT MEASUREMENT SPECIFICATIONS

### Specifications for Process Improvement-Specific PSM Measures

Information Category	Measurable Concept	Measures
Process Improvement Results	Financial	Revenue Market Share
Process Improvement Results	Internal Business Processes	Cost of Quality
Process Improvement Readiness	Alignment and Commitment	Process Improvement Risk Ratings Human Resources Performance Level of Involvement
Process Improvement Progress: Product Quality	Functional Correctness	Technical Performance Level (adaptation of PSM 4.0 measure)
Process Improvement Progress: Product Quality	Portability	Tailoring Difficulty

## MEASUREMENT INFORMATION SPECIFICATION - REVENUE

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	What is the impact of our process improvement program on revenue goals? Is the projected increase in income being realized?
<b>Information Category</b>	Process Improvement Results

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Financial

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	Products and services
<b>Attributes</b>	<ol style="list-style-type: none"> <li>1. number of units sold</li> <li>2. price per unit</li> </ol>

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	<ol style="list-style-type: none"> <li>1. number of units of each product or service sold</li> <li>2. price of each product or service sold</li> </ol>
<b>Measurement Methods</b>	Collect actual data on sales of each product and service, on a regular basis
<b>Type of Method</b>	Objective
<b>Scale</b>	<ol style="list-style-type: none"> <li>1. count of units</li> <li>2. value of price</li> </ol>
<b>Type of Scale</b>	<ol style="list-style-type: none"> <li>1. ratio</li> <li>2. ratio</li> </ol>
<b>Unit of Measurement</b>	<ol style="list-style-type: none"> <li>1. individual product or service</li> <li>2. monetary value of a unit of individual product or service</li> </ol>

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	Revenue earned over period of time
<b>Measurement Function</b>	For each product and each service of interest, accumulate the total revenue earned as a product of the number of units sold (product or service) multiplied by its price. Accumulate over all products and services for this period.

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	Planned revenue over period of time
<b>Measurement Function</b>	For each product and each service of interest, accumulate the total revenue planned as a product of the number of units projected for a given product or service multiplied by its price. Accumulate over all products and services for this period.

INDICATOR SPECIFICATION																
<b>Indicator Description and Sample</b>	<div style="text-align: center;"> <p><b>Comparison of Actual Revenue to Revenue Goals as of December 31, 20xx</b></p> <table border="1"> <caption>Comparison of Actual Revenue to Revenue Goals as of December 31, 20xx</caption> <thead> <tr> <th>Quarter</th> <th>Planned</th> <th>Actual</th> </tr> </thead> <tbody> <tr> <td>Qtr 1</td> <td>120</td> <td>115</td> </tr> <tr> <td>Qtr 2</td> <td>115</td> <td>125</td> </tr> <tr> <td>Qtr 3</td> <td>125</td> <td>135</td> </tr> <tr> <td>Qtr 4</td> <td>120</td> <td>125</td> </tr> </tbody> </table> </div>	Quarter	Planned	Actual	Qtr 1	120	115	Qtr 2	115	125	Qtr 3	125	135	Qtr 4	120	125
Quarter	Planned	Actual														
Qtr 1	120	115														
Qtr 2	115	125														
Qtr 3	125	135														
Qtr 4	120	125														
<b>Analysis Model</b>	<p>The improvement program may have been targeted at increasing the revenue based on some key customer consideration, such as ability to quickly implement small changes in functionality. Here we see an example where the projected impact was exceeded in each quarter after the first. Whether or not this is due to the process improvement activities is not clear from just this measure; other measures would be needed to describe the changes made and the relationship of those changes to the revenue increase.</p> <p>If improvements are deployed in one organization, but not another, the sales of the several organizations might be contrasted to their goals.</p>															
<b>Decision Criteria</b>	The revenue goals are set by the organization, based on its expectation of the effect of certain changes. In the case of revenue increase, it is likely that the organization will balance the level of improvement here against the cost of gaining that improvement, with a threshold (such as a 5 or 10% improvement) required to justify the investment.															
<b>Indicator Interpretation</b>	In this example, with the exception of the first quarter, where the target was missed, the results appear to meet the targets.															

<b>DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)</b>	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	At the end of each reporting period for actual values; at the end of the budget/planning cycle for the target values
<b>Responsible Individual</b>	Accounts Receivable
<b>Phase or Activity in which Collected</b>	Not applicable; collected by calendar period
<b>Tools Used in Data Collection</b>	Finance tracking system
<b>Verification and Validation</b>	Accounting procedures
<b>Repository for Collected Data</b>	Organization's financial systems

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	Monthly or quarterly
<b>Responsible Individual</b>	Accounts Receivable or Chief Financial Officer
<b>Phase or Activity in which Analyzed</b>	Throughout the fiscal year
<b>Source of Data for Analysis</b>	Finance tracking system
<b>Tools Used in Analysis</b>	Finance tracking system
<b>Review, Report, or User</b>	Process Group Management Teams Executive Leadership

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	To ensure that the increased levels of revenue are due to the process improvement, customers may need to indicate the reason for their purchase or in some other way tie the improvements to the sales that resulted in revenue increases. Otherwise, there are likely to be confounding effects from other competing initiatives to raise revenue levels.
<b>Implementation Considerations</b>	Predictive measures (sales forecasts, sales records) might also be used, instead of the actual revenue recognized once invoices have been paid. Using the sales measures allow for tracking the impact earlier than when using the revenue measures. Sales figures are subject to change, however, while revenue recognized is stable.

## MEASUREMENT INFORMATION SPECIFICATION – MARKET SHARE

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	What is the impact of our process improvement program on our market share? (for a market segment, a product line, a specific product, etc.) [for illustration, we use a single product here]
<b>Information Category</b>	Process Improvement Results

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Financial

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	License (or sale of) product or service offering (or product line)
<b>Attributes</b>	Number of customers served with this license or sale

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	Customers served
<b>Measurement Methods</b>	Collect number of customers served for a given product/service offering
<b>Type of Method</b>	Objective
<b>Scale</b>	Count of units
<b>Type of Scale</b>	Ratio
<b>Unit of Measurement</b>	Individual product or service

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	Total number of customers served by a given product (ours or that of a competitor)
<b>Measurement Function</b>	Sum the number of customers served, across all current licenses (or sales) for the product of interest

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	Total market served
<b>Measurement Function</b>	Sum the number of customers served by our product and those of all of the competitors, to determine the total market served by all products.

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	Percent of market share for product x
<b>Measurement Function</b>	Divide (the total number of customers served by a given product) by (the total market served)

INDICATOR SPECIFICATION																
<b>Indicator Description and Sample</b>	<table border="1"> <caption>Change in Market Share for our Key Offering as of December 31, 20xx</caption> <thead> <tr> <th>Product</th> <th>Last Dec (%)</th> <th>This Dec (%)</th> </tr> </thead> <tbody> <tr> <td>Product A</td> <td>25</td> <td>22</td> </tr> <tr> <td>Product B</td> <td>20</td> <td>20</td> </tr> <tr> <td>Product C</td> <td>22</td> <td>18</td> </tr> <tr> <td>Our Offering</td> <td>33</td> <td>40</td> </tr> </tbody> </table>	Product	Last Dec (%)	This Dec (%)	Product A	25	22	Product B	20	20	Product C	22	18	Our Offering	33	40
Product	Last Dec (%)	This Dec (%)														
Product A	25	22														
Product B	20	20														
Product C	22	18														
Our Offering	33	40														
<b>Analysis Model</b>	The improvement program may have been targeted at increasing the market share for a product or product line. Here we see an example where the market share for our product has grown, while that of two competitors has shrunk. To ensure that the growth is because of the impact of the improvement program, other measures are needed as well.															
<b>Decision Criteria</b>	The market share goals are set by the organization, based on its expectation of the effect of certain changes. It is likely that the organization will balance the level of improvement here against the cost of gaining that improvement, with a threshold (such as a 5 or 10% improvement) required to justify the investment.															
<b>Indicator Interpretation</b>	In this example, the results appear to have made a useful difference in market share.															

DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	At the end of each reporting period (such as end of year or end of quarter)
<b>Responsible Individual</b>	Market Analyst
<b>Phase or Activity in which Collected</b>	Not applicable; collected by calendar period

<b>Tools Used in Data Collection</b>	Sales Reports, License counts
<b>Verification and Validation</b>	Accounts Receivable can validate license and sales revenue attributable to the sales or license fees
<b>Repository for Collected Data</b>	Organization's sales records and financial systems

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	Monthly or quarterly
<b>Responsible Individual</b>	Sales Manager, Marketing Director, and/or Chief Financial Officer
<b>Phase or Activity in which Analyzed</b>	Throughout the fiscal year
<b>Source of Data for Analysis</b>	Sales and Finance tracking systems
<b>Tools Used in Analysis</b>	Sales and Finance tracking system
<b>Review, Report, or User</b>	Process Group Management Teams Executive Leadership

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	<p>To ensure that the increased levels of revenue are due to the process improvement, customers may need to indicate the reason for their purchase or in some other way tie the improvements to the sales that resulted in the increased market share. Otherwise, there are likely to be confounding effects from other competing initiatives to raise the levels.</p> <p>Depending on the information needs, this data might be aggregated by geographic region,</p>
<b>Implementation Considerations</b>	<p>Data on the number of customers served by our product will be relatively easy to get, but that for products of other companies (especially competitors) will be difficult to access. Unless the total served market is very small or very public for some reason, conclusions about market share need to be handled carefully. Such data is likely to be an estimate done by industry analysts or from marketing data made public by the competition. Using this measure to compare market share of one's own alternative products is much more reliable, because data is more readily available.</p> <p>In this example, we show a percentage share of the current market served; another approach is to examine a share of the total available market (which may be much larger, but also a very subjective number).</p>

## MEASUREMENT INFORMATION SPECIFICATION – COST OF QUALITY

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	How has my productivity been impacted by the current process improvement effort? What changes can be detected in the overall cost of quality?
<b>Information Category</b>	Process Improvement Results

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Internal Business Processes

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	Time spent on a task (by an individual during a given day)
<b>Attributes</b>	Category of work [with a selection list that includes all the types of tasks needed to segment the time into the 4 cost of quality categories – ex. Planning, building requirements, fixing defects...]

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	Time on Task
<b>Measurement Methods</b>	Use actual hours entered on daily timesheet entries by each individual, aggregated across the projects and other work for which process improvement is being applied in the organization of interest
<b>Type of Method</b>	Objective
<b>Scale</b>	Positive real numbers
<b>Type of Scale</b>	Ratio
<b>Unit of Measurement</b>	Hours

<b>DERIVED MEASURE SPECIFICATION</b>	
<b>Derived Measure</b>	Cost of Prevention (for month X)
<b>Measurement Function</b>	Sum the amount of time spent on tasks from categories like these: <ul style="list-style-type: none"> <li>- training</li> <li>- process development and maintenance</li> <li>- tools selection and installation</li> <li>- quality improvement projects</li> <li>- measurement and analysis</li> <li>- root cause analysis</li> </ul> Divide this by the grand total of all time spent on all tasks.

<b>DERIVED MEASURE SPECIFICATION</b>	
<b>Derived Measure</b>	Cost of Appraisal (for month X)
<b>Measurement Function</b>	Sum the amount of time spent on tasks from categories like these: <ul style="list-style-type: none"> <li>- technical reviews, walkthroughs, inspections</li> <li>- testing (first time)</li> <li>- audits</li> </ul> Divide this by the grand total of all time spent on all tasks.

<b>DERIVED MEASURE SPECIFICATION</b>	
<b>Derived Measure</b>	Cost of Performance (for month X)
<b>Measurement Function</b>	Sum the amount of time spent on tasks from categories like these: <ul style="list-style-type: none"> <li>- planning</li> <li>- defining and/or analyzing requirements</li> <li>- design</li> <li>- product construction</li> <li>- component integration</li> <li>- [other work, as appropriate to the organization, which is the primary effort to develop or deliver the product or service]</li> </ul> Divide this by the grand total of all time spent on all tasks.

<b>DERIVED MEASURE SPECIFICATION</b>	
<b>Derived Measure</b>	Cost of Nonconformance (for month X)

<b>Measurement Function</b>	<p>Sum the amount of time spent on tasks from categories like these:</p> <ul style="list-style-type: none"> <li>- fixing defects in product components</li> <li>- reworking design</li> <li>- revising defects in requirements or defining missing requirements</li> <li>- reviewing fixes or updates</li> <li>- testing fixes or updates</li> <li>- on-site customer support</li> <li>- help desk support</li> </ul> <p>Divide this by the grand total of all time spent on all tasks.</p>
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<b>INDICATOR SPECIFICATION</b>																																											
<b>Indicator Description and Sample</b>	<div style="text-align: center;"> <p><b>Monthly Cost of Quality Trends, as of June 20xx</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <caption>Estimated Data from Monthly Cost of Quality Trends Chart</caption> <thead> <tr> <th>Month</th> <th>Cost of Performance (%)</th> <th>Cost of Prevention (%)</th> <th>Cost of Appraisal (%)</th> <th>Cost of Non-Conformance (%)</th> <th>Target for Non-conformance (%)</th> </tr> </thead> <tbody> <tr> <td>Jan</td> <td>26</td> <td>10</td> <td>21</td> <td>40</td> <td>35</td> </tr> <tr> <td>Feb</td> <td>27</td> <td>10</td> <td>22</td> <td>39</td> <td>35</td> </tr> <tr> <td>Mar</td> <td>26</td> <td>10</td> <td>24</td> <td>38</td> <td>35</td> </tr> <tr> <td>Apr</td> <td>27</td> <td>10</td> <td>25</td> <td>37</td> <td>35</td> </tr> <tr> <td>May</td> <td>28</td> <td>10</td> <td>25</td> <td>36</td> <td>35</td> </tr> <tr> <td>Jun</td> <td>28</td> <td>10</td> <td>25</td> <td>37</td> <td>35</td> </tr> </tbody> </table> </div>	Month	Cost of Performance (%)	Cost of Prevention (%)	Cost of Appraisal (%)	Cost of Non-Conformance (%)	Target for Non-conformance (%)	Jan	26	10	21	40	35	Feb	27	10	22	39	35	Mar	26	10	24	38	35	Apr	27	10	25	37	35	May	28	10	25	36	35	Jun	28	10	25	37	35
Month	Cost of Performance (%)	Cost of Prevention (%)	Cost of Appraisal (%)	Cost of Non-Conformance (%)	Target for Non-conformance (%)																																						
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Apr	27	10	25	37	35																																						
May	28	10	25	36	35																																						
Jun	28	10	25	37	35																																						
<b>Analysis Model</b>	<p>The organization has an annual goal with respect to the cost of quality model to reduce the cost of non-conformance. In the example, it is holding approximately constant the amount of time spent in prevention activities, but increasing efforts in reviews and inspections. Thus it is expected that appraisal costs will go up, with more than a similar reduction in non-conformance costs. If the organization can reduce the non-conformance costs, while holding prevention costs approximately the same, it should see more effort going into the cost of performance.</p>																																										
<b>Decision Criteria</b>	<p>If the amount of effort going into the reviews does not show an increase of at least 5% by mid-year, the organization needs to examine how the processes are being used.</p>																																										
<b>Indicator Interpretation</b>	<p>In the example, the organization is seeing progress toward its goal, attempting to go from approximately 40% rework (nonconformance) to 35%. They have cut the time in prevention activities, though. Reasons for this should be examined, since it may impact their ability to maintain this level of progress.</p>																																										

<b>DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)</b>	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	Daily
<b>Responsible Individual</b>	Each individual in the organization
<b>Phase or Activity in which Collected</b>	All phases, all activities, all tasks
<b>Tools Used in Data Collection</b>	Organization time recording mechanism, available to each individual, where time can be entered throughout the day or at the end of the day; entry must be done daily
<b>Verification and Validation</b>	Weekly review by supervisors, as well as data validation mechanisms in the time recording system
<b>Repository for Collected Data</b>	Organization time-tracking database

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	Monthly
<b>Responsible Individual</b>	Organization measurement team
<b>Phase or Activity in which Analyzed</b>	Not applicable; this is done across projects and other work efforts
<b>Source of Data for Analysis</b>	Organization time-tracking database
<b>Tools Used in Analysis</b>	Excel or other measurement system
<b>Review, Report, or User</b>	Organization management Project managers Process improvement leaders

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	Monitor the trend in all four areas of cost, since each affects each of the others. Minimization of the nonconformance costs should be done without driving the prevention and appraisal costs too low, or the effect will not be persistent.
<b>Implementation Considerations</b>	The granularity with which data is collected in the time tracking system is a serious concern. Data must be available at the level of detail described in the derived measures here, or it will be difficult to see the improvements to the organization. It is unlikely that a standard system used for human resources accounting purposes will suffice; in general, that system needs to be seriously modified or another system must be used, to establish appropriate time categories.

## MEASUREMENT INFORMATION SPECIFICATION – PROCESS IMPROVEMENT RISK RATINGS

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	Do we face any risks that need to be mitigated for this program to succeed?
<b>Information Category</b>	Process Improvement Readiness

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Alignment and Commitment

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	Process Improvement Program
<b>Attributes</b>	Areas of potential risk

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	Risk factor rating
<b>Measurement Methods</b>	Using a set of risk factors that are relevant for the organization, for a specific risk factor for a specific category of potential risk to an improvement program, examine the cues for level of risk, and identify the perceived level of the factor.
<b>Type of Method</b>	Objective
<b>Scale</b>	Low/medium/high
<b>Type of Scale</b>	Nominal
<b>Unit of Measurement</b>	Individual risk factor

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	# of factors to be addressed
<b>Measurement Function</b>	For each category of risk factors, compute the number of factors estimated to describe a given level of threat to the improvement effort (e.g. medium, high).

INDICATOR SPECIFICATION																																					
<b>Indicator Description and Sample</b>	<p style="text-align: center;"><b># Risk Factors to be Addressed, as of January, 20xx</b></p> <table border="1"> <caption>Data for # Risk Factors to be Addressed</caption> <thead> <tr> <th>Category</th> <th>Medium Risk Factors</th> <th>High Risk Factors</th> </tr> </thead> <tbody> <tr> <td>Mission and Goals</td> <td>1</td> <td>0</td> </tr> <tr> <td>Culture</td> <td>4</td> <td>3</td> </tr> <tr> <td>Management</td> <td>1</td> <td>0</td> </tr> <tr> <td>Process Users</td> <td>3</td> <td>1</td> </tr> <tr> <td>PI Parameters</td> <td>1</td> <td>1</td> </tr> <tr> <td>PI Deliverables</td> <td>2</td> <td>1</td> </tr> <tr> <td>PI Project Mgt</td> <td>1</td> <td>0</td> </tr> <tr> <td>PI Process</td> <td>2</td> <td>3</td> </tr> <tr> <td>PI Environment</td> <td>1</td> <td>0</td> </tr> <tr> <td>PI Teams</td> <td>2</td> <td>4</td> </tr> <tr> <td>PI Maintenance</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Category	Medium Risk Factors	High Risk Factors	Mission and Goals	1	0	Culture	4	3	Management	1	0	Process Users	3	1	PI Parameters	1	1	PI Deliverables	2	1	PI Project Mgt	1	0	PI Process	2	3	PI Environment	1	0	PI Teams	2	4	PI Maintenance	1	0
Category	Medium Risk Factors	High Risk Factors																																			
Mission and Goals	1	0																																			
Culture	4	3																																			
Management	1	0																																			
Process Users	3	1																																			
PI Parameters	1	1																																			
PI Deliverables	2	1																																			
PI Project Mgt	1	0																																			
PI Process	2	3																																			
PI Environment	1	0																																			
PI Teams	2	4																																			
PI Maintenance	1	0																																			
<b>Analysis Model</b>	<p>The ratings of risk factors are an indicator of the level of risk faced by the improvement program. Until the specific risks are identified and analyzed, though, it is not clear what potential problems are being faced. The risk factors are stated in a generic form, with cues to indicate potential risks to the organization. Once the factors have been rated, the risk assessment team can see where to focus its efforts on identifying and mitigating risks. Areas with high-rated factors are likely to have more threats than those with medium-rated factors, and these are the ones for which specific risks should first be documented and examined.</p>																																				
<b>Decision Criteria</b>	<p>If many factors indicate high levels of risk, the improvement program may need to be shelved until these factors can be addressed. Common experience is that if there are more than ten high level risks to address, a program is not likely to be successful.</p>																																				
<b>Indicator Interpretation</b>	<p>In this example, there appear to be serious risks in the organization culture, the process being used for process improvement, and the characteristics of the improvement teams. Depending on what actions can be taken to remove these risks, the program may need to be re-planned or reconsidered.</p>																																				

DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	During risk assessment efforts prior to the start of the improvement effort, and whenever environment, staffing, or other key circumstances have changed
<b>Responsible Individual</b>	Process group leader
<b>Phase or Activity in which Collected</b>	Risk assessment
<b>Tools Used in Data Collection</b>	Risk Factor Spreadsheet
<b>Verification and Validation</b>	Individuals involved in the assessment each independently rate the factors, then discuss them together as a group, to agree on the level of risk
<b>Repository for Collected Data</b>	Process Group measurement database

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	After risk assessment
<b>Responsible Individual</b>	Process group leader
<b>Phase or Activity in which Analyzed</b>	After risk assessment
<b>Source of Data for Analysis</b>	Risk Factor Spreadsheet summary
<b>Tools Used in Analysis</b>	Excel or other measurement tools
<b>Review, Report, or User</b>	Process Group Management Teams Executive Leadership

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	<p>The risk factors review needs to be followed by risk identification activities which document the specific risks to the improvement effort and determine the risk exposure for each (probability x loss). For those which are significant, actions need to be planned to handle the risk, so that the improvement program can succeed.</p> <p>Sometimes the initial review of risk factors generates a more negative view of the improvement effort than is justified when the true risks are stated; reviewers often react to the cues based on prior experience or based on perceptions that cannot be substantiated when examining the current improvement effort. Thus, the initial review of factors should be considered directional, rather than the final assessment of risk.</p>
<b>Implementation Considerations</b>	Each organization may augment the standard list by adding relevant risk factors to it, based on local experience, or it may remove some which are not relevant. For improvement activities that last several years, it is wise to review the list during periods of re-planning.

## MEASUREMENT INFORMATION SPECIFICATION – HUMAN RESOURCES PERFORMANCE

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	Do we have a means to ensure involvement of management at all levels of the organization?
<b>Information Category</b>	Process Improvement Readiness

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Alignment and Commitment

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	Managers
<b>Attributes</b>	Human Resources performance incentive for process improvement

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	Existence of incentive
<b>Measurement Methods</b>	Determine from the manager's HR performance plan whether or not there is an incentive being offered for participating in the process improvement effort (or for specific results of the program)
<b>Type of Method</b>	Objective
<b>Scale</b>	Yes/no
<b>Type of Scale</b>	Nominal
<b>Unit of Measurement</b>	Individual manager

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	% of managers who have an incentive
<b>Measurement Function</b>	For each level of management, compute the percentage of those who have an incentive for process improvement, by dividing the total number of those with incentives by the total population of managers at that level.

INDICATOR SPECIFICATION																					
<b>Indicator Description and Sample</b>	<p style="text-align: center;"><b>% with Human Resources Performance Incentives, by Organization, as of January, 20xx</b></p> <table border="1"> <caption>Data for % with Human Resources Performance Incentives</caption> <thead> <tr> <th>Organization</th> <th>Senior Mgt (%)</th> <th>Middle Mgt (%)</th> <th>Supervisors (%)</th> </tr> </thead> <tbody> <tr> <td>Org A</td> <td>95</td> <td>75</td> <td>80</td> </tr> <tr> <td>Org B</td> <td>95</td> <td>75</td> <td>75</td> </tr> <tr> <td>Org C</td> <td>95</td> <td>80</td> <td>85</td> </tr> <tr> <td>Org D</td> <td>95</td> <td>85</td> <td>95</td> </tr> </tbody> </table>	Organization	Senior Mgt (%)	Middle Mgt (%)	Supervisors (%)	Org A	95	75	80	Org B	95	75	75	Org C	95	80	85	Org D	95	85	95
Organization	Senior Mgt (%)	Middle Mgt (%)	Supervisors (%)																		
Org A	95	75	80																		
Org B	95	75	75																		
Org C	95	80	85																		
Org D	95	85	95																		
<b>Analysis Model</b>	In some organizations, it is helpful to have process improvement involvement (or results) reinforced by the performance objectives for each level of management. As a program gets underway, it is useful to measure how many of the managers have those incentives established. As the program proceeds, the measure might be augmented by a measure of effectiveness, such as whether or not an incentive goal for results is being met.																				
<b>Decision Criteria</b>	The goals are set by organization, generally requiring that all managers have incentives. If a certain organization is not meeting that goal, executive leadership may need to take action to ensure compliance.																				
<b>Indicator Interpretation</b>	In this example, all senior managers have had incentives set, and organization D appears to be on track with setting its goals. The other three organizations lag, and if incentives should be set by January, it may be necessary for the executive to take action to get the incentives set.																				

DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	Upon completion of performance goal setting, generally at the start of a calendar year
<b>Responsible Individual</b>	Supervising Manager [e.g. Executive for Senior Management, Senior Manager for those who report to him or her, etc.]
<b>Phase or Activity in which Collected</b>	Not applicable
<b>Tools Used in Data Collection</b>	Simple spreadsheet
<b>Verification and Validation</b>	Human Resources Department checks personnel records to ensure reported data is correct
<b>Repository for Collected Data</b>	Process Group measurement database

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	On request
<b>Responsible Individual</b>	Process group member
<b>Phase or Activity in which Analyzed</b>	On request
<b>Source of Data for Analysis</b>	Human Resources Department
<b>Tools Used in Analysis</b>	Excel or other measurement tools
<b>Review, Report, or User</b>	Process Group Management Teams Executive Leadership Human Resources Department

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	The initial incentives might be just for involvement in the improvement program, but that involvement should at least include setting goals for results. As the program proceeds, the incentive should relate to results of the program, not just its existence.
<b>Implementation Considerations</b>	Each organization participating in the improvement effort needs to be included. Often, there is resistance from one or more organizations whose management believes them to be exempt for reasons of business pressures. Such non-compliance might be tolerated, so that progress can be made elsewhere in the business, but the culture of the organization must accept such a temporary inequity without impacting the motivation for improvement in other groups.

## MEASUREMENT INFORMATION SPECIFICATION – LEVEL OF INVOLVEMENT

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	Do we have adequate involvement of management at all levels of the organization?
<b>Information Category</b>	Process Improvement Readiness

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Alignment and Commitment

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	<ol style="list-style-type: none"> <li>1. managers</li> <li>2. meetings</li> <li>3. action items</li> </ol>
<b>Attributes</b>	<ol style="list-style-type: none"> <li>1. level of management</li> <li>2. attributes of meetings vary, but might be one or more of <ul style="list-style-type: none"> <li>• types of meetings involving management (e.g. steering committee, status, issue escalation)</li> <li>• # of attendees by level of management</li> <li>• frequency of meeting (annual, monthly, etc.)</li> <li>• # actions taken</li> <li>• # decisions reached</li> <li>• % of standard meetings in which process improvement is discussed</li> </ul> </li> <li>3. planned and actual completion dates for an action item</li> </ol>

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	<ol style="list-style-type: none"> <li>1. number of managers at a given level</li> <li>2. count of meetings with a given attribute</li> <li>3. date of completion</li> </ol>
<b>Measurement Methods</b>	Collect planned data for involvement from management team, then monitor actual involvement during meetings and for action items assigned, as they occur
<b>Type of Method</b>	Objective
<b>Scale</b>	<ol style="list-style-type: none"> <li>1. count of individuals</li> <li>2. count of meetings</li> <li>3. date</li> </ol>
<b>Type of Scale</b>	<ol style="list-style-type: none"> <li>1. ratio</li> <li>2. ratio</li> <li>3. interval</li> </ol>

<b>UNIT OF MEASUREMENT</b>	<ol style="list-style-type: none"> <li>1. individual items</li> <li>2. individual items</li> <li>3. days</li> </ol>
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<b>DERIVED MEASURE SPECIFICATION</b>	
<b>Derived Measure</b>	% of Management Involvement by Level
<b>Measurement Function</b>	For each level of management, over a given time period, compute the percentage of those involved by tracking which managers participate in the meeting attributes being tracked, dividing actual numbers by planned numbers.

<b>DERIVED MEASURE SPECIFICATION</b>	
<b>Derived Measure</b>	Management Action Item Responsiveness
<b>Measurement Function</b>	Over all managers, for a given time period, compute the responsiveness by comparing the date of completion of action items to the planned date of completion. Determine the percent that are early, on time, and late

<b>INDICATOR SPECIFICATION</b>																										
<b>Indicator Description and Sample</b>	<div style="text-align: center;"> <p><b>% of Management Involvement by Quarter for Current Year, as of December 20xx</b></p> <table border="1"> <caption>Data for % of Management Involvement by Quarter</caption> <thead> <tr> <th>Quarter</th> <th>Senior Mgt Involved</th> <th>Middle Mgt Involved</th> <th>Supervisors Involved</th> <th>Target</th> </tr> </thead> <tbody> <tr> <td>Qtr 1</td> <td>80</td> <td>75</td> <td>80</td> <td>100</td> </tr> <tr> <td>Qtr 2</td> <td>85</td> <td>75</td> <td>75</td> <td>100</td> </tr> <tr> <td>Qtr 3</td> <td>95</td> <td>80</td> <td>85</td> <td>100</td> </tr> <tr> <td>Qtr 4</td> <td>95</td> <td>85</td> <td>95</td> <td>100</td> </tr> </tbody> </table> </div>	Quarter	Senior Mgt Involved	Middle Mgt Involved	Supervisors Involved	Target	Qtr 1	80	75	80	100	Qtr 2	85	75	75	100	Qtr 3	95	80	85	100	Qtr 4	95	85	95	100
Quarter	Senior Mgt Involved	Middle Mgt Involved	Supervisors Involved	Target																						
Qtr 1	80	75	80	100																						
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Qtr 3	95	80	85	100																						
Qtr 4	95	85	95	100																						
<b>Analysis Model</b>	A goal for the improvement program is to have each level of management involved in the effort, participating 100% of the time. For levels of management where this is not the case, details below this summary need to be reviewed, to see where help is needed to get that involvement.																									
<b>Decision Criteria</b>	The goals are set by organization, generally requiring action when the number not participating is large enough to hinder deployment of the changes. A small percentage not participating may be a problem, if business value requires that all organizations deploy the changes at the same time. A larger value might be tolerated if staged implementation is viable.																									
<b>Indicator Interpretation</b>	In this example, with the exception of second quarter, when other pressures may have prevailed, the organization appears to be gradually getting effective management involvement in their improvement program.																									

<b>DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)</b>	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	At each scheduled meeting For each assigned action item
<b>Responsible Individual</b>	Process group member
<b>Phase or Activity in which Collected</b>	Not applicable; collected by meeting and action item throughout the year
<b>Tools Used in Data Collection</b>	Simple spreadsheet
<b>Verification and Validation</b>	Meeting minutes provide lists of invitees and participants, as well as status of assigned action items
<b>Repository for Collected Data</b>	Process Group measurement database

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	Monthly
<b>Responsible Individual</b>	Process group member
<b>Phase or Activity in which Analyzed</b>	Throughout the improvement project, all phases
<b>Source of Data for Analysis</b>	Meeting minutes
<b>Tools Used in Analysis</b>	Excel or other measurement tools
<b>Review, Report, or User</b>	Process Group Management Teams Executive Leadership

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	This measure is likely to be needed on a sub-organization, as well as over the total organization, to be able to address those areas where management support is marginal.
<b>Implementation Considerations</b>	Getting appropriate levels of involvement generally requires that the managers have some active role in the improvement effort. Thus, to sustain the involvement in meetings and monitoring, each manager should have some role in the development and/or deployment of the improvements underway.

## MEASUREMENT INFORMATION SPECIFICATION – TECHNICAL PERFORMANCE LEVEL

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	How well does the process suit its users?
<b>Information Category</b>	Process Improvement Progress – Product Quality

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Functional Correctness

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	Process item (process, procedure, or other process asset)
<b>Attributes</b>	<p>Typical attributes to monitor include:</p> <ul style="list-style-type: none"> <li>• level of adoption of the process item</li> <li>• frequency that tailoring is required</li> <li>• usability survey results</li> <li>• number of waivers issued</li> <li>• process audit findings (non-compliances) related to the material</li> </ul> <p>For sake of describing this specific measure, we use level of adoption and process audit findings</p>

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	<ol style="list-style-type: none"> <li>1. use of process item on a project</li> <li>2. # of non-compliances for this item on a project</li> </ol>
<b>Measurement Methods</b>	Reported by quality assurance staff during audit of a project, using a checklist of all process items being monitored
<b>Type of Method</b>	Objective
<b>Scale</b>	<ol style="list-style-type: none"> <li>1. yes/no</li> <li>2. count of non-compliances</li> </ol>
<b>Type of Scale</b>	<ol style="list-style-type: none"> <li>1. nominal</li> <li>2. ratio</li> </ol>
<b>Unit of Measurement</b>	<ol style="list-style-type: none"> <li>1. value (yes, no)</li> <li>2. integer values</li> </ol>

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	<ol style="list-style-type: none"> <li>1. % using process item</li> <li>2. number of non-compliances</li> </ol>

<b>Measurement Function</b>	<ol style="list-style-type: none"> <li>for a given time period, sum number of users of each process item of interest across all active projects and divide by number of projects to get % using each item</li> <li>sum count of non-compliances for each process item across all active projects</li> </ol>
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<b>INDICATOR SPECIFICATION</b>																																				
<b>Indicator Description and Sample</b>	<div style="text-align: center;"> <p><b>Technical Performance Level of New Process Assets, as of April 20xx</b></p> <table border="1"> <caption>Estimated Data from Chart</caption> <thead> <tr> <th>Month</th> <th>% Adoption of PM Plan</th> <th>% Adoption of Estimation worksheet</th> <th># non-compliances for PM Plan</th> <th># non-compliances for Estimation</th> <th># Non-compliance Target</th> <th>Adoption Target</th> </tr> </thead> <tbody> <tr> <td>Jan</td> <td>78%</td> <td>82%</td> <td>15</td> <td>12</td> <td>10</td> <td>25</td> </tr> <tr> <td>Feb</td> <td>85%</td> <td>75%</td> <td>12</td> <td>10</td> <td>10</td> <td>28</td> </tr> <tr> <td>Mar</td> <td>92%</td> <td>80%</td> <td>10</td> <td>8</td> <td>5</td> <td>30</td> </tr> <tr> <td>Apr</td> <td>95%</td> <td>85%</td> <td>8</td> <td>6</td> <td>5</td> <td>30</td> </tr> </tbody> </table> </div>	Month	% Adoption of PM Plan	% Adoption of Estimation worksheet	# non-compliances for PM Plan	# non-compliances for Estimation	# Non-compliance Target	Adoption Target	Jan	78%	82%	15	12	10	25	Feb	85%	75%	12	10	10	28	Mar	92%	80%	10	8	5	30	Apr	95%	85%	8	6	5	30
Month	% Adoption of PM Plan	% Adoption of Estimation worksheet	# non-compliances for PM Plan	# non-compliances for Estimation	# Non-compliance Target	Adoption Target																														
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<b>Analysis Model</b>	As the processes are rolled out, there are likely to be some projects which cannot immediately adopt them, for various reasons – project already underway, project has committed to customer to use other processes, etc. Thus the initial adoption target may be less than 100%. As those barriers are removed, though, the target is raised, and progress is monitored to those targets. Adoption should reach the targets, if the process material is a good fit to its purpose. Non-compliances might exist initially, as teams adjust to the new process, but should gradually approach zero, if the item is a good fit.																																			
<b>Decision Criteria</b>	If the adoption and compliance levels do not reach targets at the rate planned, further examination is warranted, perhaps through surveys or studying lessons learned.																																			
<b>Indicator Interpretation</b>	In this case, it appears that the adoption is meeting its plan, though initially projects had difficulty with compliance.																																			

<b>DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)</b>	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	Each process audit of a project
<b>Responsible Individual</b>	Quality Assurance Staff
<b>Phase or Activity in which Collected</b>	Throughout the project
<b>Tools Used in Data Collection</b>	Audit checklists

<b>Verification and Validation</b>	Project team review of audit findings
<b>Repository for Collected Data</b>	Quality Assurance audit data repository

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	Monthly
<b>Responsible Individual</b>	Process improvement team leaders
<b>Phase or Activity in which Analyzed</b>	Throughout deployment; may be useful to monitor for first year of use on significant process items.
<b>Source of Data for Analysis</b>	Quality Assurance data
<b>Tools Used in Analysis</b>	Excel or other measurement tools
<b>Review, Report, or User</b>	Management teams Process improvement group

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	This measure addresses how well the process material developed by the process improvement effort fits the needs of the people who will use it, that is, how widely the material is used on a regular basis in their work. If there is a need to adapt or tailor the material, it is an indication of inadequate fit to the intended function.
<b>Implementation Considerations</b>	Regular audits need to be done, in order to get useful data on a timely basis

## MEASUREMENT INFORMATION SPECIFICATION – TAILORING DIFFICULTY

INFORMATION NEED DESCRIPTION	
<b>Information Need</b>	How difficult is it for projects to use a particular process item? How often must it be tailored, and how much effort is required?
<b>Information Category</b>	Process Improvement Progress – Product Quality

MEASURABLE CONCEPT	
<b>Measurable Concept</b>	Portability

ENTITIES AND ATTRIBUTES	
<b>Relevant Entities</b>	1. process item used by a project
<b>Attributes</b>	1. tailoring required 2. effort to tailor

BASE MEASURE SPECIFICATION	
<b>Base Measures</b>	1. tailoring performed 2. tailoring effort
<b>Measurement Methods</b>	Collect actual effort required to tailor, by process item
<b>Type of Method</b>	Objective
<b>Scale</b>	1. yes/no 2. hours of effort
<b>Type of Scale</b>	1. nominal 2. ratio
<b>Unit of Measurement</b>	1. individual process item for an individual project 2. hours spent by all project personnel involved in the tailoring

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	% Users who Tailor
<b>Measurement Function</b>	Across all projects using the process item, compute the number of projects on which the item was tailored and divide by the total number of projects using the item.

DERIVED MEASURE SPECIFICATION	
<b>Derived Measure</b>	Mean Time for Tailoring
<b>Measurement Function</b>	Across all projects which tailored the item, compute the mean of the amount of time reported for tailoring the item.

INDICATOR SPECIFICATION																
<b>Indicator Description and Sample</b>	<p style="text-align: center;"><b>Tailoring Difficulty for Life Cycles, Alpha Process Set v. 2.1, as of January 1, 20xx</b></p> <table border="1"> <caption>Data for Tailoring Difficulty Chart</caption> <thead> <tr> <th>Life Cycle Model</th> <th>% of users who tailor</th> <th>mean # hrs required</th> </tr> </thead> <tbody> <tr> <td>Waterfall</td> <td>~80.00%</td> <td>~35</td> </tr> <tr> <td>Crystal</td> <td>~55.00%</td> <td>~10</td> </tr> <tr> <td>XP</td> <td>~40.00%</td> <td>~5</td> </tr> <tr> <td>Package</td> <td>~95.00%</td> <td>~15</td> </tr> </tbody> </table>	Life Cycle Model	% of users who tailor	mean # hrs required	Waterfall	~80.00%	~35	Crystal	~55.00%	~10	XP	~40.00%	~5	Package	~95.00%	~15
Life Cycle Model	% of users who tailor	mean # hrs required														
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XP	~40.00%	~5														
Package	~95.00%	~15														
<b>Analysis Model</b>	<p>Reasons that a process item require tailoring vary. Some items (such as a waterfall life cycle or a packaged system life cycle) usually require some tailoring to fit the project well. Other items, such as an agile approach, may require tailoring because they are less mature in definition or the organization has less experience in their use.</p> <p>The fact that something requires tailoring is important to determine, but even more critical to the users is how much effort it takes to tailor the process item. If the effort is great, users tend to be dissatisfied, and the process item may need to be improved.</p>															
<b>Decision Criteria</b>	<p>For each item, there is likely to be an expectation of how much tailoring is required. If the item need to be tailored more often than expected, or it requires more effort than expected, the reasons should be examined and action be taken. If tailoring is expected, but none is reported, use of the item should be examined, to be sure it is in use and is effective.</p>															
<b>Indicator Interpretation</b>	<p>In this example, one might question why the waterfall cycle needs so much tailoring, since it is likely to be a mature approach for most organizations. The packaged system cycle seems to require little effort to tailor, but almost always needs to be tailored; some simple adjustments might make it easier to use without tailoring.</p>															

<b>DATA COLLECTION PROCEDURE (FOR EACH BASE MEASURE)</b>	
<i>Complete this section for each base measure listed on the previous page.</i>	
<b>Frequency of Data Collection</b>	At the end of each project planning period
<b>Responsible Individual</b>	Project Manager
<b>Phase or Activity in which Collected</b>	Planning
<b>Tools Used in Data Collection</b>	Organization time recording mechanism, available to each individual, where time can be entered throughout the day or at the end of the day; entry must be done daily
<b>Verification and Validation</b>	Weekly review by supervisors, as well as data validation mechanisms in the time recording system
<b>Repository for Collected Data</b>	Organization time-tracking database

<b>DATA ANALYSIS PROCEDURE (FOR EACH INDICATOR)</b>	
<b>Frequency of Data Reporting</b>	By release of Process Set, or as needed for analysis
<b>Responsible Individual</b>	Process Group
<b>Phase or Activity in which Analyzed</b>	Project Planning
<b>Source of Data for Analysis</b>	Report solicited from Project Managers or Quality Assurance Staff
<b>Tools Used in Analysis</b>	Organization time-tracking database; summary report from project manager
<b>Review, Report, or User</b>	Process Group Management Teams Executive Leadership

<b>ADDITIONAL INFORMATION</b>	
<b>Additional Analysis Guidance</b>	So that process materials are not modified unnecessarily (and then revert to prior versions), process groups should ensure that results reported represent the majority of users of the process materials before reacting to reported results. It is likely that new users will need to do some tailoring to adapt to new items, which over time will require less change. Needs of different sizes of projects may also vary.
<b>Implementation Considerations</b>	Collecting tailoring data by process item is likely to be onerous, if there are many small items, thus this measure should focus on the large-grained items such as project life cycle descriptions and project WBS templates.