|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **W**  **H**  **E**  **R**  **E**  **F**  **O**  **U**  **N**  **D** | **DEFECT ORIGIN** | | | | | | | | | |
|  | **Requirement** | **Analysis** | **Design** | **Coding** | **Unit Testing** | **Integration Testing** | **System Testing** | **Field** | **Total** |
| **Requirement** | 88 |  |  |  |  |  |  |  | **88** |
| **Analysis** | 110 | 55 |  |  |  |  |  |  | **165** |
| **Design** | 67 | 59 | 99 |  |  |  |  |  | **225** |
| **Coding** | 34 | 63 | 72 | 311 |  |  |  |  | **480** |
| **Unit Testing** | 44 | 44 | 55 | 121 | 10 |  |  |  | **274** |
| **Integration Testing** | 34 | 9 | 32 | 38 | - | 11 |  |  | **124** |
| **System Testing** | 6 | 5 | 5 | 23 | - | - | 9 |  | **48** |
| **Field** | 7 | 2 | 4 | 12 | - | - | - | 3 | **28** |
| **Total** | **390** | **237** | **267** | **505** | **10** | **11** | **9** | **3** | **1432** |

1. **Defect removal rate for every phase:**

Product size = 90KLOC

Therefore, **Defect removal rate= Defects removed/90KLOC**

|  |  |  |
| --- | --- | --- |
| **Phase** | **Defects Detected** | **Defect Removal Rate** |
| **Requirement** | 88 | 0.977 defects/KLOC |
| **Analysis** | 165 | 1.833 defects/KLOC |
| **Design** | 225 | 2.5 defects/KLOC |
| **Coding** | 480 | 5.333 defects/KLOC |
| **Unit Testing** | 274 | 3.044 defects/KLOC |
| **Integration Testing** | 124 | 1.377 defects/KLOC |
| **System Testing** | 48 | 0.533 defects/KLOC |
| **Field** | 28 | * 1. defects/KLOC |

1. **Defect Injection Rate for every phase:**

Product size = 90KLOC

Therefore, **Defect injection rate= Defects injected/90KLOC**

|  |  |  |
| --- | --- | --- |
| **Phase** | **Defects Injected** | **Defect Removal Rate** |
| **Requirement** | 390 | 4.333 defects/KLOC |
| **Analysis** | 237 | 2.633 defects/KLOC |
| **Design** | 267 | 2.966 defects/KLOC |
| **Coding** | 505 | 5.611 defects/KLOC |
| **Unit Testing** | 10 | 0.111 defects/KLOC |
| **Integration Testing** | 11 | 0.122 defects/KLOC |
| **System Testing** | 9 | 0.1 defects/KLOC |
| **Field** | 3 | * 1. defects/KLOC |

1. **Defect escape rate for every phase:**

Product size = 90KLOC

Therefore, Defect escape rate= Defects escaped/90KLOC

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Phase** | **Defects Injected** | **Defects Detected** | **Defects Escaped** | **Defect Escape Rate** |
| **Requirement** | 390 | 88 | 390-88 = **302** | 3.355 defects/KLOC |
| **Analysis** | 237 | 165 | 390+237-88-165 = **374** | 4.155 defects/KLOC |
| **Design** | 267 | 225 | 390+237+267-88-165-225 = **416** | 4.622 defects/KLOC |
| **Coding** | 505 | 480 | 390+237+267+505-88-165-225-480 = **441** | 4.9 defects/KLOC |
| **Unit Testing** | 10 | 274 | 390+237+267+505+10-88-165-225-480-274 = **177** | 1.96 defects/KLOC |
| **Integration Testing** | 11 | 124 | 390+237+267+505+10+11-88-165-225-480-274-124 = **64** | 0.711 defects/KLOC |
| **System Testing** | 9 | 48 | 390+237+267+505+10+11+9-88-165-225-480-274-124-48 = **25** | 0.277 defects/KLOC |
| **Field** | 3 | 28 | 390+237+267+505+10+11+9+3-88-165-225-480-274-124-48-28 =  **0** | 0 defects/KLOC |

1. **The most effective phase in removing defects:**

**Defect Removal Effectiveness in Development phases:**

*Defect Removal Effectiveness for each development step = [Defects removed/Defect existing on step entry+ Defects injected during development] \* 100%*

**DRE in Requirement phase:**

Defects removed in current phase = 88

Defects existing on step entry (escaped from previous phase) = 0

Defects injected in current phase = 390

**Therefore, DRE = [88/ (0 + 390)] \*100% = 22.56%**

**DRE in Analysis phase:**

Defects removed in current phase = 165

Defects existing on step entry (escaped from previous phase) = 302

Defects injected in current phase = 237

**Therefore, DRE = [165/ (302+237)] \*100% = 30.61%**

**DRE in Design phase:**

Defects removed in current phase = 225

Defects existing on step entry (escaped from previous phase) = 374

Defects injected in current phase = 267

**Therefore, DRE = [225/ (374+267)] \*100% = 35.10%**

**DRE in Coding phase:**

Defects removed in current phase = 480

Defects existing on step entry (escaped from previous phase) = 416

Defects injected in current phase = 505

**Therefore, DRE = [480/ (416+505)] \*100% = 52.11%**

**DRE in Unit Testing phase:**

Defects removed in current phase = 274

**Therefore, DRE = [274/ (274+124+48+28)] \*100% = 57.80%**

**Defect Removal Effectiveness in Testing phases:**

*[Defects removed at current phase/ Defects removed at current phase + Defects removed at subsequent phases] \* 100%*

**DRE in Integration Testing phase:**

Defects removed in current phase = 124

**Therefore, DRE = [124/ (124 + 48+28)] \*100 = 62%**

**DRE in System Testing phase:**

Defects removed in current phase = 48

**Therefore, DRE = [48/ (48+28)] \*100 = 63.15%**

**DRE in Field:**

Defects removed in current phase = 28

**Therefore, DRE = [28/28] \*100 = 100%**

**Consolidated table for Defect Removal Effectiveness:**

|  |  |
| --- | --- |
| **Phase** | **Defect Removal Effectiveness** |
| Requirement | **22.56%** |
| Analysis | **30.61%** |
| Design | **35.10%** |
| Coding | **52.11%** |
| Unit Testing | **57.80%** |
| Integration Testing | **62%** |
| System Testing | **63.15%** |

From the above table we can see that System Testing phase has a DRE of 63.15 % which is higher compared to DRE in other phases**. Hence, System Testing phase is the most effective in removing defects.**

1. **Overall defect removal effectiveness:**

Overall DRE of the project = [1- (Defects removed in Field/Total number of Defects)] \*100%

Therefore,

Overall DRE = [1- (28/1432)] \*100% = 98.04%

1. **Yes, reviews and inspections were effective in removing the defects.** We can corroborate this using following data.

Total number of defects in the project = 1432

Number of defects caught through inspections and reviews = 958 (88+165+225+480)

Therefore, percentage of defects caught through inspections and reviews is 66.89% which proves the effectiveness of reviews and inspections.

1. Number of defects originated in Requirement phase = 390

If this number increases by 25%, then number of defects originated would be [(25/100) \*390] + 390 = 487.5 approximately equal to 488.

Number of defects detected in Requirement phase = 88

If this number increases by 25%, then number of defects detected would be [(25/100) \*88] + 88 = 110

Difference between the original number of defects injected and detected would be 390 – 88 = 302

And after raising the numbers by 25%, the difference would be 488-110 = 378

Which means 76 additional defects. These additional defects will be carried down to subsequent phases during which they might or might not be caught. If the defects go unnoticed then there is a good chance of increase in the number of errors in the subsequent phases, especially coding. **Hence it will have a negative impact on the defects originated in the coding phase.**

1. Number of defects originated in design phase = 267

If we increase this number by 5%, then the number of defects originated will be [(5/100) \*267] + 267 = 280 approximately.

Number of defects detected in coding phase = 480

If we increase this number by 95%, then the number of defects detected would be 936.

However, this change will have not have any impact on defect removal effectiveness of the testing phases. This conclusion can be strengthened by Dunn’s formula:

*Defect Removal Effectiveness for Testing phases= [Defects removed (current step)/ Defects removed at current phase+ Defects removed at subsequent phase] \*100%*

Considering the above formula to calculate the defect removal effectiveness for testing phases, it can be noticed that only defects removed at the subsequent changes can affect the defect removal effectiveness for testing phases. Hence any number of defects originated in the design phase or detected during the coding phase will not have any impact. **Hence, there will be no impact.**