

Using Orthogonal Defect Classification for Defect Analysis

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Abstract

ISO 9000 defines defect as Non-fulfillment of a requirement related to an intended or specified use. All of us commonly understand defect as those undesirable aspect of our product or service delivery.

Defect Analysis is using defects as data for continuous quality improvement. Defect analysis generally seeks to classify defects into categories and identify possible causes in order to direct process improvement efforts. Defects are usually categorized as Fatal, Major or Minor depending on the priority attached to fixing the bug. However, to gain a deeper understanding of the effectiveness of the software process to develop any product/application, it is essential to examine the details of defects more minutely. Orthogonal Defect Classification (ODC) is a concept, which enables developers, Quality Managers and Project Managers to evaluate the effectiveness and completeness of the verification processes.

In our organization, NIIT Technologies, in process-defects are analyzed at various stages of the project lifecycle on the basis of the defect types e.g. Requirements incorrectly captured, S&G violated, Incorrect documentation etc. This in-process defect analysis has proved to be an effective way of reducing the number of defects in subsequent lifecycle phases and ensuring a zero defect delivery to the client. In addition to this, projects customize the organization's ODC schema to achieve greater benefits in their measurement and analysis.

Introduction

There are core measures for which organization level goals are defined. Every project carries a target for achieving the relevant goals. These measures are composed of both process and product measures. The goals are in line with organization's business objectives.

At the beginning of the project, project manager needs to plan for the critical processes and the measures to control these critical processes.

It was observed that to achieve the quality goals, controlling the defects through timely analysis was a critical process. The measures associated with this process were identified as the "number of defects in various lifecycle phases & the classification of defects into categories". As the product quality is dependent on the processes followed, establishing the right processes and measures at each activity/phase will ensure a quality product.

In order to meet these requirements, NIIT Technologies has tailored the Orthogonal Defect Classification technique to make the defect analysis & control more effective in meeting the organization goals.

Also, as a CMMI Level 5 organization, our focus has been on continuous improvement and defect prevention – two basic requirements of Level 5 Process Areas in the CMMI Model.

Alternatives Considered

"Quality is never an accident; it represents the wise choice of many alternatives" said William A Foster.

In our endeavor to arrive at a suitable technique for controlling defects, some of the alternatives considered were:

- Looking at source of defects i.e. the phase where the defect was injected – Not very effective in controlling defects
- Doing Causal Analysis at phase end to control defects in the subsequent phases – Moreover, given the qualitative nature of the analysis, the method does not lend itself well to measurement and quantitative analysis
- Statistical models – Typically, this may be measured in terms of the number of defects remaining in the field, the failure rate of the product, the short term defect detection rate, etc. Although this may provide a good report card, it often occurs so late in the development cycle that it is of little value to the developer. Ideally, a developer would like to get feedback during the process.
- Use of standard models like Raleigh for reliability

After deliberating on the pros & cons of these alternatives, Tailoring ODC concept was selected

- It brings the rigor of scientific techniques on area that is prone to qualitative judgment
- It can be easily adopted to suit project needs for all types of projects – Maintenance, Development, Testing etc.

Defect Classification

As part of the definition of the defect types, we have identified 31 defect types as part of our Quality Management System. This creates the framework for the organization to carry out the data analysis at the project level. These defect types are:

Requirements Analysis (RA)

1. Requirements not captured
2. Requirements captured incorrectly
3. Violation of RA Guidelines or templates

Design

4. Incomplete screen design
5. Incorrect screen design
6. Incomplete database design
7. Incorrect database design
8. Incomplete report layout
9. Incorrect report layout
10. Incomplete interface definition
11. Incorrect interface definition
12. Incomplete security design
13. Incorrect security design
14. Incorrect functionality
15. Violation of design Guidelines or templates
16. Incorrect / not optimized SQL
17. Incorrect logic in design
18. Incomplete Unit Test Cases
19. Incorrect Unit Test Cases
20. Incomplete Integration Test Cases
21. Incorrect Integration Test Cases
22. Incomplete Functional Test Cases
23. Incorrect Functional Test Cases

Construction

24. Code missing
25. Incorrect logic in code
26. Exception handling error
27. Navigation errors
28. Violation of Coding Guidelines or templates

Project Documentation

29. Incomplete Documentation
30. Incorrect Documentation
31. Violation of Documentation Guidelines or template

The concept of orthogonal Defect Classification is imparted in the QMS training programs to all role holders in the organization.

In order to have a more effective defect classification specific to the project, projects use the organization defect type data given above and past projects' learnings in developing the customized ODC.

The following section illustrates some instances of the

customization and the resultant quantitative benefits. Development and Maintenance project instances have been included herein to demonstrate that this concept can be effectively applied irrespective of type of project.

Project 1: Development Project

The objective of the project, which we completed for a European client, was to provide a new data structure and supply infrastructure for three different business programs within the client's organization.

During the project reviews, it was found that the actual number of defects found during the Functional Design phase were much less than the planned number of defects for that phase. On further analysis, it was found that the defects from the Functional Design phase had started leaking into the subsequent phases.

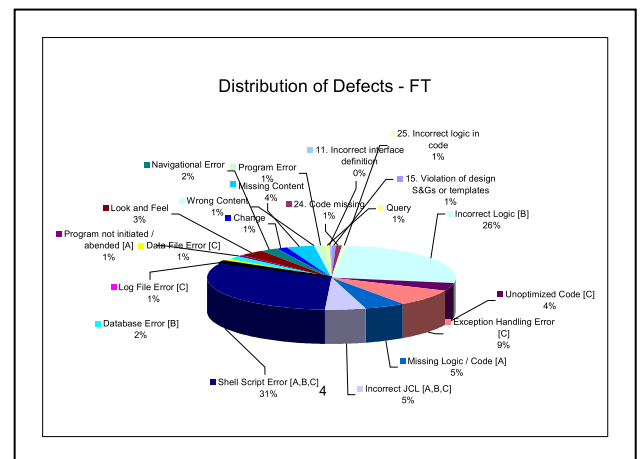
The project team on Causal Analysis figured that the defect type as defined in QMS were not sufficient to identify what the exact problem was. They then created a list of defect types, which were very specific to their project needs and mutually exclusive to each other. E.g. for the construction phase, QMS prescribes a defect type "Incorrect Logic in code". This was further classified by the project team as :

- a. Exception Handling Error
- b. Shell Script Error
- c. Data type mismatch
- d. Static data error
- e. Missing workflow / code

Similarly, other defect types were also created for use in the project; a list, which was more concise than what QMS prescribed. This classification of defects helped the project team identify the exact nature of bugs being encountered during the course of reviews and hence, focus on the specific areas of improvement in the project.

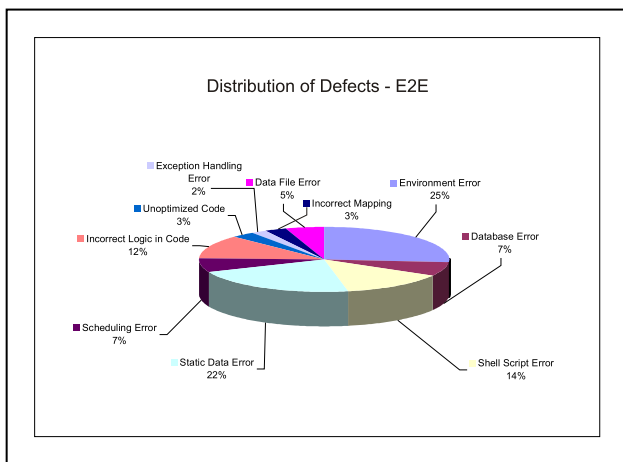
Benefits Achieved

In project 1, the defects trend analysis using a customized Orthogonal Defect Classification led to a substantial reduction in errors for particular category. The improvements were seen as follows :



Distribution of Defects - Functional Testing Phase

1. The error type "Shell Script Error" reduced from 121 during Functional Testing to a mere 14 in the End-to-End Testing phase i.e. the %age of Shell Script errors reduced from 31% in FT to 14% in E2E. "Exception Handling error" reduced from 9% in FT to 2% in E2E.
2. The number of problems reduced from 0.2 weighted defects per FP to less than 0.02 defects in Acceptance Testing.
3. 80% of the defects were found in the Code reviews and only 20% in Unit Testing during the Construction hence, reducing the Cycle time in the project.



Distribution of Defects – End to End Testing Phase

3.2 Project 2: Support & Maintenance Project

In Project 2, a Support & Maintenance project, which we are implementing for a US based client, during the course of implementing the First release for an application, the number of defects found were high.

The team customized the Defect Types on the basis of kind of defects found and finalized the list of Defect Types that they would use as follows:

- a. Code
- b. Build
- c. Execution
- d. Casebook
- e. RT Plan/TRC
- f. Test Results

On analyzing the defect types using Orthogonal Defect Classification, it was found that the highest number of defects were attributable to defects leakage during reviews of Casebooks.

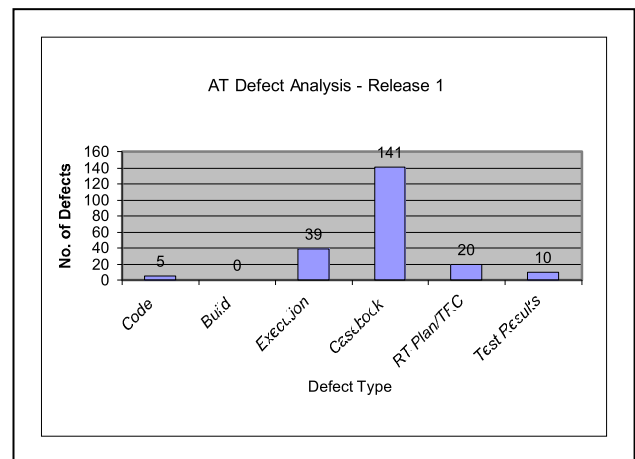
During Causal Analysis, the project team addressed the issue of ineffective reviews of Casebooks and the one of the Top root causes was found to be due to manual reviews of the casebooks. As part of their Corrective actions, the team created a tool, which automated the review activity of Casebooks.

Benefits Achieved

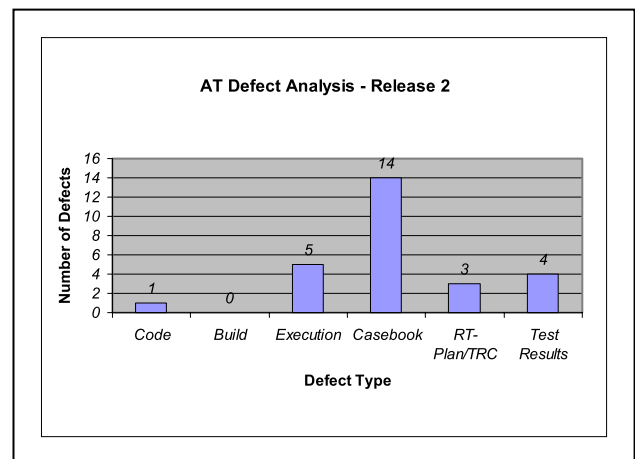
On analysis of defects in the subsequent Release of the same application, it was found that by creating the tool, the team was

able to reduce the defects in Casebooks drastically.

- a. The number of defects in Casebooks during Acceptance Testing of Release 2 reduced to a mere 14 as against 141 errors during Acceptance Testing of Release 1.
- b. The effort saved in the project by using a tool to automate review of casebooks was about 20%.



Distribution of Defects – Release 1



Distribution of Defects – Release 2

4. Usage of Tools

As part of promoting the usage of Orthogonal Defect Classification, the internal process automation tool used by projects has the following report, which shows the phase – defect type matrix.

This report is again customizable by the users depending on the defect classifications identified for their respective projects.

S No.	Category	PSU	RQA	HLD	LLD	CNS	TES	ACC	WAR	TOTAL(Weighted)
1	Code missing.	0	0	0	0	5	0	0	0	5
2	Database design Incorrect.	0	0	0	0	1	0	0	0	1
3	Functionality Incorrect	0	0	0	0	0	0	5	0	5
4	Incorrect logic in code	0	0	0	0	15	0	0	0	15
5	Interface definition Incorrect	0	82	0	35	38	0	0	10	165
6	Logic in design Incorrect.	0	0	0	25	0	0	0	0	25
7	Report layout Incomplete.	0	0	0	1	0	0	0	0	1
8	Requirements captured incorrectly.	0	0	0	0	5	0	0	0	5
9	Requirements not captured.	6	0	15	0	23	0	0	0	44
10	Screen design Incomplete.	0	0	0	6	0	0	0	0	6
11	Screen design Incorrect.	0	0	0	0	5	0	0	0	5
12	Security design Incorrect	0	0	0	22	0	0	0	0	22
13	Violation of CNS S&Gs or Templates	0	0	0	0	4	0	0	0	4
14	Violation of RA S&Gs or Templates	0	0	0	1	0	0	0	0	1

5. Future Directions

As a CMMI Level 5 organization, it is our continued effort to devise ways and means of continually improving our defect analysis and defect prevention mechanisms. Future directions:

- 1.Continue usage of Orthogonal Defect Classification as an effective method of defect analysis.
- 2.Developing taxonomy of defect types and Calibration at an organization level so as to minimize the need of customization of the same.
- 3.Study the correlation between tailoring and acceptance defects.

References

“Orthogonal Defect Classification–A Concept for In-Process Measurements” R. Chillarege, I.S. Bhandari, J.K. Chaar, M. J. Halliday, D.S. Moebus, B.K. Ray, M.–Y. Wong