Chapter 6
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6.1 Introduction

Free/Open Source Software market is growing rapidly across all domains of knowledge, making it increasingly difficult for potential F/OSS users to choose between them. While choosing F/OSS Products, the potential F/OSS users focus upon extensibility and maintainability besides considering their functional requirements. The leading concern of F/OSS users is the availability of support and maintenance as it largely depends upon the voluntary efforts of F/OSS development teams. So it is necessary for potential F/OSS users to evaluate how well their requests for fixing bugs, enhancing features, translation requests, support requests etc. are being managed. The software defects are also considered to be among the few direct measurements of software processes and products. Thus F/OSS Projects can be assessed on the basis of past records maintained in Defect Management System (DMS) regarding bug fixes, feature enhancements, translation requests, support requests etc.

Surprisingly little research has focused on the inefficiencies and problems occurring during the process of Defect Management in F/OSS Projects. In the current work, F/OSS Defect Management is explored to determine its impact on F/OSS quality to analyze the past experience, degree of improvement or deterioration and responsiveness towards users for various F/OSS Projects. Based on the findings, certain problems have been identified in Defect Management which may have serious effects on F/OSS quality in the long term if effective countermeasures are not taken. These problems can be solved to a large extent if various tasks involved in Defect Management are distributed among F/OSS Participants on the basis of their skill sets.
6.2 Problems in Defect Management and Suggestions

During the current study, various problems that have been identified in Defect Management are discussed as follows. Also an attempt is made to address these problems.

- Most of the F/OSS Projects are found to be suffering from the problem of crushing load of duplicate or invalid defects reported by F/OSS users. It increases the unnecessary work load of F/OSS Development Team. Many times resolution of such defects is already available but the users have to wait for the response of the development team for their reported defects.

Defect Management System should have easy to use functionality for searching the existing defect records. There should be clearly defined training document for guiding the users on how to search the existing defect records before reporting a new one. In case reporter finds that a similar defect is already reported then Defect Management System should have the functionality for adding additional information (if any) along with existing defect record. This will result in unified information about any particular defect and hence will help development team in reproduction and thereafter in resolution of the defect.

Many times there exist long pending defects which are not fixed even in new patches/releases. In such cases, generally users will resubmit them which will also cause duplicate defect records. So Defect Management System should provide a feature to renew the same defect rather than submitting the new duplicate defect.

- It has been found that in few F/OSS Projects, the defect resolution status remains default (None) rather than being updated with relevant resolution status (Fixed, Duplicate, Out of Date, Won’t Fix, Works for Me, Invalid etc.) even after the defect is closed. Although such defects are closed but the F/OSS users are not able to know exactly what actions have been taken on their reported defects.
Defect Management System should have the functionality which enforces the development team to update the resolution status correctly while closing the defect.

- It has been found that in most of F/OSS Projects, the F/OSS development team is not defining the priority of each defect being reported, although Defect Management System has the functionality to assign priority to reported defects. When a defect is reported, the priority is always set to default value 5 i.e. Normal (1-Highest, 9-Lowest) which is generally not updated by Development Team.

Due to lack of prioritization of reported defects, the resolution of many critical defects may be delayed. F/OSS Project development team should clearly define the criterion to identify the priority of each reported defect and make some of the team members responsible to assign the priority as per the criterion.

- It is seen that all the F/OSS Projects have quite large number of defects being reported by anonymous users. Thus it makes infeasible for development team to contact the reporter to gather additional information or to communicate the defect status information.

There is no specific reason for anonymous participation but it seems that some users either do not want to disclose their identity or do not want to follow the lengthy procedure of registration. So it is required the user registration procedure should be simplified as well as personal information should be protected from public accessibility.

- It is also observed that defect reporting is a widely dispersed activity and large proportions of all defects are reported by users contributing once, twice or thrice. Only very few users are reporting defects on a frequent basis. Although no significant relationship could be observed between irregular participation in defect reporting and other defect parameters but it seems that one of the probable reasons is that F/OSS users report defects while evaluating the F/OSS Product for
future use but never start using it or discontinue the usage after some time. In certain cases, the users may be discouraged as they are not able to get the resolution as per their expectation with in the desired time period.

F/OSS development team should periodically establish communication with such users to encourage them to provide feedback and participate regularly. Surveys may also be conducted to know the level of satisfaction regarding usage of F/OSS Product and any issues that need to be addressed by development team.

- It is observed that many F/OSS Projects do not carry out defect resolution consistently and efficiently. The defect arrival is showing downward trend with the passage of time still defect resolution is not able to keep pace with defect arrival thus accumulating pending defects. It is also found that backlog of pending defects accumulate gradually while their resolutions are carried out in bursty manner near the forthcoming releases. All these factors cause an increasing trend of overall resolution age as well as pending age.

The detailed analysis shows that most of the defects are closed in reasonable time period while few defects take quite longer resolution time and aggravate the overall scenario. F/OSS development team should periodically review such long pending defects and prioritize them for resolution.

- It is also observed that there is no significant difference in resolution age of defects resolved with code fix or without any code fix (such as Duplicate, Out of Date, Won’t Fix, Works for Me, Invalid etc.). It is not justified that a defect is closed after 100 days or longer with the status information as Duplicate, Out of Date, Won’t Fix, Works for Me etc. Such behavior may cause loss of interest among participating users for further involvement.
A process need to defined so that as soon as a defect is reported, members of development team should review it and if defect does not require any code change, it should be closed immediately with appropriate resolution status. By reducing Non-fix defect resolution age, overall resolution efficiency can be improved.

- It is found that all the defect types (Bugs, Feature Requests, Patches, Miscellaneous) are dispersed among all the resolution age categories although proportion of bugs decrease with increasing resolution age while others (Feature Requests, Patches, Miscellaneous) increase with increasing resolution age. It is also observed that each defect type is showing an overall increasing trend of pending age in all the selected projects.

Ideally bugs should be resolved within shorter period depending upon the criticality of the bugs; while feature requests, patch submissions may be delayed till forthcoming releases/patches. Under miscellaneous category, the resolution should be carried out based upon the type of request. Due to volunteer nature of F/OSS participants, nobody can ensure that they will have enough time to respond to a defect quickly. So spreading the load across several development team members may lead to more reliability and to a shorter defect removal time.

- It is observed that Defect Resolution is concentrated among a few individuals mainly from core team while Defect Reporting is found to be a widely dispersed activity mostly contributed by users external to core team. Generally, the most active users in the projects carry out most of the tasks while others contribute only once or twice.

Although F/OSS Projects are benefited by active participation of globally distributed community in Defect Reporting but some initiatives need to be taken to encourage their participation in Defect Resolution also.
6.3 Proposed Process for Defect Management

Based on the suggestions mentioned in the previous section, a process is proposed as shown in Figure 6.1, which can help to improve the effectiveness as well as efficiency of Defect Management.

![Figure 6.1: Proposed Process Diagram](image)

It is proposed that support and maintenance activities should be distributed among various levels in order to improve the effectiveness and efficiency in Defect Management. The roles and responsibilities at these levels can be distributed as follows:

- **Support Level 1**: This level may comprise volunteer F/OSS users who may not have sufficient technical skill set to help development team but are ready to participate in F/OSS development process. This team should have responsibility to communicate with F/OSS users, obtain their feedback and conduct surveys periodically to know the level of
satisfaction regarding usage of F/OSS Product and any issues that need to be addressed by development team.

- **Support Level 2**: This level may comprise volunteer F/OSS users cum developers who have sufficient technical skill set to help development team. They should be assigned the responsibility to review all the reported defects within stipulated period, make efforts to reproduce, collect additional information if required, set priority based upon prior defined criterion and assign them to team at level 3. They should keep on monitoring that no defect should remain pending for a long period without any appropriate reason. If there is any long pending defect without any justified reason, it should be escalated to Core Team for corrective measures. The members at this level should also resolve the defects which does not require any code change and set their appropriate status in the Defect Management System. They should also build knowledgebase comprising frequently occurring defects related to installation, configuration etc. and enabling F/OSS users to browse through easily.

- **Support Level 3**: This level may comprise volunteer F/OSS developers who have good technical skill set and knowledge of source code of F/OSS Project. This team will have the responsibility to carry out necessary code changes to fix the defects as well to incorporate required feature enhancements. Whenever a defect is assigned, they should resolve the defect with in reasonable time frame. If some additional information is required about the defects, it should be obtained through level 2 team. Many times some of the defects can not be resolved due to constraints like software design, technology, resources, irreproducible etc. In all such cases, relevant information should be communicated to users timely.

- **Quality Assurance Team**: This team should comprise F/OSS volunteers preferably having some knowledge or experience in software quality assurance. They should have responsibility to monitor the activities carried out at all levels e.g. responsiveness towards
users, defect resolution period, backlog of defects, code review etc. and should assure that quality is maintained at all the levels. They should generate and analyze the statistics periodically and should escalate serious concerns (if any) to core team.

- **F/OSS Core Team:** This team comprises the initiators and project leaders who have the overall responsibility. They should control the overall direction of project, take corrective measures for serious concerns and decide future strategy for forthcoming releases.

### 6.4 Conclusion

The research findings contribute to an understanding of Defect Management practices and provide empirical evidences with special focus on effectiveness and efficiency in defect resolution. Several problems have been identified in Defect Management. A layered process is proposed where roles and responsibilities are clearly defined and distributed among F/OSS participants. F/OSS Projects may use the proposed process which can help to improve the effectiveness and efficiency in Defect Management and thus assure better quality of F/OSS Products.