
Defect Prevention

a key process area for Level 5: Optimizing

The purpose of Defect Prevention is to identify the cause of defects and prevent them from recurring.

Defect Prevention involves analyzing defects that were encountered in the past and taking specific actions to prevent the occurrence of those types of defects in the future. The defects may have been identified on other projects as well as in earlier stages or tasks of the current project. Defect prevention activities are also one mechanism for spreading lessons learned between projects.

Trends are analyzed to track the types of defects that have been encountered and to identify defects that are likely to recur. Based on an understanding of the project's defined software process and how it is implemented (as described in the Integrated Software Management and Software Product Engineering key process areas), the root causes of the defects and the implications of the defects for future activities are determined.

Both the project and the organization take specific actions to prevent recurrence of the defects. Some of the organizational actions may be handled as described in the Process Change Management key process area.

Defect Prevention

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Goals

- Goal 1** **Defect prevention activities are planned.**
- Goal 2** **Common causes of defects are sought out and identified.**
- Goal 3** **Common causes of defects are prioritized and systematically eliminated.**

Commitment to perform

Commitment 1 **The organization follows a written policy for defect prevention activities.**

This policy typically specifies that:

1. Long-term plans and commitments are established for funding, staffing, and other resources for defect prevention.
2. The resources needed are allocated for the defect prevention activities.
3. Defect prevention activities are implemented across the organization to improve the software processes and products.
4. The results of the defect prevention activities are reviewed to ensure the effectiveness of those activities.

5. Management and technical actions identified as a result of the defect prevention activities are addressed.

Commitment 2 The project follows a written organizational policy for defect prevention activities.

(Commitment 2) This policy typically specifies that:

1. Defect prevention activities are included in each project's software development plan.
2. The resources needed are allocated for the defect prevention activities.
3. Project management and technical actions identified as a result of the defect prevention activities are addressed.

Ability to perform

Ability 1

An organization-level team to coordinate defect prevention activities exists.

1. This team is either part of the group responsible for the organization's software process activities (e.g., software engineering process group) or its activities are closely coordinated with that group.

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Refer to the Organization Process Focus key process area.
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Ability 2

A team to coordinate defect prevention activities for the software project exists.

1. This team is closely tied to the team responsible for developing and maintaining the project's defined software process.

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Members of the team coordinating defect prevention activities are usually assigned to this team on a part-time basis and have other software engineering activities as their primary responsibility.

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(Ability 2)

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Refer to Activities 1 and 2 of the Integrated Software Management key process area for practices covering developing and maintaining the project's defined software process.

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Ability 3**Adequate resources and funding are provided for defect prevention activities at the project and organization levels.**

1. Defect prevention activities are planned into each person's responsibilities, as appropriate.

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Examples of defect prevention activities include:

- task kick-off meetings,
- causal analysis meetings,
- reviewing and planning proposed actions, and
- implementing actions.

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2. Management participation in the defect prevention activities is planned.
3. Each software project is represented on the team coordinating defect prevention activities for the organization, as appropriate.

4. Tools to support defect prevention activities are made available.

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Examples of support tools include:

- statistical analysis tools, and
- database systems.

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Ability 4

Members of the software engineering group and other software-related groups receive required training to perform their defect prevention activities.

(Ability 4)

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Examples of software-related groups include:

- software quality assurance,
- software configuration management, and
- documentation support.

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Examples of training include:

- defect prevention methods,
- conduct of task kick-off meetings,
- conduct of causal analysis meetings, and
- statistical methods (e.g., cause/effect diagrams and Pareto analysis).

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Refer to the Training Program key process area.

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Activities performed

Activity 1

The software project develops and maintains a plan for its defect prevention activities.

This plan:

1. Identifies the defect prevention activities (e.g., task kick-off and causal analysis meetings) that will be held.
2. Specifies the schedule of defect prevention activities.
3. Covers the assigned responsibilities and resources required, including staff and tools.
4. Undergoes peer review.

(Activity 1)

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Refer to the Peer Reviews key process area.

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Activity 2

At the beginning of a software task, the members of the team performing the task meet to prepare for the activities of that task and the related defect prevention activities.

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Kick-off meetings are held to familiarize the members of the team with the details of the implementation of the process, as well as any recent changes to the process.

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These kick-off meetings cover:

1. The software process, standards, procedures, methods, and tools applicable to the task, with an emphasis on recent changes.

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Changes may be implemented as an experiment to evaluate a recommendation from a previous causal analysis meeting.

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2. The inputs required and available for the task.

3. The outputs to be produced with examples, if available.
4. The methods to be used to evaluate the outputs.
5. The methods to be used to verify adherence to the software process.
6. A list of errors that are commonly made or introduced during the current stage and recommended preventive actions for these errors.
7. The team assignments.
8. The task schedule.
- (Activity 2)** 9. The software product quality goals for the task and software project.

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Refer to the Software Quality Management key process area.

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Activity 3

Causal analysis meetings are conducted according to a documented procedure.

This procedure typically specifies that:

1. Each team that performs a software task conducts causal analysis meetings.
 - q A causal analysis meeting is conducted shortly after the task is completed.
 - q Meetings are conducted during the software task if and when the number of defects uncovered warrants the additional meetings.

- q Periodic causal analysis meetings are conducted after software products are released to the customer, as appropriate.
- q For software tasks of long duration, periodic in-process defect prevention meetings are conducted, as appropriate.

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An example of a long duration task is a level-of-effort, customer support task.

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2. The meetings are led by a person trained in conducting causal analysis meetings.
3. Defects are identified and analyzed to determine their root causes.

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An example of a method to determine root causes is cause/effect diagrams.

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4. The defects are assigned to categories of root causes.

(Activity 3)

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Examples of defect root cause categories include:

- inadequate training,
- breakdown of communications,
- not accounting for all details of the problem, and
- making mistakes in manual procedures (e.g., typing).

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5. Proposed actions to prevent the future occurrence of identified defects and similar defects are developed and documented.

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Examples of proposed actions include modifications to:

- the process,
- training,
- tools,
- methods,
- communications, and
- software work products.

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6. Common causes of defects are identified and documented.

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Examples of common causes include:

- frequent errors made in invoking a certain system function, and
- frequent errors made in a related group of software units.

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7. The results of the meeting are recorded for use by the organization and other projects.

Activity 4

Each of the teams assigned to coordinate defect prevention activities meets on a periodic basis to review and coordinate implementation of action proposals from the causal analysis meetings.

(Activity 4)

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The teams involved may be at the organization or project level.

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The teams:

1. Review the output from the causal analysis meetings and select action proposals that will be addressed.

2. Review action proposals that have been assigned to them by other teams coordinating defect prevention activities in the organization and select action proposals that will be addressed.
3. Review actions taken by the other teams in the organization to assess whether these actions can be applied to their activities and processes.
4. Perform a preliminary analysis of the action proposals and set their priorities.

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Priority is usually nonrigorous and is based on an understanding of:

- the causes of defects,
- the implications of not addressing the defects,
- the cost to implement process improvements to prevent the defects, and
- the expected impact on software quality.

An example of a technique used to set priorities for the action proposals is Pareto analysis.

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5. Reassign action proposals to teams at another level in the organization, as appropriate.
6. Document their rationale for decisions and provide the decision and the rationale to the submitters of the action proposals.
7. Assign responsibility for implementing the action items resulting from the action proposals.

(Activity 4)

- q Implementation of the action items includes making immediate changes to the activities that are within the purview of the team and arranging for other changes.

q Members of the team usually implement the action items, but, in some cases, the team can arrange for someone else to implement an action item.

8. Review results of defect prevention experiments and take actions to incorporate the results of successful experiments into the rest of the project or organization, as appropriate.

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Examples of defect prevention experiments include:

- using a temporarily modified process, and
- using a new tool.

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9. Track the status of the action proposals and action items.

10. Document software process improvement proposals for the organization's standard software process and the projects' defined software processes as appropriate.

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The submitters of the action proposal are designated as the submitters of the software process improvement proposals.

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Refer to Activity 5 of the Process Change Management key process area for practices covering handling of software process improvement proposals.

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11. Review and verify completed action items before they are closed.

12. Ensure that significant efforts and successes in preventing defects are recognized.

Activity 5

Defect prevention data are documented and tracked across the teams coordinating defect prevention activities.

1. Action proposals identified in causal analysis meetings are documented.

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Examples of data that are in the description of an action proposal include:

- originator of the action proposal,
- description of the defect,
- description of the defect cause,
- defect cause category,
- stage when the defect was injected,
- stage when the defect was identified,
- description of the action proposal, and
- action proposal category.

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2. Action items resulting from action proposals are documented.

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Examples of data that are in the description of an action item include:

- the person responsible for implementing it,
- a description of the areas affected by it,
- the individuals who are to be kept informed of its status,
- the next date its status will be reviewed,
- the rationale for key decisions,
- a description of implementation actions,
- the time and cost for identifying the defect and correcting it, and
- the estimated cost of not fixing the defect.

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3. The defect prevention data are managed and controlled.

(Activity 5)

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"Managed and controlled" implies that the version of the work product in use at a given time (past or present) is known (i.e., version control), and changes are incorporated in a controlled manner (i.e., change control).

If a greater degree of control than is implied by "managed and controlled" is desired, the work product can be placed under the full discipline of configuration management, as is described in the Software Configuration Management key process area.

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Activity 6

Revisions to the organization's standard software process resulting from defect prevention actions are incorporated according to a documented procedure.

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Refer to Activity 1 of the Organization Process Definition key process area for practices covering the organization's standard software process.

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Activity 7

Revisions to the project's defined software process resulting from defect prevention actions are incorporated according to a documented procedure.

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Refer to Activity 2 of the Integrated Software Management key process area for practices covering the project's defined software process.

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Activity 8

Members of the software engineering group and software-related groups receive feedback on the status and results of the organization's and project's defect prevention activities on a periodic basis.

(Activity 8)

The feedback provides:

1. A summary of the major defect categories.

2. The frequency distribution of defects in the major defect categories.
3. Significant innovations and actions taken to address the major defect categories.
4. A summary status of the action proposals and action items.

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Examples of means to provide this feedback include:

- electronic bulletin boards,
- newsletters, and
- information flow meetings.

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Measurement and analysis

Measurement 1 Measurements are made and used to determine the status of the defect prevention activities.

(Measurement 1)

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Examples of measurements include:

- the costs of defect prevention activities (e.g., holding causal analysis meetings and implementing action items), cumulatively;
- the time and cost for identifying the defects and correcting them, compared to the estimated cost of not correcting the defects;
- profiles measuring the number of action items proposed, open, and completed;
- the number of defects injected in each stage, cumulatively, and over releases of similar products; and
- the number of defects.

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Verifying implementation

Verification 1 The organization's activities for defect prevention are reviewed with senior management on a periodic basis.

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The primary purpose of periodic reviews by senior management is to provide awareness of, and insight into, software process activities at an appropriate level of abstraction and in a timely manner. The time between reviews should meet the needs of the organization and may be lengthy, as long as adequate mechanisms for exception reporting are available.

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These reviews cover:

1. A summary of the major defect categories and the frequency distribution of defects in these categories.
2. A summary of the major action categories and the frequency distribution of actions in these categories.
3. Significant actions taken to address the major defect categories.
- (Verification 1)** 4. A summary status of the proposed, open, and completed action items.
5. A summary of the effectiveness of and savings attributable to the defect prevention activities.
6. The actual cost of completed defect prevention activities and the projected cost of planned defect prevention activities.

Technology Change Management

a key process area for Level 5: Optimizing

The purpose of Technology Change Management is to identify new technologies (i.e., tools, methods, and processes) and track them into the organization in an orderly manner.

Technology Change Management involves identifying, selecting, and evaluating new technologies, and incorporating effective technologies into the organization. The objective is to improve software quality, increase productivity, and decrease the cycle time for product development.

The organization establishes a group (such as a software engineering process group or a technology support group) that works with the software projects to introduce and evaluate new technologies and manage changes to existing technologies. Particular emphasis is placed on technology changes that are likely to improve the capability of the organization's standard software process (as described in the Organization Process Definition key process area).

By maintaining an awareness of software-related technology innovations and systematically evaluating and experimenting with them, the organization selects appropriate technologies to improve the quality of its software and the productivity of its software activities. Pilot efforts are performed to assess new

Technology Change Management

a key process area for Level 5: Optimizing

and unproven technologies before they are incorporated into normal practice. With appropriate sponsorship of the organization's management, the selected technologies are incorporated into the organization's standard software process and current projects, as appropriate.

Changes to the organization's standard software process (as described in the Organization Process Definition key process area) and the projects' defined software processes (as described in the Integrated Software Management key process area) resulting from these technology changes are handled as described in the Process Change Management key process area.

Goals

- | | |
|---------------|---|
| Goal 1 | Incorporation of technology changes are planned. |
| Goal 2 | New technologies are evaluated to determine their effect on quality and productivity. |
| Goal 3 | Appropriate new technologies are transferred into normal practice across the organization. |

Commitment to perform

Commitment 1 The organization follows a written policy for improving its technology capability.

This policy typically specifies that:

1. Objectives for technology change management are established and documented.

(Commitment 1) 2. A documented plan addresses the objectives for technology change management.

Commitment 2 Senior management sponsors the organization's activities for technology change management.

Senior management:

1. Helps to define a strategy that addresses the organization's goals for product quality, productivity, and cycle time for product development.
2. Helps to define a strategy that addresses the customer's and end users' needs and desires, as appropriate.

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The end users referred to in these practices are the customer-designated end users or representatives of the end users.

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3. Coordinates with the organization's managers in defining their goals and approaches for accomplishing the organization's strategy.

4. Makes a commitment to the effort for technology change management that is visible throughout the organization.
5. Establishes long-term plans and commitments for funding, staffing, and other resources.

Commitment 3 Senior management oversees the organization's technology change management activities.

Senior management:

1. Helps to establish policies for technology change management and reviews and approves these policies.
2. Allocates resources for technology change management activities.

- (Commitment 3)**
3. Helps relate organizational strategies and objectives to strategies for technology change management.
 4. Participates in establishing the plans for technology change management.
 - q Senior management coordinates requirements and issues for technology change management at all appropriate levels of the organization.
 - q Senior management coordinates with the organization's managers to secure the managers' and staff's support and participation.

Ability to perform

Ability 1

A group responsible for the organization's technology change management activities exists.

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A group is the collection of departments, managers, and individuals who have responsibility for a set of tasks or activities. A group could vary from a single individual assigned part time, to several part-time individuals assigned from different departments, to several individuals dedicated full time. Considerations when implementing a group include assigned tasks or activities, the size of the project, the organizational structure, and the organizational culture. Some groups, such as the software quality assurance group, are focused on project activities, and others, such as the software engineering process group, are focused on organization-wide activities.

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(Ability 1)

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1. The group is either part of the group responsible for the organization's software process activities (e.g., software engineering process group) or its activities are closely coordinated with that group.
 2. The group coordinates and helps to:
 - q explore potential areas for applying new technology;
 - q select and plan for new technologies;
 - q acquire, install, and customize new technologies;
 - q communicate and coordinate with related research and development activities within the organization; and
 - q communicate with the technology suppliers on problems and enhancements.

Ability 2

Adequate resources and funding are provided to establish and staff a group responsible for the organization's technology change management activities.

1. Experienced staff members with expertise in specialized areas are available to this group to help in evaluating, planning, and supporting initiatives for technology change management.

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Examples of specialized areas include:

- workstations,
- computer hardware,
- software reuse,
- computer-aided software engineering (CASE) technology,
- software measurement,
- formal methods, and
- programming languages.

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2. Tools to support technology change management are made available.

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Examples of support tools include:

- workstations,
- database programs, and
- subscriptions to on-line technology databases.

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Ability 3

Support exists for collecting and analyzing data needed to evaluate technology changes.

(Ability 3)

This support includes the ability to:

1. Record selected process and product data automatically.
2. Support data analysis.
3. Display selected data.

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The results of data analysis are presented in formats that appropriately convey the information content, e.g., graphical displays.

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Ability 4

Appropriate data on the software processes and software work products are available to support analyses performed to evaluate and select technology changes.

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Examples of process and product data include:

- resource expenditures and productivity by project, process stage, tools and methods used, program category, degree of program modification, etc.;
- schedule time by project, process stage of each project, program category, program size, degree of program modification, etc.;
- peer-review data, including defect data and review efficiencies;
- defect data showing stage introduced, stage removed, type, cause, severity, and time and effort to fix;
- change activity, including amount of code produced, amount of documentation produced, etc.;
- data on the activities to fix defects, including the identification of the defects, the product version where the defect fix was implemented, and identification of defects introduced in implementing each defect fix; and
- density of defects by project, product type, specific product, and specific subproduct (e.g., program modules).

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Ability 5

Members of the group responsible for the organization's technology change management activities receive required training to perform these activities.

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Examples of training include:

- the organization's standard software process,
- technology transfer and change management,
- software process improvement,
- tools and methods used by the organization,
- analytical and support facilities available to the organization, and
- principles of statistical quality control.

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Refer to the Training Program key process area.

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Activities performed

Activity 1**The organization develops and maintains a plan for technology change management.**

This plan:

1. Covers the assigned responsibilities and resources required, including staff and tools.
2. Defines the long-term technical strategy for automating and improving the organization's standard software process and enhancing the organization's market position.
3. Identifies the procedures to be followed in performing the organization's technology change management activities.

(Activity 1)

4. Describes the approach for introducing new technologies to address specific needs of the organization and projects.
 - q Process areas that are potential areas for technology changes are identified.

- q Approaches for identifying opportunities for technology changes are identified.
 - q The specific planned or candidate technologies are identified.
 - q Where appropriate, the life span for the planned technologies is estimated, from introduction to replacement.
 - q The make/buy tradeoff studies are documented.
 - q Approaches for assessing unproven candidate technologies are defined.
 - q The acquisition and installation procedures are defined.
 - q The initial training, continuing training, and consultation support are defined.
5. Undergoes peer review.
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Refer to the Peer Reviews key process area.
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6. Is reviewed by the affected managers.

Activity 2

The group responsible for the organization's technology change management activities works with the software projects in identifying areas of technology change.

This group:

1. Solicits suggestions for technology changes.
2. Identifies available new technologies that may be appropriate to the organization's and projects' needs.
 - q A periodic search is made to identify commercially available technologies that meet identified and anticipated needs.

(Activity 2)

- q Systematic efforts are made to maintain awareness of leading relevant technical work and trends of new technologies.
 - q Systematic efforts are made to review the technologies used externally and to compare these technologies to those used within the organization.
 - q Areas where new technologies have been used successfully are identified, and data and documentation of experience with using them are collected and reviewed.
3. Evaluates new technologies to determine their applicability to the organization's and projects' current and future needs.

Activity 3**Software managers and technical staff are kept informed of new technologies.**

1. Information on new technologies is disseminated as appropriate.
2. Information on advanced technologies already in use in parts of the organization is disseminated as appropriate.
3. Information on the status of technologies being transferred into the organization is disseminated as appropriate.

Activity 4**The group responsible for the organization's technology change management systematically analyzes the organization's standard software process to identify areas that need or could benefit from new technology.**

This group:

1. Analyzes the organization's standard software process to determine areas where new technologies would be most helpful.

2. Identifies helpful technology changes and determines the economics of those changes.
3. Defines the relationship of the identified technology to the organization's standard software process.
- (Activity 4)** 4. Defines the expected outcomes of the technology change qualitatively and quantitatively, as appropriate.
5. Determines the need for piloting each potential technology change.
6. Determines the priority of the candidate new technologies.
7. Documents results of the analysis activities.

Activity 5

Technologies are selected and acquired for the organization and software projects according to a documented procedure.

This procedure typically specifies that:

1. Requests for the acquisition of new technologies are documented.
 - q Management approval is required for technologies with projected expenses above a predefined level.
2. Preliminary cost/benefit analyses are performed for the potential technology changes.
3. Predefined and approved selection criteria are used to identify the highest potential benefits.
4. Requirements and plans for the selected technology changes are defined and documented.

- q Where practical, the expected life span and plans for replacement/upgrade are estimated.
- q Where appropriate, tradeoff studies are performed, reviewed, and documented to determine whether the technology should be developed internally or procured externally.
- q Where appropriate, the plan provides for installing the new technology on a pilot basis to determine its effectiveness and economic benefits.
- q The requirements and plans are reviewed by the managers of the affected groups and the group responsible for technology change management activities.

Activity 6 Pilot efforts for improving technology are conducted, where appropriate, before a new technology is introduced into normal practice.

1. These pilot efforts are conducted to determine the feasibility and economics of untried or advanced technologies.
2. The plans for the pilot effort are documented.
 - q The plan covers the objectives, evaluation criteria, and activities for the pilot effort.
3. The plan for conducting the pilot effort is reviewed and approved by the managers of the affected groups.

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Examples of affected groups include:

- software engineering (including all subgroups),
- software estimating,
- system engineering,
- system test,
- software quality assurance,
- software configuration management,
- contract management, and
- documentation support.

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4. The group responsible for technology change management activities provides consultation and assistance to the project implementing the pilot effort.
5. The pilot effort is performed in an environment that is relevant to the development or maintenance environment.
6. The results of the pilot effort are collected, analyzed, and documented.
 - q Lessons learned and problems encountered during the effort are documented.
 - q The benefits and impacts of broader use in the organization are estimated. The uncertainty in these estimates is assessed.
 - q A decision is made whether to terminate the effort, proceed with broad-scale implementation of the technology, or replan and continue the pilot effort.

(Activity 6)

Activity 7

Appropriate new technologies are incorporated into the organization's standard software process according to a documented procedure.

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Refer to Activity 1 of the Organization Process Definition key process area and Activity 5 of the Process Change Management key process area for practices covering changes to the organization's standard software process.

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Activity 8

Appropriate new technologies are incorporated into the projects' defined software processes according to a documented procedure.

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Refer to Activity 2 of the Integrated Software Management key process area for practices covering revision of the project's defined software process.

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Measurement and analysis

Measurement 1 **Measurements are made and used to determine the status of the organization's activities for technology change management.**

(Measurement 1)

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Examples of measurements include:

- the overall technology change activity, including number, type, and size of changes; and
- the effect of implementing the technology change, compared to the goals.

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Verifying implementation

Verification 1 **The organization's activities for technology change management are reviewed with senior management on a periodic basis.**

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The primary purpose of periodic reviews by senior management is to provide awareness of, and insight into, software process activities at an appropriate level of abstraction and in a timely manner. The time between reviews should meet the needs of the organization and may be lengthy, as long as adequate mechanisms for exception reporting are available.

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These reviews:

1. Summarize the activities for technology change management.
2. Identify needed strategy changes.
3. Result in the resolution of issues.
4. Result in the approval of revisions to the plans for technology change management, as appropriate.

Verification 2 The software quality assurance group reviews and/or audits the activities and work products for technology change management and reports the results.

(Verification 2)

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Refer to the Software Quality Assurance key process area.

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At a minimum, the reviews and/or audits verify:

1. The plans for technology change management.
2. The process for selecting, procuring, and installing new technologies.

Process Change Management

a key process area for Level 5: Optimizing

The purpose of Process Change Management is to continually improve the software processes used in the organization with the intent of improving software quality, increasing productivity, and decreasing the cycle time for product development.

Process Change Management involves defining process improvement goals and, with senior management sponsorship, proactively and systematically identifying, evaluating, and implementing improvements to the organization's standard software process and the projects' defined software processes on a continuous basis.

Training and incentive programs are established to enable and encourage everyone in the organization to participate in process improvement activities. Improvement opportunities are identified and evaluated for potential payback to the organization. Pilot efforts are performed to assess process changes before they are incorporated into normal practice.

When software process improvements are approved for normal practice, the organization's standard software process and the projects' defined software processes are revised as appropriate. The practices for revising the organization's standard software process are found in the Organization Process Definition key

Process Change Management

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process area, and the practices for revising the projects' defined software processes are found in the Integrated Software Management key process area.

Goals

- Goal 1** **Continuous process improvement is planned.**
- Goal 2** **Participation in the organization's software process improvement activities is organization wide.**
- Goal 3** **The organization's standard software process and the projects' defined software processes are improved continuously.**

Commitment to perform

Commitment 1 **The organization follows a written policy for implementing software process improvements.**

This policy typically specifies that:

1. The organization has quantitative, measurable goals for software process improvement and tracks performance against these goals.

2. The organization's process improvements are directed toward improving product quality, increasing productivity, and decreasing the cycle time for product development.
3. All of the organization's staff and managers are expected to participate in improving the software processes.

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Skilled and motivated people are recognized as the principal process improvement resource.

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Commitment 2 Senior management sponsors the organization's activities for software process improvement.

(Commitment 2) Senior management:

1. Establishes the organization's long-term goals and plans for process improvement.
2. Allocates resources for process improvement activities.
3. Coordinates with the software managers to ensure they have reasonable, yet aggressive, process improvement goals and effective process improvement plans to meet these goals.
4. Monitors process improvement performance against goals.
5. Maintains a consistent priority focus on process improvement in the face of product crises.
6. Ensures that process improvement issues are promptly resolved.
7. Rewards employee participation in the process improvement activities.

Process Change Management

Level 5: Optimizing

Ability to perform

Ability 1 **Adequate resources and funding are provided for software process improvement activities.**

1. Resources are allocated to:
 - q lead, guide, and support the process improvement activities;
 - q maintain the process improvement records;
 - q develop, control, and disseminate process changes; and
 - q establish and operate the administrative and human resources functions to conduct the communications, motivation, and recognition activities needed to maintain a high level of employee participation.

- (Ability 1)**
2. Experienced individuals who have expertise in defining and analyzing software processes are available to help the organization in its process improvement activities.
 3. Tools to support process improvement are made available.

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Examples of support tools include:

- statistical analysis tools,
- database systems,
- process automation tools, and
- process modeling tools.

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Ability 2 **Software managers receive required training in software process improvement.**

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Examples of training include:

- managing technological and organizational change,
- team building, and
- teamwork skills as applied to continuous process improvement.

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Refer to the Training Program key process area.

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Ability 3

The managers and technical staff of the software engineering group and other software-related groups receive required training in software process improvement.

(Ability 3)

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Examples of software-related groups include:

- software quality assurance,
- software configuration management, and
- documentation support.

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Examples of training include:

- the principles of quality and process improvement, and
- the procedures for proposing process improvements.

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Refer to the Training Program key process area.

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Ability 4

Senior management receives required training in software process improvement.

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Examples of training include:

- benchmarking and comparative evaluation,
- principles of process improvement,
- setting and tracking goals for process improvement, and
- motivation and team building in an environment of continuous process improvement.

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Activities performed

Activity 1

A software process improvement program is established which empowers the members of the organization to improve the processes of the organization.

Activity 2

The group responsible for the organization's software process activities (e.g., software engineering process group) coordinates the software process improvement activities.

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Refer to the Organization Process Focus key process area for practices covering the group responsible for the organization's software process improvement activities.

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This group:

1. Defines organizational goals and measurement plans for software process performance.
2. Reviews the organizational goals for process performance with senior management for their endorsement.

3. Participates in the effort to define the organization's training needs for process improvement and supports the development and presentation of training course materials.

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Refer to the Training Program key process area.

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4. Defines and maintains the procedures for handling process improvement proposals.
5. Reviews software process improvement proposals and coordinates the actions for these proposals.
6. Tracks status, accomplishments, and participation in the process improvement activities and periodically reports the results to senior management.
7. Coordinates and tracks changes to the organization's standard software process.
8. Defines, establishes, and maintains the process improvement records.

Activity 3

The organization develops and maintains a plan for software process improvement according to a documented procedure.

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Refer to Activity 2 of the Organization Process Focus key process area for other practices covering the organization's software process improvement plan.

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This procedure typically specifies that:

1. The software process improvement plan is based on:
 - q the organization's business and strategic operating plans, and

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q customer satisfaction indicators.

2. The software process improvement plan undergoes peer review.

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Refer to the Peer Reviews key process area.

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3. The software process improvement plan is reviewed by the affected managers.

4. The software process improvement plan is managed and controlled.

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"Managed and controlled" implies that the version of the work product in use at a given time (past or present) is known (i.e., version control), and changes are incorporated in a controlled manner (i.e., change control).

If a greater degree of control than is implied by "managed and controlled" is desired, the work product can be placed under the full discipline of configuration management, as is described in the Software Configuration Management key process area.

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Activity 4

The software process improvement activities are performed in accordance with the software process improvement plan.

The plan covers:

1. The resources required, including staff and tools.
2. The highest priority process areas for improvement.
3. Measurable short-term and long-term goals for software process performance and improvement.

4. Teams and their assignments for addressing improvements for specific process areas.

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Examples of teams include:

- working groups,
- process action teams, and
- technical committees.

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5. The procedures for:
 - q the senior managers overseeing the software process improvement activities;
 - q the software managers planning and coordinating the software process improvement activities;
 - q individuals and teams identifying, evaluating, and introducing appropriate software process improvements; and
 - q the teams developing software process improvements for assigned process areas.
6. The administrative and support plans required to maintain continuous process improvement.
 - q Appropriate administrative procedures are included to encourage participation in and facilitate the software process improvement activities.
 - q Administrative personnel are included in oversight and review of the software process improvement activities.
 - q The roles and contributions of employees to continuous process improvement are recognized.

(Activity 4)

Activity 5

Software process improvement proposals are handled according to a documented procedure.

This procedure typically specifies that:

1. Software process improvement proposals are submitted.

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The software process improvement proposals can be submitted at any time and can address any area of the software processes.

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Examples of sources for software process improvement proposals include:

- the findings and recommendations of software process assessments,
- the organization's software process improvement goals,
- analysis of data on customer problems and customer satisfaction,
- analysis of data on project performance compared to software quality and productivity goals,
- the results of process benchmarks,
- the potential for process/task automation,
- analysis of data on defect causes,
- the measured effectiveness of the software process activities,
- examples of software process improvement proposals that were successfully adopted, and
- feedback on previously submitted software process improvement proposals, as appropriate.

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2. Each software process improvement proposal is evaluated; a decision is made whether to implement the proposal, and the decision rationale is documented.

(Activity 5)

3. The expected benefits of each software process improvement proposal are determined.

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Examples of expected benefit areas include:

- productivity,
- quality,
- cycle time,
- other indicators of customer or end user satisfaction, and
- any other internal factors.

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4. The priority of software process improvement proposals selected for implementation is determined.
 - q Focus on high-priority software process improvement proposals is maintained.
5. Implementation of the software process improvement actions resulting from the proposals is assigned and planned.
6. Software process improvement actions that require a substantial effort are assigned to a team responsible for implementation.

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Examples of substantial efforts include improvements requiring piloting of new technologies and other large changes.

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Teams to focus on specific software process areas are established.

Actions that are appropriate for piloting are coordinated.

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Examples of teams include:

- working groups,
- process action teams, and
- technical committees.

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- (Activity 5)**
7. The status of each software process improvement proposal is tracked.
 8. Software process improvement proposals for which the response has been unusually long are identified and acted upon.
 9. Software process changes that are judged to have a major impact on product quality or productivity or that will significantly alter satisfaction of the customer and end users are reviewed and approved by appropriate management before they are implemented.
 10. Completed software process improvement actions are reviewed, verified, and approved before they are closed.
 11. Submitters of the software process improvement proposals receive:
 - q prompt acknowledgment of their proposals, and
 - q notification of the disposition of their proposals.

Activity 6 **Members of the organization actively participate in teams to develop software process improvements for assigned process areas.**

1. Each of these process improvement teams is funded and the activities are planned and scheduled.
2. Goals are established for each process improvement effort; where possible, these goals are defined quantitatively.
3. The plans are approved by the managers of the affected groups and the group that defines and maintains the affected process descriptions.

(Activity 6)

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Examples of affected groups include:

- software engineering (including all subgroups, such as software design, as well as the software task leaders),
- software estimating,
- system engineering,
- system test,
- software quality assurance,
- software configuration management,
- contract management, and
- documentation support.

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Activity 7

Where appropriate, the software process improvements are installed on a pilot basis to determine their benefits and effectiveness before they are introduced into normal practice.

1. Adjustments to the proposed process improvement are made and documented during the pilot effort to optimize its implementation.
2. Lessons learned and problems encountered are documented.
3. The benefits, risks, and impacts of the process improvement's broader use in the organization are estimated, and the uncertainty in these estimates is assessed.
4. A decision is made whether to terminate the effort, proceed with broad-scale implementation of the improvement, or replan and continue the pilot effort.

Activity 8

When the decision is made to transfer a software process improvement into normal practice, the improvement is implemented according to a documented procedure.

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This procedure typically specifies that:

1. The resources needed to support major changes to the software process are established and funded.
- (Activity 8)** 2. The strategy for collecting data to measure and track the change in software process performance is documented, reviewed, and agreed to.
 - q This strategy is agreed to by the individuals responsible for implementing the software processes affected by the change.
 - q The support tools are instrumented, as appropriate, to record the desired data automatically.
3. Training courses are updated to reflect the current software process, and training is provided before installing the process change for general use.

XTOLERI()
Refer to the Training Program key process area.
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4. Consultation support, appropriate to the expected needs, is established before installing the process change for broad-scale use and is continued as needed.
5. Appropriate process changes are incorporated into the organization's standard software process.

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Refer to Activity 1 of the Organization Process Definition key process area for practices covering the organization's standard software process.
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6. Appropriate process changes are incorporated into the projects' defined software processes.

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Refer to Activity 2 of the Integrated Software Management key process area for practices covering the project's defined software process.

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Activity 9 **Records of software process improvement activities are maintained.**

(Activity 9)

1. Information about the initiation, status, and implementation of software process improvement proposals is maintained.
2. Ready access is provided to the software process improvement records.
3. Historical data is maintained and reports are produced on software process improvements.

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Examples of records and reports include:

- the project's productivity, quality, and schedule performance;
- the program's defect history;
- the organizational software quality and productivity trends; and
- the cost, schedule, and productivity of software process development and improvement.

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Refer to Activity 5 of the Organization Process Definition key process area for practices covering the organization's software process database, which is one of the possible mechanisms for maintaining process improvement records.

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Activity 10 **Software managers and technical staff receive feedback on the status and results of the software process improvement activities on an event-driven basis.**

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The feedback provides:

1. A summary of the major software process improvement activities.
2. Significant innovations and actions taken to address software process improvement.
3. A summary status of the software process improvement proposals that are submitted, open, and completed.

(Activity 10)

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Examples of means to provide this feedback include:

- electronic bulletin boards,
- newsletters, and
- information flow meetings.

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Measurement and analysis

Measurement 1 Measurements are made and used to determine the status of the software process improvement activities.

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Examples of measurements include:

- the number of software process improvement proposals submitted and implemented for each process area;
- the number of software process improvement proposals submitted by each of the projects, groups, and departments;
- the number and types of awards and recognitions received by each of the projects, groups, and departments;
- the response time for handling software process improvement proposals;
- the percentage of software process improvement proposals accepted per reporting period;
- the overall change activity, including number, type, and size of changes;
- the effect of implementing each process improvement compared to its defined goals;
- overall performance of the organization's and project's processes, including effectiveness, quality, and productivity compared to their defined goals;
- overall productivity and software quality trends for each project; and
- process measurements that relate to the indicators of the customer's satisfaction.

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Verifying implementation

Verification 1 The activities for software process improvement are reviewed with senior management on a periodic basis. XTOLERI()

The primary purpose of periodic reviews by senior management is to provide awareness of, and insight into, software process activities at an appropriate level of abstraction and in a timely manner. The time between reviews should meet the needs of the organization and may be lengthy, as long as adequate mechanisms for exception reporting are available.

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These reviews are held to:

1. Summarize participation in the process improvement activities.
2. Assess process performance.
3. Identify needed goal changes.
4. Resolve issues.
5. Approve revisions to the software process improvement plan as appropriate.

Verification 2 **The software quality assurance group reviews and/or audits the activities and work products for software process improvement and reports the results.**

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Refer to the Software Quality Assurance key process area.
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(Verification 2) At a minimum, the reviews and/or audits verify:

1. The preparation of the organization's software process improvement plan.
2. The process of initiating, submitting, reviewing, approving, and planning implementation of software process improvement proposals.
3. The degree to which the process measurements conform to the software process descriptions and reflect actual performance.

4. The process for documenting, reviewing, approving, controlling, and disseminating changes to the organization's standard software process and projects' defined software processes.
5. The degree to which software process improvement activities are consistently measured and tracked.
6. The degree to which actual software process improvement performance achieves the plans and goals.

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