DEFECT PREVENTION AND CAUSAL ANALYSIS IN SOFTWARE ENGINEERING

Sreenivasa Pisupati
Vice President
W3Softech India Private Limited
sreenivasa.pisupati@w3softech.com

ABSTRACT

Defect Prevention is a process of preventing the defects to reoccur in software engineering. Defects are defined as errors that occur in different phases of the software process.

The principles of defect prevention are:

Programmers evaluate their own errors
The use of feedback
Process improvement is an integral part of the process
Takes time to learn process improvement

Defect prevention is a necessary procedure for delivering a quality & defect free software product. Defect prevention has a great impact on improving the software process by backing up the testing process, and reducing the cost of fixing errors. Fixing errors is cheaper when they are detected early in the process. Defect prevention should be instilled in all members who are involved in the development process. It is every one's responsibility; it is a discipline that should be adopted by an organization. Defect prevention activities are also a mechanism for communicating lessons learned among software projects and groups.

KEY WORDS: DP, KPA, Pareto Chart, DPL,C/E Diagram.

INTRODUCTION

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 activity is also a mechanism for spreading lessons learned across the projects. It also involves looking at the organizational level database and taking preventive actions. Defect Prevention (DP) is a strategy applied to the software development life cycle that identifies root causes of defects and prevents them from recurring.

Defect Prevention (DP) involves analyzing defects encountered in the past and specifying checkpoints and actions to prevent the occurrence of similar defects in the future.

Defect Prevention is identified by the Software Engineering Institute as a level 5 Key Process Area (KPA) in the Capability Maturity Model (CMM).

OBJECTIVES OF DEFECT PREVENTION

Identify and analyze the causes of defects and reduction in the number of defect and defect categories

Reduction in the extent of defect escape between phases

Reduction in frequency of common defects

Reduction in Cost and rework effort

Enhancement of productivity

ENTRY CRITERIA
Software Requirement Specifications, Test case documents

EXIT CRITERIA

Analysis and recommendation to prevent defects
All defects are closed

DELIVERABLES FORM DEFECT PREVENTION PROCESS

Proposed actions to prevent the future occurrence of identified defects. Defects, which are similar in nature, are identified and documented

A summary of the major defect categories is documented

The frequency distribution of defects in the major defect categories is documented

Significant innovations and actions taken to address the major defect categories are documented. The Lessons Learnt details are being updated in the Project Historical database for future references

A summary status of the action proposals and action items documented

METHODS OF DEFECT PREVENTION

Reviews and Inspections – Self Review, Peer Review and Inspections
Walkthroughs – Prototyping of the actual design which gives you the basic idea of the product functionality along with it's look and feel
Defect Logging and Documentation – Provide key parameters that supports Defect Analysis and measurements
Root Cause Analysis
Pareto Analysis
Fishbone Analysis

DEFECT PREVENTION PROCESS

Process Overview:

The process of Defect prevention is as follows:
Discuss in Kick-off Meeting
Defect Reporting
Causal Analysis
Action Proposals
Action Plan Implementation and tracking
Measure results

KICK-OFF MEETING

The Objective of the Kick-off Meeting is to identify the tasks involved during the current stage/ phase, task schedule, list of defects that may commonly be introduced during the phase, etc. During the project Initiation kick-off DPL will be nominated for the project.

This Kick-off Meeting could be organized as a part of Project initiation and Phase-startup review Meeting. (Project managers can combine the Phase-end-review and Phase-start-review into one). During this meeting the central defect prevention database and action database is referred for the list of Defects occurred in various projects, causal analysis, proposed corrective and recommended preventive actions taken by the Defect Prevention Leader (DPL).

The preventive actions necessary for the current stage/ phase is extracted from the database and documented in the SPMP & Test Plan, and DPL will be responsible for implementation of the preventive actions.

DEFECT REPORTING

In this process, the defects found during the current phase are identified, gathered, categorized, and a significant amount of information about them is collected by the Defect prevention leader. Categorization of errors is based on the Defect Types is defined.

Bug Tracking system could be used to collect the defects found on project management, review, test etc.

CAUSAL ANALYSIS

Causal analysis meeting is formalized amongst the project members by DPL. This could be a part of Phase-end-review. However separate Causal analysis meeting can be conducted, if the number of defects identified is critical in nature.

During this meeting the defects for analysis is selected by the DPL. This could be done using any statistical analysis method (C/E diagram, Pareto Chart etc.). Those selected set of defects are further analyzed for their root causes and source from which they were originated.

Guidelines to draw C/E diagram and Pareto Chart are given as Appendix A1 and Appendix A2 respectively.

The time at which errors are analyzed is important, because it prevents further errors from being produced and propagated throughout the process.

Various measurements are performed to identify the root causes of the defects.

The result of root causes is categorized. Examples of root cause categories include

❑ Inadequate training
❑ Process deficiency
❑ Mistakes in manual procedures/ documents (typing, printouts etc)
❑ Not accounting for all details of the problem
❑ Breakdown of communications, etc

During this meeting the Causal Analysis Report for Defect Prevention is filled. The sample format of the Causal Analysis Report is given below:

Causal Analysis Description			
Project Code:	Project Name:		Date:
Phase:	PM/PL:		Duration:
DP Team Leader/ Team Members:			
Participants:			
Major type of defects (Defect type that contribute to 80% defects: refer to Pareto):			
Type of defects that can be eliminated:			
Summary Points from CA meeting			

ACTION PROPOSALS

Detailed Action list should be prepared for each category of the root cause by the defect prevention leader (DPL). A Process Representative group (PRG) will be nominated by the DPL from within the project members/Team. PRG member of the respective project will coordinate in consolidating the entire action and update the Action plan.

Sometime the type of error, which occurs most frequently, may be the cheapest to correct; in this case it would be appropriate to do a Pareto based on cost to see which error accounts for most of the correction cost.

Further, during the SEPG meetings the actions taken for Defect Prevention will be reviewed from the "Phase Wise DP Action Proposals" database and will be prioritized based upon various factors like cost, effort, manpower etc. Appropriate measures will be taken at the Organization level to reduce the recurring /commonly found causes.

ACTION PLAN IMPLEMENTATION & TRACKING

DPL with the help of PRG initiates the implementation. The progress and result of the implementation of action proposals are verified and validated by periodic review, DPL audit and internal audit. Those results are consolidated and submitted to SEPG for further review. Once it is approved by the SEPG, the preventive actions taken by one project can be included in the organization specific quality process. All those results are recorded and documented within the project.

MEASURE RESULTS

Various measurements are done to determine the effects of addressing the common causes of defects and other problems on the project's software process performance. E.g. measuring the change in the project's software process performance etc. Also data on effort expended to perform defect prevention; number of defect prevention changes implemented are captured in the "Phase Wise DP Action Proposals" database and analyzed for further process improvement.

PROCESS IMPROVEMENT AND DEFECT PREVENTION PLAN

Perform Root Cause Analysis using the Defect Log and techniques like Pareto and Fishbone Diagrams

After the 1st stage of Causal Analysis perform Causal Analysis Trend Review

Come up with the Output of the Causal Analysis – Preventive Action Plan

Include this output in the overall Defect Prevention Plan

Adhere to the Defect Prevention Plan while executing future projects

DEFECT PREVENTION AUDIT:

It is required that all activities of the Defect prevention process are being performed unto satisfaction. For the same, Quarterly DP audits will be performed at the Organization level. In case project duration is less than three months then DP audit should be carried out at least once in the complete project life cycle. Normally an audit team comprising of DPLs from across projects to perform the DP audit.

PARETO ANALYSIS OR 80/20 ANALYSIS

Pareto analysis is a statistical technique in decision making that is used for selection of a limited number of tasks that produce significant overall effect

Large majority of problems (80%) are produced by a few key causes (20%)

The application of the Pareto analysis in risk management allows management to focus on the 20% of the risks that have the most impact on the project

PARETO CHART
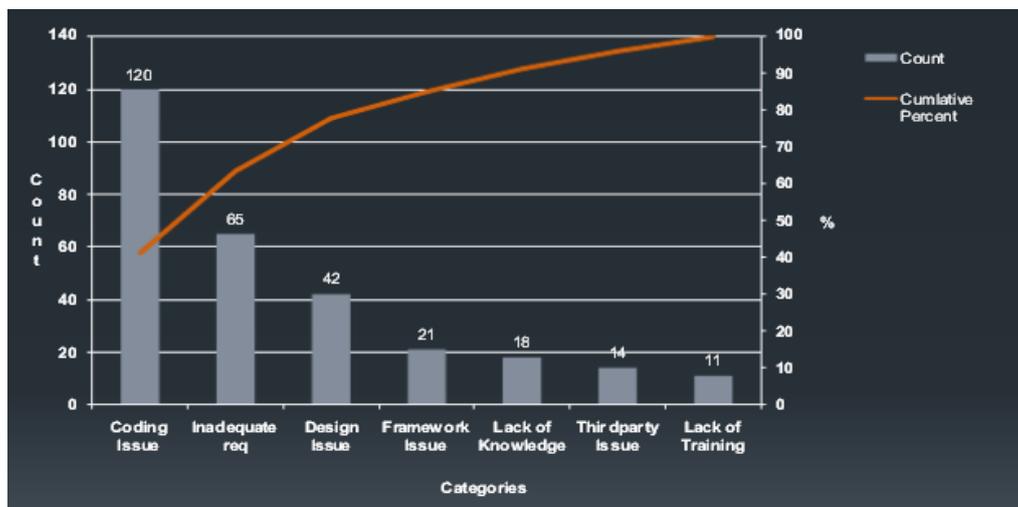
APPENDIX "A1": CAUSE & EFFECT (ISHIKAWA OR FISHBONE)

Introduction

To solve any type of problem, it is necessary to first identify the various causes, which are responsible for that particular problem. Cause & Effect (Ishikawa or Fishbone) is used, when we need to identify, explore and display all the possible causes of a specific problem or condition.

Objective

To establish a guideline for development of the Cause & Effect diagram.

Procedure

C & E diagram is developed to represent the relationship between some "effects" and possible "causes". The effect or problem is reported on right side of the chart and the major influences or "causes" are listed to the left.

C & E diagrams are drawn to clearly illustrate the various causes affecting a process by sorting out and relating the causes. For every effect there are likely to be several major categories of causes. The major categories can be but not limited to

- People & Environment
- Material (Input)
- Skill
- Process and method etc

Steps in creating the C & E diagram

Begin the process by agreeing on one statement that describe the selected problem (s) in terms of what it is specifically, where it occurs, when it happens and its extent.

Generate the causes needed to build a cause & Effect Diagram by Structured Brainstorming about the possible causes without previous preparation.

Construct the actual Cause & Effect Diagram by:

Placing the problem statement in the box on the right.

Drawing the tradition major cause category steps in the process, or any causes that are helpful in organizing the most important factor.

Placing the Brainstormed ideas in the appropriate major categories.

For each cause ask, "Why does it happen?" and list responses as branches off the major causes.

In order to find the most basic causes of the problem:

Look for causes that appear repeatedly

Reach a team consensus

Gather data to determine the relative frequencies of the different causes

APPENDIX "A2": PARETO CHART

Introduction
To solve any problem out of a list of problems, it is very much necessary to select which problem is to be solved first or which problem has much importance. Pareto Chart is used when we need to display the relative importance of all of the problems or conditions in order to: choose the starting point for problem solving, monitor success or identify the basic cause of the problem.

Objective
To establish a guideline for development of the Pareto Chart.
Procedure
A Pareto chart is a special form of vertical bar graph, which helps us to determine which problem to solve in what order. We will generally gain more by working on the tallest bar than tackling the smaller bars.

Steps in Creating Pareto Chart
Select the problems that are to be compared and rank orderly by:
Brainstorming e.g. what are our major quality problems in Department "A".
Using existing data e.g. "Let's take a look at Department A's quality reports over the last month to find the major problem areas".
- Select the standard for comparison unit of measurement, e.g. annual cost, frequency etc.
Select time period to be studied e.g. 8 hours, 8 days, 8 weeks.
Gather necessary data on the site of each category e.g. "Defect A occurred X times in last 6 months" or "Defect B cost X Rs. In the last 6 months" etc.
Compare the frequency or cost of each category relative to all other categories e.g., "Defect A happened 75 times: Defect B happened 107 times: Defect C happened 35 times", etc; or "Defect A cost Rs. 60,000 annually; defect B cost Rs. 45,000 annually", etc.
List the categories from left to right on the horizontal axis in their order of decreasing frequency or cost. The categories containing the fewest items can be combined into an "other" category, which is placed on the extreme right as the last bar.
Above each classification or category, draw a rectangle whose height represents the frequency or cost in that classification.

Using Defect Log and Templates for Analysis -1
Create a Defect Log to categorize the defects based on Priority/Severity, Functionality, and Cause etc
Define the Corrective Action Taken and Preventive Action proposed to ensure defect does not recur in future

CONCLUSION

Defect Prevention activities are a mechanism for propagating the knowledge of lessons learned between projects. Defect Prevention plan should be prepared as a part of the Project management plan in the project and should be approved by Senior Management. The Defect Prevention meetings should be planned in the project at every phase-end and the records should be available. All defects found during the course of project life cycle should be available in the Bug Tracking System and all Causal Analysis Reports should be available in the project as per the plan. Statistical analysis methods should be used for analysis of defects. Defect Metrics should be calculated for the project as per the Plan. The actions proposals drawn as a result of the Causal Analysis should be tracked to closure by the DPL.The learning from the corrective actions (either from the previous phase of the project or from the DP proposal database) should be considered as input to the DP Plan for the current phase/ project. The Defect analysis and the prevention plan reflects the maturity in the software process.

REFERENCES

[1] Brett Pettichord,Cem Kaner and James Bach, Lessons learned in software testing, John Wiley and sons, published 2002,Edition 1

[2] Rex Black, Managing the Testing Process, published 1999, Edition 1