

# Software Configuration Management (SCM) Support Process Capability Maturity Model.

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## **Abstract**

Software Configuration Management (SCM) is a concept of trying to group the changing artifacts of software development to try to manage the complexity of modern day software. This paper provides a roadmap for improving the SCM support process based on a meta-model. I developed a model that defines key practice areas that are important for the SCM support group. The model deals with the process, quality assurance and usability aspect of the SCM activities. A questionnaire to assess the state of the current process and a mapping of the questions to the model is also presented. This is the first attempt at dealing with the support aspect of the SCM part of software development.

**Keywords:** Software Configuration Management, process improvement, meta-model, key practices, quality assurance, usability.

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## 1. Introduction

Software is becoming increasingly complicated with millions of lines of code and thousands of files in most projects. This increasing complexity requires innovative management techniques in all aspects of the software development cycle. One such technique called Software Configuration Management (SCM) is used to manage different software configurations of the evolving software products.

Software Engineers are constantly changing the software products and need an efficient method for tracking and managing these changes. There is a need for the capability to go to any version of the software to determine what changes were made, by whom and why. For example, developers may have to go back to old versions during maintenance phases to fix bugs. SCM helps deal with these and other related issues.

There are a variety of tools available to help with the tasks of software configuration management. These tools vary from free and usually unsupported tools to commercial tools that cost hundreds and even thousands of dollars in licensing and support costs for each developer. There are online resources and survey results [1] and research papers [2] that provide overview of the tools available to describe the capabilities of tools.

There are standards [3, 4] that explain what SCM is and how to go about creating plans to deal with SCM issues. There are detailed discussions of models to represent the change process in different projects and situations [5]. However, there is very little research in defining a formal method or model for supporting SCM activities.

Typically software companies that have multiple projects and products, create a SCM group that supports the entire organization. These groups specialize in the SCM tools/environment and methodology. They help the individual projects meet their SCM requirements. This eliminates the need for each group to create their own SCM solution. In addition the SCM group helps provide consistency within the organization and aids in managing SCM activities in a controlled and effective manner.

The SCM group typically follows some process in providing support to its customers. This process may be defined and documented or may be informal. The process and its maturity level will determine the level of support and customer satisfaction that the group can achieve. What is needed is a model that guides a new or existing SCM support group to assess where they stand and how to improve what they are trying to accomplish. At present there is no such model for SCM support groups to use. There are ANSI and ISO standards that explain

what SCM is all about and how to develop plans. There is also research on SCM activities but nothing exists for providing any guidance for the SCM support process.

In this report I provide a model to guide a SCM support group to understand what things should be a part of the process. A questionnaire is provided to help a group assess where they stand so that they can start to improve their process. The goal is to enable the SCM support group to provide the best possible service to the development and management communities.

I have defined key areas that have to be focused on and practices and procedures that should be defined and dealt with adequately for providing successful SCM support. The model helps assess the level of process maturity for a SCM group and provides insights into how to continuously improve the support process. It also helps set and clarify expectations for all parties involved.

This paper is organized as follows: in the next chapter I provide an overview of process improvement models that provide a framework for continuous process improvement efforts. The next chapter describes the meta model that serves as the framework for defining the SCM support model. Next I present an overview of the SCM; what it is, why it is needed and what are the main concepts of SCM. This is followed by a discussion of some typical activities of a SCM support group. This is followed by the main topic of this paper, the SCM Support Process Model. This is the section where I define the motivation for having the model and its contents. The model focuses on the process, quality assurance and usability aspects of the SCM support process. This is followed by information about the questionnaire that I developed for assessing the process maturity of SCM support group. The results of a pilot survey, possible directions for future work and conclusions are given in the final chapter. The actual questionnaire used in the survey is presented in Appendix A and is followed by a co-relation between the questionnaire and the parts of the Model in Appendix B.

## **2. Process Improvement Models**

In order to improve any process there a number things that have to happen. First of all management has to agree that there is a need to improve the process and be willing to provide the resources that are needed. Once the sponsorship for process improvement has been gained it is important to understand where the process is and what it should look like at the end of the improvement cycle. Goals for the effort have to be set. A reference model for the process that is being studied is very crucial as it provides a framework to work in and guides the design of the final process that is to be achieved. There has been considerable research in the process improvement field and some models are

highlighted in this section to help define a framework for using the model that I have developed.

The IDEAL<sup>SM</sup> model [6] developed by the Software Engineering Institute (SEI) provides an excellent framework for understanding the cycle of ongoing process improvement and how the various activities fit together. The IDEAL model has five phases: Initiating, Diagnosing, Establishing, Acting and Learning. Activities in the Initiating phase lay the groundwork for a successful improvement effort. They include defining the stimulus for improvement, obtaining sponsorship, and establishing the infrastructure. In the Diagnosing phase the current process is assessed relative to where the organization wants to be and recommendations for improvement are generated. Activities in the Establishing phase help plan the specifics of how to reach the destination and include setting strategies and priorities, acting on the assessment report and developing a process improvement action plan. The Acting phase activities are carrying out the plans formulated in the previous phase and defining processes and measures. In the final phase, Learning, the results from the changes to process are analyzed and documented and used in the formulation of a future actions. It in turn forms the basis for iterating the entire IDEAL process again.

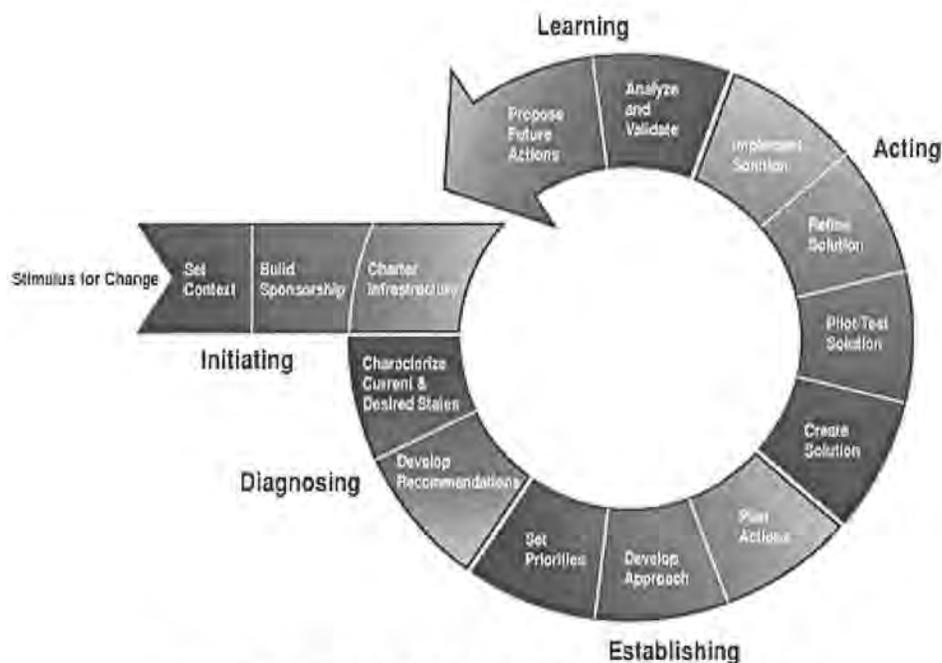


Figure 1. Ideal Model for Process Improvement.

**I – Initializing:** Laying the groundwork for a successful improvement effort.

- D – Diagnosing:** Determining where you are relative to where you want to be.
- E – Establishing:** Planning the specifics of how you will reach your destination.
- A – Acting:** Doing the work according to the plan.
- L – Learning:** Learning from the experience and improving your ability to adopt new technologies in the future.

Many process models have been proposed to aid in the diagnosing stage of the IDEAL model. A process is assessed against the model and recommendations for improvement are generated from the assessment. These recommendations serve as a basis for the action plan generated in the next IDEAL phase, namely the Establishing phase. SEI's Capability Maturity Model for Software (SW-CMM, or CMM<sup>sm</sup> for short) [7] and its latest version being worked on (CMMI-SE/SW, or CMMI<sup>sm</sup> for short) [8] provide organizations with guidance for controlling and improving their overall software development and maintenance processes. In these models maturity levels serve as the basic organizational framework. The models has five maturity levels where each maturity level can be considered as a plateau and serves as a foundation for the next higher level. In the CMM, an organization improves its process capabilities by successively moving up the maturity levels.

### 3. Process Maturity Meta-Model

Software process models, such as CMM, seem so focused on the process that they ignore the quality of the resulting product. These models assume that a high quality or mature process will automatically produce a high quality product. In a recent article [9], process-oriented methods are taken to task for their process preoccupation. The emphasis on assessing quality rather than achieving it is the major shortcoming of these methods. I believe that the assignment of a maturity level to an organization's software development process is a major contributing factor in this rigid preoccupation with process. I believe that the product or deliverables created as a part of the process should be included as part of the process assessment. In particular I believe that the quality assurance and usability of these products or deliverables serve an important role in evaluating the process.

The meta-model [10] was developed to overcome some of the assessments shortcomings mentioned above, and especially to help produce more useful information to proceed with the action planning. Its main purpose is to serve as a guide for the identification of key practices that will drive the process assessment. The meta-model has been devised to be used for single-focus process areas and considers aspects related to the process as well as the process of assuring the quality and usability of end products or deliverables produced by that process.

When identifying the key practices for any process the meta-model uses three categories of core process, quality assurance and usability of the products and services being produced. Each of these categories is divided into four phases of identify, monitor, measure and feedback. In the identify phase the key practices for each category are defined and documented. Once these key practices are defined it is important to monitor adherence to the policies and procedures defined. In addition to monitoring we have to measure the effectiveness of the process to see how well the process is working. Based on the monitoring and measurements we have to generate recommendations for improving the process, validate these recommendations and incorporate them into the process for continuous improvement.

The meta-model helps us identify the contents of the model for the process we want to improve. The model acts as a guide for what the process should look like and provides a framework for assessing and improving the current process. The following table provides a view of the different components of the meta-model.

Phase	Meta Practices		
	Core Process	Quality Assurance	Usability
<b>Identify</b>	Define important elements	Define important elements	Define important elements
<b>Monitor</b>	Monitor adherence	Monitor adherence	Monitor adherence
<b>Measure</b>	Define, collect and analyze measures	Define, collect and analyze measures	Define, collect and analyze measures
<b>Feedback</b>	Generate, evaluate and incorporate recommendations	Generate, evaluate and incorporate recommendations	Generate, evaluate and incorporate recommendations

**Table 1.** Process Maturity Meta-Model.

This meta-model was used to develop the SCM support model presented in this paper. The process, quality assurance and usability aspects of the SCM support process were considered and adequate key practices were identified for each aspect of the support process. Each of the three categories were further divided into four areas to determine what practice areas have to be defined in the identify part, what has to be monitored, what measurements are necessary for

analyzing the process and how to incorporate the feedback that is generated to improve the process iteratively.

## **4. Software Configuration Management (SCM)**

In this section I will briefly discuss what SCM is, the problems it tries to solve and the main concepts of SCM.

### **4.1. What is SCM?**

Software Configuration Management (SCM) extends management disciplines to the software development process. SCM is a part of the software engineering process that deals with managing changes to the various artifacts that are generated in any software project. It helps in identifying the important items for each phase of the software development lifecycle, setup policies for managing changes to these items and provide the tools to help in the management of these items. SCM tools allow users to store information related to the different aspects of each artifact of the software products and retrieve it as needed. Users can get status information about the current state, what was done, by whom and when to any particular item.

### **4.2. Why we need SCM?**

Software Configuration Management is practiced in some form whether it is planned or not in any project that involves interaction between several individuals. Even groups that do not develop a formal SCM policy and plan, follow some norms that help them coordinate amongst each other to get the work done. By using the SCM principles the group can develop a rigorous plan to deal with the each aspect of the project and communicate it with all the teams and organizations. There are fewer chances of misunderstandings and everyone knows what is expected instead of coming up with ad hoc solutions to problems as they arise.

### **4.3. Main Concepts of SCM**

SCM has two main parts to it; identify what has to be managed (policy) and then provide tools to manage the process (implementation). Developing a policy is very crucial part of any SCM activity. It lets those involved plan what they want to do and asis equivalent to the design phase of a software project.

The implementation or how part comes later and is determined by the policies that have to be implemented.

Small projects can get away with some informal planning and implementation. However larger projects especially those with multiple development teams involved require detailed planning and documentation. This helps communicate the policies to everyone and reduces confusion.

### **4.3.1 Configuration Identification**

The first thing that has to be done is to determine what items are of importance and what kind of information has to be maintained about each item. This is very crucial because it will determine the kind of tools have to be used to implement the policies. It is important to decide on the procedure for adding and removing items from the configurations and how to determine the state of each item. Typically Configuration Change Boards (CCB) are created to deal with these issues. This allows management to determine the status of the project at any given time.

The main topics covered in this phase are:

- definition of the product structure and selection of configuration items
- documentation of configuration items
- definition of numbering/versioning scheme
- establishment of a configuration baseline

### **4.3.2 Change control**

Once items to be managed have been identified policies for controlling changes to these items have to be established. The level of formality of these decisions varies for each project and each group. Some may have very informal guidelines as to who can make changes and the process for notifying others about the changes. Whereas other groups may have very formal procedures for requesting a change, getting approval, reviewing the change and getting final approval before the change can be incorporated into the product.

The main topics covered in this phase are:

- document and justify a change
- evaluate consequences of a change
- implement and verify a change
- process deviations and waivers

### **4.3.3 Status Accounting**

There has to be some method for determining the status of the project. Policies to determine and report the status of the project have to be determined. Each organization establishes a set of procedures for dealing with status accounting. Again the level of formality vary for each group and project.

The main topics covered in this phase are:

- planned and approved baseline
- actual baseline
- design/build standard control including deviations
- status reports

### **4.3.4 Audit and Review**

After the changes have been made there has to be a defined procedure to verify and validate that the final product meets the requirements. There are two main formal audits; functional and physical configuration audit. Functional configuration audit involves verification that the development of a configuration item has been completed satisfactorily, that the item has achieved the performance and functional characteristics specified in the functional and allocated configuration identification, and that its operational and support documents are complete and satisfactory. The physical configuration audit verifies that a configuration item, as built, conforms to the technical documentation that defines it.

The main topics covered in this phase are:

- functional configuration audit
- physical configuration audit

## **5. Role of SCM Support Team**

A software development organization may choose to create a Software Configuration Management (SCM) team to support the SCM activities for its projects. This allows all the projects to leverage the expertise of a cohesive group without having to develop and duplicate such expertise in each individual group. Also having one central group can promote consistency in policies and procedures by creating a development environment that supports best practices while giving the flexibility to customize the development environment to meet the needs of individual projects. In this section I will be discussing some of the activities performed by the SCM support group. The activities listed below are

examples and not a required set of tasks that every SCM support group should support.

1. **Policy creation:** The SCM support group defines a standard set of policies and procedures that based on research in the SCM field and experience of the team members. This helps create a framework for effective SCM activities and software development environment. The SCM group also guides individual project teams implement and adapt the standard organizational policies to meet the needs of individual group.
2. **Development infrastructure models:** Each project has its individual requirements that can change with time. Resource requirements can vary based on the size of the team, the structure of the team (e.g., co-located team vs. distributed team etc.), the product being developed, the platforms that need to be supported, the stage of the product life-cycle. The SCM group helps the individual teams develop an infrastructure model to support their development requirements. This includes requirement definition, testing of suggested models, ensuring scalability of solution to meet future growth needs, special requirement like distributed team support etc. Typically the SCM support group will have standard models that have been tested and will help the team adapt these models to meet the requirements of the project.
3. **SCM repository management:** The SCM group is responsible for the creation of SCM repository and managing their availability, size, usability etc. The development project teams have the ability to create new elements in the repository and check things out, modify them and check in new version. However the SCM group may choose to restrict the deletion or modification of permissions etc for SCM contents. This allows the SCM group to ensure that all relevant repository data and history is maintained. The SCM group also defines branching, version management, configuration management and other policies related to SCM repository contents. The SCM group is also responsible for developing policies and mechanisms to support team requirements for distributed teams that require sharing of repository data and issues like security and data consistency that arise from such usage models.
4. **SCM mechanisms:** The SCM support group is responsible for defining and implementing some standard SCM mechanisms to manage and control SCM repository contents. The mechanisms vary based on the organization and the individual projects using the repository. The SCM support group may help individual project groups define and implement mechanisms to meet project requirements but the amount of involvement for the SCM support group is typically negotiated for each requirement.

5. **Development tool support:** The SCM group is typically responsible for testing new development tools and incorporating them into the development environment. Individual groups may use their own custom tools to meet the development needs but the core set of tools is supported by the SCM group. This provides consistency amongst different groups and all groups can benefit from the centralized support of the core development tools.
6. **Resource management:** The SCM group is usually responsible for managing resources to ensure availability of the SCM repository etc. This in turn requires them to manage things like hardware resources for the repositories, network infrastructure to provide adequate access etc. In addition the SCM support group may help project groups identify critical resources needed for development work and aid in developing resource requirement and management plans. This would be especially useful when starting new projects as it would help determine the adequacy of current resources to support the additional requirement and have additional resources be identified and in place before they are needed.
7. **Risk management:** The SCM group has to ensure the availability of SCM repositories, tools and other resources that it is responsible for. It has to do some level of risk management planning to ensure adequate response in emergencies. The SCM group may also be responsible for helping project groups do risk management planning based on their knowledge and experience with the development environment.
8. **Build systems:** The SCM support group may be involved in the definition and implementation of a standard build system that allows individual project groups build their software. This would provide consistency in how different products developed by an organization get built and would leverage from having a standard system in place and not having to develop a new one for each product.
9. **Test systems:** The SCM support group may be involved in the definition and implementation of a test system that provides a standardized procedure for testing the product being worked on by different groups.
10. **Software life-cycle models:** The SCM support group may be involved in defining the life-cycle for each product. The involvement would be especially important when defining the requirements for each stage of product development because the SCM group would be the one supporting the development activities.
11. **Training:** The SCM group is typically responsible for providing training related to the development environment, tools supported and SCM activities,

procedures and policies. This can be especially beneficial for educating new developers about the procedures and policies of the organization.

## 6. SCM Support Process Model

Support activity of any kind is interrupt driven and reactive by nature. Customer requests vary in nature and frequency and it is difficult to plan what needs to be done on any particular day. However, there are a number of things that can be done to move a support from fire-fighting mode to a more organized method. The first step in doing this is to develop a model for what the group does, procedures to be followed and processes that are clearly explained to the customers so that expectations are set correctly.

First of all there has to be a clear and documented model for activities that the support group has to perform. This model should include details about what should be done in each situation. The support group members have to be educated about the policies and procedures of the group and there has to be a channel for handling requests that are not defined in the model. Customers have to be educated about the support model, clear expectations have to be set, and there should be a clear list of requirements that have to be met before a support request can be handled. This makes the support process a lot more smoother as all parties involved know exactly what is expected from others. Also such a model allows for assessment of the support process to identify areas that need improvement and to develop a plan for improving productivity and effectiveness.

The following model for supporting SCM activities has been developed using the Meta-Model described in "A Meta-Model for Software Process Maturity" [10]. The model focuses on three key areas; the process, quality assurance and usability aspects of SCM support activities. Each of these key areas is further divided into the identify, monitor, measure and feedback category.

For each category in the three areas of the model I present the main key practice followed by sub practices where appropriate. For some of the key practices I provide questions that help identify areas of importance for that key practice. These questions are provided merely as guidelines for possible contents of the policy or procedure and not a requirement. Each organization will define these policies and procedures to tailor the process to meet individual needs.

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## 6.1 Key practices for SCM support activities – Core Process

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The following key practices are necessary for defining the process for conducting the SCM support activities.

### 6.1.1 Identify

#### 1. Define policy for importance of SCM

*-Why have the group*

#### 2. Define SCM support process

*-What things need to get done*

##### 2.1 Define policy for determining support requirements

- *What tasks/activities are supported by the group?*
- *What support is needed from other groups?*
- *What is the procedure for handling support requests?*
- *Are expectations for response times communicated to and agreed upon by the users?*
- *What is the escalation process? How is it communicated to the users?*

##### 2.2 Define policy for assessing resources to meet support requirements

##### 2.3 Define policy for SCM group training

##### 2.4 Define group communication policy

- *Identify groups that have to be notified for different situations, e.g. developer community, management and others affected by SCM support activities.*
- *Who is responsible for communications?*

#### 3. Define activities of SCM support group

*-What does the SCM support group do*

##### 3.1 Define policy for providing change control mechanisms

- *What change control mechanisms are needed?*
- *What is the scope and complexity of control mechanism?*
- *Who implements these mechanisms?*

### 3.2 Define policy for providing status accounting mechanisms

- *What status accounting mechanisms are needed?*
- *Who implements these mechanisms?*
- *Who is responsible for monitoring the mechanisms?*

### 3.3 Define policy for providing audit mechanisms

- *What audit mechanisms are needed?*
- *Who implements these mechanisms?*
- *Who is responsible for monitoring the mechanisms?*

### 3.4 Define policy for customizing the SCM environment for individual group needs.

- *What development team structures are supported? How are distributed teams, remote development sites and new acquisitions etc. handled?*
- *Are special mechanisms needed for supporting distributed teams?*
- *How is repository data accessed and manipulated?*

### 3.5 Define policy for managing SCM repositories

- *Who controls repository creation?*
- *What is the initial content of repository? Who decides?*
- *How is the size and complexity of the repository managed?*
- *Is there a policy for archiving unused repositories?*
- *What is the version management policy*
  - *What is the version numbering scheme?*
  - *Is there a version labeling convention?*
- *What branching conventions are used?*
- *How is parallel/concurrent development co-ordinated?*
- *How is workspace creation management handled?*

### 3.6 Define a policy to identify development tools requirements

- *What is the procedure testing new tools?*
- *How are new tools introduced into the development environment?*
- *How long are tool versions maintained?*
- *Who supports development tools and at what levels?*
  - *How is this information communicated to and agreed upon with the development community?*
- *What are the guidelines for training team members?*
  - *What level of training is needed to support each tool?*
  - *Is there cross training within the group to provide redundant coverage?*

### 3.7 Define resource management policy

- *What is requirement assessment procedure for resource needs?*
- *Who is responsible for providing the resources?*
- *Who monitors resource usage?*
- *What usage control mechanisms are needed and used?*

### 3.8 Define risk management policy.

- *Is there a process to assess risks of changes being made?*
- *Is there an assessment of risk when starting new projects?*
  - *What is the impact on resources?*
- *Is there adequate skill level and resources to support new tools, methodologies etc?*
- *Are crucial resources identified?*
- *What is the risk management plan if a repository or resource is not available?*

## 6.1.2 Monitor

### 1. Monitor adherence to SCM support process.

- 1.1. Monitor support requests and compliance to policies when handling them.
- 1.2. Monitor communications between the support group and its customers
- 1.3. Monitor adequacy of head count in support group.
- 1.4. Monitor SCM support group member training.

### 2. Monitor completion of SCM support group activities.

- 2.1. Monitor change control mechanism availability and functioning.
- 2.2. Monitor status accounting mechanism availability and functioning.
- 2.3. Monitor audit mechanism availability and functioning.
- 2.4. Monitor SCM environment customization requests.
- 2.5. Monitor adherence to SCM repository management policies.
- 2.6. Monitor development tool usage and requests for new tools and versions.
- 2.7. Monitor resource usage.
- 2.8. Monitor compliance with risk assessment and management policy.

## 6.1.3 Measure

### 1. Define measures of SCM support process

- 1.1. Measure response time for support requests

- 1.2. Measure time to resolve issues
- 1.3. Track requests that require escalation of issues.
- 1.4. Track requests that require acquisition of new knowledge.
2. **Define measures of SCM activities performed**
  - 2.1. Measure number of requests for each type of SCM support activity
  - 2.2. Measure amount of time spent in performing each type of SCM support activity
3. **Define activities to collect measures of SCM process performance**
4. **Define activities to collect measures of SCM support group activities performed**
5. **Define activities to analyze measures of SCM process performance**
6. **Define activities to analyze measures of SCM support group activities performed**

#### **6.1.4 Feedback**

1. **Generate recommendations for process improvement based on analysis of SCM process measurements**
2. **Evaluate recommendations for process improvement based on analysis of SCM support process**
3. **Evaluate SCM support group recommendations**
4. **Incorporate recommendations into SCM support process**

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## 6.2 Key practices for SCM support activities – Quality Assurance

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The following key practices are necessary for providing quality assurance for SCM support activities.

### 6.2.1 Identify

1. **Define policy for importance of quality assurance of SCM support group**
  - 1.1. Define quality assurance policies for change control mechanisms
    - *Does it do what was expected?*
    - *Is this what the customer really wanted?*
    - *Is the change control mechanism in agreement with SCM policies?*
  - 1.2. Define quality assurance policies for status accounting mechanisms
  - 1.3. Define quality assurance policies for audit mechanisms.
  - 1.4. Define policy to ensure implementation of the SCM environment customizations meet customer requirements?
    - *Are adequate resources available to support the team structure.*
    - *Are challenges of specifics like distributed development addressed adequately?*
      - *What is the policy and procedure for sharing data between sites?*
      - *How are security issues handled?*
      - *Are data access/networking resources adequate?*
      - *Support issues may require special handling due to possible geographical separation?*
  - 1.5. Define policy to assure validity of SCM repository contents..
    - *How is the completeness and correctness of the SCM repositories contents assessed?*
    - *Is there any verification that version management schemes are being used correctly?*
    - *Are work products developed concurrently or in parallel checked for correctness and completeness?*
    - *Are appropriate versions and configuration information maintained for the entire life cycle of the product?*
    - *Is it possible to re-create all releases that are supported at any given time*

- *Are the workspace contents checked for correctness and completeness?*

1.6. Define policy to assure tool availability and correctness of tool functionality.

- *Are correct development tool versions being used?*
- *Are correct tool versions available for the entire life-cycle of products?*
- *Is backward compatibility of new tools tested before being incorporated into the development environment?*

1.7. Define policy to assure adequate resource availability

- *What is the procedure for ensuring availability of resources?*
- *Are there any controls to restrict resource usage for authorized purposes only?*
- *Is adequate planning done to ensure resource availability? Are there guidelines for such planning?*
- *How is cost of resource of unavailability measured and reported?*

1.8. Define policy to assure proper risk management activities are being performed.

- *Is there a procedure for identifying the possible risks of each activity?*
- *Is there a procedure to determine the participants needed to analyze particular activity or situation?*
- *What is the procedure to select a course of action?*
- *Are the results of risk analysis shared with those effected?*

## **2. Define factors that define quality of SCM support activities**

- 2.1. Identify measure of completeness for each activity
- 2.2. Identify measure of correctness of each activity
- 2.3. Identify the success criteria or each support request

## **3. Define activities to verify quality of SCM activities performed**

- 3.1. Define procedure to ensure that results of support activities are consistent with policies and changes don't conflict with previous decisions.

### **6.2.2 Monitor**

- 1. Monitor adherence to quality assurance policy for SCM activities**
- 2. Monitor quality of SCM support activities**

### **6.2.3 Measure**

- 1. Define measures of quality assurance of SCM support activities**
- 2. Define activities to collect measures of SCM support activities**
- 3. Define activities to analyze measures of SCM support activities**

### **6.2.4 Feedback**

- 1. Generate recommendation for process improvement based on SCM support quality measures**
- 2. Evaluate recommendations for SCM support process**
- 3. Incorporate recommendations into SCM support process**

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## 6.3 Key practices for SCM support activities – Usability

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The following key practices are necessary for determining the effectiveness of SCM support activities. These key practices help ensure that the support process is able to meet the needs of the users and is in sync with the changing requirements of end-users.

### 6.3.1 Identify

1. **Define policy for importance of user satisfaction with SCM support activities**
2. **Define factors that determine user satisfaction with SCM support activities**
  - *Request was met within expected time limits for the urgency level*
  - *Activity performed was correct*
  - *Solution was satisfactory*
  - *User was consulted about the completion of request*
3. **Define activities to verify user satisfaction with SCM support**
  - *Randomly survey users about their support requests*
  - *Identify measures for survey*
  - *Set goals for satisfaction levels*

### 6.3.2 Monitor

1. **Monitor adherence to SCM support user satisfaction policy**
2. **Monitor user satisfaction with SCM support activities**

### 6.3.3 Measure

1. **Define measures of user satisfaction with SCM support activities**
2. **Define activities to collect measures of user satisfaction with SCM support activities**
3. **Define activities to analyze measures of user satisfaction with SCM support activities**

### **6.3.4 Feedback**

- 1. Generate recommendation for process improvement based on SCM support user satisfaction measures**
- 2. Evaluate recommendations for SCM support process**
- 3. Incorporate recommendations into SCM support process**

## **7. Questionnaire**

Based on the key practices identified in the model above a questionnaire was created to conduct a high level assessment of an organization's SCM support process. The Questionnaire is given in Appendix A . The questions attempt to ascertain whether policies and procedures for the key process areas were in place and documented and that there was some type of monitoring measurement and feedback where appropriate. The contents of the policies were not assessed because each organization has differing needs and goals.

A mapping between the questions and the parts of the model they deal with is provided in Appendix B. This table helps in identifying the areas of weakness in the organization's support process. The questionnaires helps assess the SCM support process by determining the degree to which the key practices are being carried.. Are procedures and policies defined and documented, is compliance to these policies and procedures tracked and are appropriate measurements made to see how well things are being done, and are the recommendations based on the measurements fed back into the process?

The questionnaire helps identify the areas that are weak and need to be improved. The group can create plans for defining and documenting their process based on the model and tune the support process based on the results of monitoring and measurements. The current questionnaire provides a first level of assessment and can be used repeatedly to check the impact of changes on the process.

## **8. Survey Results**

I conducted a small pilot survey to test my model. SCM support team members, managers and members of the development community were surveyed. In all 15 people were surveyed.

The following tables summarize the results of the survey. The mapping of the questions to the key practices that is presented in Appendix B was used to relate the results to the individual key practices for each part of the model. Three

tables are provided for the Process, Quality Assurance and Usability categories of the model. Each table is further divided into the four phases of identify, monitor, measure and feedback. The key practices for each phase and the rating are tabulated. The numerical rating scale is: None = 1, Some = 2, Most = 3, and All or Always = 4.

The rating scale described above are used to rate how well each Key practice in the model is being dealt with in the organization being assessed. The result of the pilot assessment survey are as follows.

### Core Process

Phase	Key Practices	Rating
Identify	Define policy for importance of SCM	2.0
	Define SCM support process	3.1
	Define activities of SCM support group	2.4
Monitor	Monitor adherence to SCM support process.	2.2
	Monitor completion of SCM support group activities.	2.4
Measure	Define measures of SCM support process	2.4
	Define measures of SCM activities performed	2.4
	Define activities to collect measures of SCM process performance	1.9
	Define activities to collect measures of SCM support group activities performed	2.1
	Define activities to analyze measures of SCM process performance	1.8
	Define activities to analyze measures of SCM support group activities performed	2.0
Feedback	Generate recommendations for process improvement based on analysis of SCM process measurements	1.8
	Evaluate recommendations for process improvement based on analysis of SCM support process	1.7
	Evaluate SCM support group recommendations	3.0
	Incorporate recommendations into SCM support process	2.3

**Table 2.** Results of Survey for Core Process.

The process portion of the model has some informal policies and very little documentation of some of the activities. Monitoring and measurements are made for some selected areas and feedback from the group members is informally incorporated into the process. Based on the comments there are some areas that are very well defined and monitored. These are areas that have caused problems in the past and were highlighted as areas that needed improvement.

## Quality Assurance

Phase	Key Practices	Rating
Identify	Define policy for importance of quality assurance of SCM support group	1.9
	Define quality factors of SCM support activities	1.9
	Define activities to verify quality of SCM activities performed	2.0
Monitor	Monitor adherence to quality assurance policy for SCM activities	1.1
	Monitor quality of SCM support activities	2.3
Measure	Define measures of quality assurance of SCM support activities	2.1
	Define activities to collect measures of SCM support activities	1.4
	Define activities to analyze measures of SCM support activities	1.3
Feedback	Generate recommendation for process improvement based on SCM support quality measures	1.3
	Evaluate recommendations for SCM support process	1.2
	Incorporate recommendations into SCM support process	1.2

**Table 3.** Results of Survey for Quality Assurance.

There are some informal norms about the quality assurance aspect of the support process. These are monitored on an ad hoc basis. Very few measurements are made and feedback for process improvement based on the QA aspect of the support process is negligible.

## Usability

Phase	Key Practices	Rating
Identify	Define policy for importance of user satisfaction with SCM support activities	2.4
	Define factors that determine user satisfaction with SCM support activities	2.5
	Define activities to verify user satisfaction with SCM support	2.2
Monitor	Monitor adherence to SCM support user satisfaction policy	2.2
	Monitor user satisfaction with SCM support activities	1.3
Measure	Define measures of user satisfaction with SCM support activities	1.4
	Define activities to collect measures of user satisfaction with SCM support activities	1.3
	Define activities to analyze measures of user satisfaction with SCM support activities	1.3
Feedback	Generate recommendation for process improvement based on	1.3

SCM support user satisfaction measures	
Evaluate recommendations for SCM support process	1.3
Incorporate recommendations into SCM support process	1.2

**Table 4.** Results of Survey for Usability.

There are some very informal guidelines about the usability aspect of the support process. Things like when to close a call and the process for verifying the completion of a task are known as group norms but are not clearly defined or documented. Monitoring of these norms is done initially when a new team member is coming up to speed but not after the initial training period. There is very little in the way of measurement other than informal input from customers and these may lead to some changes in process improvement but this too varies on the situation.

One important point that was highlighted by the comments was that a large part of the work done by the SCM support organization was reactive in nature. Major activities are planned with great level of detail but there is a lot of "fire-fighting" to deal with emergencies.

Overall the support process is very informal and lacks adequate monitoring and measurement. The process related part of the support process is the most defined and monitored, with QA and usability being very informal and with minimal monitoring and measurement. Process improvement is typically in response to situations where a particular problem has gained the attention of management.

## 9. Future Work

So far I have only conducted the survey on a small pilot group. I have presented a brief overview of the survey results in the previous section. So far I have been able to define where a group should be and where it currently stands. The next steps would be to prioritize the recommendations to develop a plan of action that defines what actions will be done to improve the process. More detailed statistics gathering is required to take snapshots of performance as changes are made. This will help in assessing the impact of each change thus helping guide process improvement in the future. A detailed study of implementing the process improvement cycle is needed to improve the implementation process itself.

I would like to further formalize the model and get some statistics to prove its validity and usefulness. This is the first version and I am sure there will

be additional things that will be necessary to provide a more comprehensive and complete model.

## 10. Conclusion

SCM is a significant part of the software development process and there is a lot of research in defining what SCM is and how to plan for SCM activities. However there is very little in the way of guidance for providing SCM support for software organizations. I hope to change this by providing a starting point in this area. The first iteration of the model that captures the process, quality assurance and usability aspects of the SCM support process and the results of a small survey are presented in this report.

The survey results show that there are very few policies and procedure that are defined for the SCM support process. The survey results also show that a majority of the support work is reactive and in "fire-fighting" mode to deal with emergencies. I believe there is a strong correlation between the two. I believe that having a defined and documented process helps in setting the expectations for both the support group and its end-users. If all parties know what is needed of them the support process can be a lot smoother and planned. This is what I plan to prove by working with the support organizations to define and document their processes and improve performance. This paper presents a beginning in this research area with lots more to come.

The Meta-model was very helpful in providing a framework for identifying area of the support process that needed to be considered. Having the four phases of identify, monitor, measure and feedback provides a natural progression for identifying key practices for each category of process, quality assurance and usability. The meta-model helps the user to make sure that all aspects of the process are dealt with. Policies and procedures have to be defined and documented and once these are in place it is important to check whether they are being used and followed as intended. Measurements allow us to check the effectiveness of the procedure and help generate feedback for improving the process. The survey results highlight the fact that most groups and organizations focus on the process part and very little attention is paid to the quality assurance and usability of the products and services being provided.

One major difficulty that I had in using the meta-model was about deciding the level of abstraction for the key practices. I generated very extensive lists of practices for each category and then had to group them into higher level key practices. Some guidelines for the level of abstraction would be helpful in guiding the process of generating a model. Overall the meta-model is very effective in generating models for any type of process that has to be improved.



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# Appendix A: Software Configuration Management (SCM) Support Process Assessment Questionnaire

## Introduction

This questionnaire is designed to provide a high level assessment of the Software Configuration Management (SCM) support process for your organization. Please answer the questions below. Please contact the author, Baljinder Singh Ghotra ([ghotra@synopsys.com](mailto:ghotra@synopsys.com)) if you have questions or need further information.

## Information About You

Please provide the following information about yourself. This information is used in case I need clarification about your responses. Information about the respondents *will not be* included in any report without the express permission of the individual.

Name \_\_\_\_\_  
Title \_\_\_\_\_  
Department \_\_\_\_\_  
Company \_\_\_\_\_

Please provide a brief description of your involvement with the SCM support group.

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## Term Definitions

The following definitions help clarify some of the terms used in this survey. Please read them carefully.

**Auditing:** An element of configuration management that consists of independent examinations of work products and activities to assess compliance with designated criteria.

**Change control:** The process and procedures to identify, document, review, and authorize any changes to the software under configuration management.

**Configuration:** The functional and physical characteristics of hardware or software as set forth in technical documentation or achieved in a product.

**Configuration control:** An element of configuration management that consists of the proposal, justification, evaluation, coordination, approval or disapproval of proposed changes, and the implementation of approved changes in the configuration of a configuration item (CI) after the configuration baseline(s) has been established for the CI.

**Configuration management (CM):** A discipline that applies technical and administrative direction and surveillance over the lifecycle of items to

- ❖ Identify and document the functional and physical characteristics of configuration items.
- ❖ Control changes to configuration items and their related documentation.
- ❖ Record and report information needed to manage configuration items effectively, including the status of proposed changes and implementation status of approved changes.
- ❖ Audit configuration items to verify conformance to specifications, drawings, interface control documents, and other contractual requirements.

**Configuration status accounting:** An element of configuration management that consists of the recording and reporting of information needed to manage a configuration effectively. This information includes a listing of the approved configuration identification, the status of proposed changes to the configuration, and the implementation status of approved changes.

**Escalation:** A process of raising the priority of an issue by following predefined steps to expedite the closure of an issue.

**Functional configuration audit (FCA):** An audit conducted to verify that the development of a configuration item has been completed satisfactorily, that the

item has achieved the performance and functional characteristics specified in the functional and allocated configuration identification, and that its operational and support documents are complete and satisfactory.

**Mechanism:** An automated tool or manual process that accomplishes a given task.

**Physical configuration audit (PCA):** An audit conducted to verify that a configuration item, as built, conforms to the technical documentation that defines it.

**Procedure:** A detailed description of a process to be followed to complete a given task. The user(s) may be required to follow manual steps or there may be an automated tool to perform the task.

**Release:** A configuration management action whereby a particular version of software is made available for a specific purpose.

**SCM support group:** A collection of departments, managers, and individuals who are responsible for coordinating and implementing software configuration management for a project.

**Software configuration control board (SCCB):** Group responsible for evaluating and approving or disapproving proposed changes to configuration items and for ensuring implementation of approved changes. Configuration control boards can be hierarchical.

**Software configuration management (SCM):** Configuration management applied to software systems. SCM involves identifying the configuration of the software at given points in time, systematically controlling changes to the configuration, and maintaining the integrity and trace-ability of the configuration throughout the software lifecycle.

**Version:** An instance of a configuration item. Once a version is baselined it cannot be changed without creating a new version.

**Version control:** A means to identify and manage configuration items as they change over time, usually provided by a software tool designed for configuration management.

## Instructions

Please answer the following questions for a particular project or time period. Please indicate the project or time period below. This will help define the context for your responses.

Time Period \_\_\_\_\_  
Project \_\_\_\_\_

The information you provide will be used to assess the organization's process in general and not to test the knowledge of individual team members.

Mark or circle the choices that best answer the question. You can select multiple choices as necessary. Please provide additional comments and information in the section at the end of the survey and also for individual questions as you see fit. And now on to the survey...

## Questionnaire

### 1. Does management have a policy supporting the importance of SCM?

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

### 2. Does management view SCM support to be of major importance and have written policies to this effect?

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

### 3. Is the SCM support process defined?

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)?    Yes    No    Don't know

**4. Are SCM tasks/activities supported by the SCM support group defined?**

All    Most    Some    None    Don't know

**5. Are support group dependencies on resources from other groups defined?**

Yes    No    Don't know

Are these dependencies:    Documented    Informal

Are they published (on the web or hard copy)?    Yes    No    Don't know

How often are these dependencies negotiated and agreed upon?

Always    Often    Sometimes    Never    Don't Know

**6. Is there a procedure for handling SCM support requests?**

Yes    No    Don't know

If available is it: Documented    Informal

Is it published (on the web or hard copy)?    Yes    No    Don't know

How often is this procedure followed?

Always    Often    Sometimes    Never    Don't Know

**7. Is there a procedure to monitor support requests?**

Yes    No    Don't know

If available is it: Documented    Informal

Is it published (on the web or hard copy)?    Yes    No    Don't know

How often is it used?

Always    Often    Sometimes    Never    Don't Know

**8. Are expectations for response times for support requests communicated to and agreed upon by the users?**

Yes No Don't know

Is this information: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

**9. Is there a mechanism to measure initial response time for support requests?**

Yes No Don't know

Is this information published (on the web or hard copy)? Yes No Don't know

**10. Is there a mechanism to measure time to resolve issues?**

Yes No Don't know

Is this information published (on the web or hard copy)? Yes No Don't know

**11. Is there a mechanism to measure number of requests for each type of SCM support activity?**

Yes No Don't know

How often is this measurement made?

Always Often Sometimes Never Don't Know

**12. Is there a mechanism to measure amount of time spent in performing each type of SCM support activity?**

Yes No Don't know

How often is this measurement made?

Always Often Sometimes Never Don't Know

**13. Is there a procedure to determine if the request was met within expected time limits for the urgency level?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is this procedure followed?

Always Often Sometimes Never Don't Know

**14. Is there an escalation process defined for support requests?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**15. Is there a procedure to track requests that require escalation of issues?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**16. Is there a procedure to handle support requests that can not be completed according to user requirements?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**17. Is there a policy that defines when a support request can be closed?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**18. Is there a procedure to monitor that the closure of support requests is in compliance with policy?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**19. Are there defined measures for levels of user satisfaction?**

Yes No Don't know

If available is it: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

How often are these measures updated?

Always Often Sometimes Never Don't Know

**20. Are there defined goals for user satisfaction levels for the SCM support group?**

Yes No Don't know

If available is it: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

**21. Is there a procedure for determining user satisfaction with the handling of their support requests?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**22. Is there a procedure to determine the level of user satisfaction achieved by the group?**

Yes No Don't know

If available is it: Documented Informal

Is the procedure published (on the web or hard copy)? Yes No Don't know

Are the results published (on the web or hard copy)? Yes No Don't know

**23. Is there a policy that defines the development team structures (such as distributed teams, remote development sites and new acquisitions etc.) that are supported?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**24. Is there a procedure to add new team structures to be supported and to update existing supported team structures?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**25. Is there a procedure to identify the support requirements for each type of development team structure?**

All    Most    Some    None    Don't know

If available is it: Documented    Informal

Is it published (on the web or hard copy)?    Yes    No    Don't know

How often are these requirements updated?

Always    Often    Sometimes    Never    Don't Know

**26. Is there a policy for sharing repository data between development sites or between teams?**

Yes    No    Don't know

If available is it: Documented    Informal

Is it published (on the web or hard copy)?    Yes    No    Don't know

**27. Is there a procedure to ensure integrity and proper use of repository data?**

Yes    No    Don't know

If available is it: Documented    Informal

Is it published (on the web or hard copy)?    Yes    No    Don't know

**28. Is there a procedure for handling security issues when data is shared between development sites?**

Yes    No    Don't know

If available is it: Documented    Informal

Is it published (on the web or hard copy)?    Yes    No    Don't know

How often is the security tested?

Always    Often    Sometimes    Never    Don't Know

**29. Is there a procedure to identify designated contact person(s) from each user group?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is this information updated?

Always Often Sometimes Never Don't Know

**30. Is there a procedure to measure the effectiveness of communications between the support group and its customers?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**31. Is there a procedure to determine the resource requirements to meet support goals?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**32. Is there a procedure to determine adequacy of support group resources?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**33. Are there training guidelines for SCM support group team members?**

Yes No Don't know

If available are the guidelines: Documented Informal

Are they published (on the web or hard copy)? Yes No Don't know

**34. Is there a procedure to determine if the guidelines for SCM support group member training are being followed?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**35. Is there a procedure to track requests that require acquisition of new knowledge?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

Is this information used in planning for future training ?

Yes No Don't Know

**36. Is there cross training within the group to provide redundant coverage?**

Yes No Don't know

**37. Is there a policy for SCM repository creation?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**38. Is there a policy for deciding the contents of a SCM repository?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**39. Is there a procedure to manage each repository?**

All Most Some None Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used? Always Usually Sometimes Seldom Never  
Don't Know

**40. Is there a policy for managing unused repositories?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**41. Is there a procedure to assess the completeness and correctness of the SCM repository contents?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**42. Is there a version management policy?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**43. Is there a version numbering scheme?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**44. Is there a version labeling convention?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**45. Is there a procedure to define the branching conventions to be used for coordinating concurrent and parallel development work?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**46. Is there a procedure to ensure work products developed concurrently or in parallel are correct and complete?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is this validation and verification done?

Always Often Sometimes Never Don't Know

**47. Is there a procedure to verify that version management schemes are being used correctly?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**48. Are the different stages of each product's life cycle defined?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**49. Is there a procedure to ensure that appropriate versions and configuration information are maintained for the entire life cycle of the product?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**50. Is it possible to re-create all releases that are supported at any given time?**

Yes No Don't know

How often is this tested?

Always Often Sometimes Never Don't Know

**51. Is there a policy for workspace management?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**52. Is there a procedure for checking the workspace contents for correctness and completeness?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**53. Is there a definition of what change control mechanisms are needed?**

Yes No Don't know

If available is it: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

**54. Is responsibility for implementation of change control mechanisms assigned and agreed upon?**

Always Often Sometimes Never Don't Know

**55. Is the responsibility for monitoring the change control mechanisms assigned and agreed upon?**

Always Often Sometimes Never Don't Know

**56. Is there a definition of what status accounting mechanisms are needed?**

Yes No Don't know

If available is it: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

**57. Is responsibility for implementation of status accounting mechanisms assigned and agreed upon?**

Always Often Sometimes Never Don't Know

**58. Is the responsibility for monitoring the status accounting mechanisms assigned and agreed upon?**

Always Often Sometimes Never Don't Know

**59. Is there a definition of what audit mechanisms are required?**

Yes No Don't know

If available is it: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

**60. Is responsibility for implementation of audit mechanisms assigned and agreed upon?**

Always Often Sometimes Never Don't Know

**61. Is the responsibility for monitoring the audit mechanisms assigned and agreed upon?**

Always Often Sometimes Never Don't Know

**62. Is there a procedure to determine if the requested SCM (change control, status accounting and audit) mechanisms agree with SCM policies?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is this validation done?

Always Often Sometimes Never Don't Know

**63. Is there a procedure to verify and validate that the SCM mechanisms provided by the SCM support group satisfy customer requirements?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is this validation done?

Always Often Sometimes Never Don't Know

**64. Is there a procedure for testing new SCM tools?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**65. Is there a procedure for introducing new SCM tools into the development environment?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**66. Is there a procedure for deciding who supports SCM tools and at what levels?**

Yes No Don't know

If available is it: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

**67. Is there a procedure to determine the level of training that is needed to support each SCM tool?**

Yes No Don't know

If available is it: Documented Informal

Is this information published (on the web or hard copy)? Yes No Don't know

**68. Is there a procedure to determine how long tool versions are to be maintained?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

Is the information generated published? Yes No Don't know

**69. Is there a procedure to determine if the correct tool versions are available for the entire life-cycle of products?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**70. Is there a procedure to determine if the correct development tool versions are being used?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**71. Is there a procedure to test backward compatibility of new tool versions before these tools are incorporated into the development environment?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**72. Is there a procedure for planning to ensure adequate resource availability?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**73. Is there a procedure to measure the cost of resource unavailability?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**74. Is the cost of resource unavailability reported?**

Yes No Don't know

**75. Is there a mechanism for monitoring resource usage?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**76. Is there a mechanism for restricting resource usage for authorized purposes only?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

**77. Is there a procedure to assess risks such as impact on resources, tool support, infrastructure demands etc. ) involved in starting new projects?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**78. Is there a procedure to assess the risks of a proposed change in SCM policies, procedures or mechanisms?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always   Often   Sometimes   Never   Don't Know

**79. Is there a risk management plan for situations where a repository or crucial resource is not available?**

Yes   No   Don't know

If available is it: Documented   Informal

Is it published (on the web or hard copy)?   Yes   No   Don't know

**80. Is there a procedure to identify participants needed to analyze risks involved in a particular activity or situation?**

Yes   No   Don't know

If available is it: Documented   Informal

Is it published (on the web or hard copy)?   Yes   No   Don't know

**81. Is there a procedure to select a particular course of action during risk assessment?**

Yes   No   Don't know

If available is it: Documented   Informal

Is it published (on the web or hard copy)?   Yes   No   Don't know

How often is it used?

Always   Often   Sometimes   Never   Don't Know

**82. Is there a procedure for communicating the results of risk analysis?**

Yes   No   Don't know

If available is it: Documented   Informal

Is it published (on the web or hard copy)?   Yes   No   Don't know

**83. Is there a procedure for evaluating the effectiveness of risk management procedures?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**84. Is there a procedure that defines how to collect and analyze the results of SCM support process monitoring and measurements pertaining to the process, quality assurance and usability aspects of the?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**85. Is there a procedure for SCM support team members and users to provide input for process improvement?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is this done?

Always Often Sometimes Never Don't Know

**86. Is there a procedure for generating recommendations for process changes and improvements?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**87. Is there a procedure to assess the impact of these recommendations on the SCM support process?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**88. Is there a procedure for incorporating recommendations into the process?**

Yes No Don't know

If available is it: Documented Informal

Is it published (on the web or hard copy)? Yes No Don't know

How often is it used?

Always Often Sometimes Never Don't Know

**89. Please provide any additional information or comments that you feel are relevant to the SCM support process of your organization or comments in general about this survey.**

## Appendix B: Mapping of Questionnaire to the Model.

The following table presents information about which question corresponds to each part of the model presented in this paper. Many of the questions have a follow-up question that inquires how frequently a procedure or policy is used. These questions are referred to as part (b) of the respective question. As is shown in the table below these follow-up questions help us determine if the policies and procedures defined in the identify, measure and feedback categories are being followed.

	Process	Quality Assurance	Usability
Identify	1, 2, 3, 4, 5, 6, 8, 14, 16, 23, 24, 25, 26, 28, 29, 31, 33, 36, 37, 38, 39, 40, 42, 43, 44, 45, 48, 51, 53, 54, 56, 57, 59, 60, 64, 65, 66, 67, 68,	2, 27, 41, 46, 47, 49, 50, 52, 62, 69, 70, 71, 72, 79, 80, 81, 82,	2, 13, 16, 17, 19, 20, 63
Monitor	5b, 6b, 7, 11b, 12b, 15, 25b, 28b, 30b, 39b, 55, 58, 61, 75, 84b, 85b, 86b, 87b, 88b	41b, 46b, 47b, 49b, 50b, 52b, 62b, 69b, 70b, 71b, 72b, 73b, 76, 77b, 78b, 81b, 83b, 84b, 86b, 87b, 88b	13b, 18, 19b, 63b, 84b, 86b, 87b, 88b
Measure	9, 10, 11, 12, 30, 32, 34, 35, 84	73, 77, 78, 83, 84	21, 22, 84,
Feedback	35b, 84, 85, 86, 87, 88	74, 84, 86, 87, 88	84, 86, 87, 88