**Rough Calculation determining total for every phase:**

**Figure 1: Total Defects Injected and Defects Removed in each phase**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Phases** | **Requirement** | **Analysis** | **Design** | **Coding** | **Unit Testing** | **Integration Testing** | **System Testing** | **Field** | **Total** |
| **Requirement** | 29 |  |  |  |  |  |  |  | 29 |
| **Analysis** | 19 | 57 |  |  |  |  |  |  | 76 |
| **Design** | 38 | 51 | 49 |  |  |  |  |  | 138 |
| **Coding** | 25 | 37 | 38 | 231 |  |  |  |  | 331 |
| **Unit Testing** | 13 | 14 | 41 | 103 | 9 |  |  |  | 180 |
| **Integration Testing** | 21 | 22 | 42 | 32 | - | 7 |  |  | 124 |
| **System Testing** | 9 | 2 | 13 | 24 | - | - | 8 |  | 56 |
| **Field** | 2 | 2 | 3 | 2 | - | - | - | 2 | 11 |
| **Total** | 156 | 185 | 186 | 392 | 9 | 7 | 8 | 2 | 945 |

**Answer 1: Calculation for Defect Removal Rate:**

Given, product size = 120 KLOC.

Also, from “Figure 1” showed above, referring “Total” vertical column values for each phase and divide it by "120” KLOC to get Defect Removal Rate for each phase.

1. **Requirement phase:**

Defect Removal Rate for Requirement phase= (29/120) = 0.24 = 0.2

1. **Analysis phase:**

Defect Removal Rate for Analysis phase= (76/120) = 0.63 = 0.6

1. **Design phase:**

Defect Removal Rate for Design phase= (138/120) = 1.15 = 1.2

1. **Coding phase:**

Defect Removal Rate for Coding phase= (331/120) = 2.76 = 2.8

1. **Unit Testing phase:**

Defect Removal Rate for Unit Testing phase= (180/120) = 1.5

1. **Integration Testing phase:**

Defect Removal Rate for Integration Testing phase= (124/120) = 1.03 = 1

1. **System Testing phase:**

Defect Removal Rate for System Testing phase= (56/120) = 0.47 = 0.5

Also, “defect removal rate” for every phase has been calculated “per 120 KLOC”.

Following table displays the “defect removal rate for every phase”.

|  |  |
| --- | --- |
| **Phases** | **Defects Removal/120 KLOC** |
| **Requirement** | 0.2 |
| **Analysis** | 0.6 |
| **Design** | 1.2 |
| **Coding** | 2.8 |
| **Unit Testing** | 1.5 |
| **Integration Testing** | 1 |
| **System Testing** | 0.5 |
| **Field** | - |
| **Total** | 7.8 |

**Answer 2: Calculation for Defect Injection Rate:**

Given, product size = 120 KLOC

Also, from “Figure 1” showed above, referring “Total” horizontal column values for each phase and divide it by "120” KLOC to get Defect Injection Rate for each phase.

1. **Requirement phase:**

Defect Injection Rate for Requirement phase= (156/120) = 1.3

1. **Analysis phase:**

Defect Injection Rate for Analysis phase= (185/120) = 1.5

1. **Design phase:**

Defect Injection Rate for Design phase= (186/120) = 1.6

1. **Coding phase:**

Defect Injection Rate for Coding phase= (392/120) = 3.3

For all the testing phases i.e. Unit Testing, Integration Testing and System Testing and Field, no need to calculate defect injection rate as in testing phases and in Field, new defect creation or injection does not take place rather diagonal values for the testing phases represent the number of bad fixes. Also, “defect injection rate for every phase” has been calculated “per 120 KLOC”.

Following table displays the “defect injection rate for every phase”.

|  |  |
| --- | --- |
| **Phases** | **Defect Injection/120 KLOC** |
| **Requirement** | 1.3 |
| **Analysis** | 1.5 |
| **Design** | 1.6 |
| **Coding** | 3.3 |
| **Unit Testing** | - |
| **Integration Testing** | - |
| **System Testing** | - |
| **Field** | - |
| **Total** | 7.7 |

**Answer 3: Calculation for Defect Escape Rate:**

Given, product size = 120 KLOC

Also, from “Figure 1” showed above, referring “Total” horizontal and vertical column values for each phase to get Defect Escape Rate.

1. **Requirement phase:**

Defect Escape Rate for Requirement phase= ((156-29)/120) = 1.058 = 1.1

1. **Analysis phase:**

Defect Escape Rate for Analysis phase= (((185+156) - (76+29))/120) = 1.96 = 2

1. **Design phase:**

Defect Escape Rate for Design phase= (((186+185+156) - (138+76+29))/120) = 2.36 = 2.4

1. **Coding phase:**

Defect Escape Rate for Coding phase= (((392+186+185+156) - (331+138+76+29))/120) = 2.875 = 3.0

1. **Unit Testing phase:**

Defect Escape Rate for Unit Testing phase= (((9+392+186+185+156) - (180+331+138+76+29))/120) = 1.45 = 1.5

1. **Integration Testing phase:**

Defect Escape Rate for Integration Testing phase= (((7+9+392+186+185+156) - (124+180+331+138+76+29))/120) = 0.475 = 0.5

1. **System Testing phase:**

Defect Escape Rate for System Testing phase= (((8+7+9+392+186+185+156) - (56+124+180+331+138+76+29))/120) = 0.075 = 0.1

1. **Field:**

There is no Defect Escape Rate for Field as Field is the last stage and defects cannot be escaped to further stage from the Field stage.

Also, “defect escape rate for every phase” has been calculated “per 120 KLOC”.

Following table displays the “defect escape rate for every phase”.

|  |  |
| --- | --- |
| **Phases** | **Defect Escape rate per 120 KLOC** |
| **(Defects at Exit of Phase per 120 KLOC)** |
| **Requirement** | 1.1 |
| **Analysis** | 2 |
| **Design** | 2.4 |
| **Coding** | 3.0 |
| **Unit Testing** | 1.5 |
| **Integration Testing** | 0.5 |
| **System Testing** | 0.1 |
| **Field** | - |
| **Total** | 10.6 |

**Calculation for Defect Escaped Rate from Previous Phase:**

Given, product size = 120 KLOC

Also, from “Figure 1” showed above, referring “Total” horizontal and vertical column values for each phase to get Defect Escaped Rate from Previous Phase.

1. **Requirement phase:**

There is no Defect Escape Rate for Requirement phase as Requirement phase is the 1st phase so there is no chance that defect comes from the previous phase.

1. **Analysis phase:**

Defect Escape Rate for Analysis phase= ((156-29)/120) = 1.058 = 1.1

1. **Design phase:**

Defect Escape Rate for Design phase= (((185+156) - (76+29))/120) = 1.96 = 2

1. **Coding phase:**

Defect Escape Rate for Coding phase= (((186+185+156) - (138+76+29))/120) = 2.36 = 2.4

1. **Unit Testing phase:**

Defect Escape Rate for Unit Testing phase= (((392+186+185+156) - (331+138+76+29))/120) = 2.875 = 3.0

1. **Integration Testing phase:**

Defect Escape Rate for Integration Testing phase= (((9+392+186+185+156) - (180+331+138+76+29))/120) = 1.45 = 1.5

1. **System Testing phase:**

Defect Escape Rate for System Testing phase= (((7+9+392+186+185+156) - (124+180+331+138+76+29))/120) = 0.475 = 0.5

1. **Field:**

Defect Escape Rate for Field = (((8+7+9+392+186+185+156) - (56+124+180+331+138+76+29))/120) = 0.075 = 0.1

Also, “defect escaped rate from previous phase” has been calculated “per 120 KLOC”.

Following table displays the “defect escaped rate from previous phase”.

|  |  |
| --- | --- |
| **Phases** | **Defect Escaped from Previous Phase per 120 KLOC** |
| **Requirement** | - |
| **Analysis** | 1.1 |
| **Design** | 2 |
| **Coding** | 2.4 |
| **Unit Testing** | 3.0 |
| **Integration Testing** | 1.5 |
| **System Testing** | 0.5 |
| **Field** | 0.1 |
| **Total** | 10.6 |

**Answer 4:**

1. Overall Inspection Effectiveness = (((331+138+76+29) / 945) \* 100) % = 60.74%
2. Overall Test Effectiveness = (((180 + 124 + 56) / (180 + 124 + 56 + 11)) \* 100) % = 97.03%
3. **Overall Defect Removal Effectiveness:**

From “Figure 1” showed above, Total number of defects removed in Field = 11

**Overall Defect Removal Effectiveness = ((1 – (11 / 945)) \* 100) % = 98.84%**

**Answer 5:**

**Calculation of Defect Removal Effectiveness for each phase:**

Referring “Total” column values from “Figure 1” showed above for the following calculation.

1. **Requirement phase:**

Defect Removal Effectiveness for Requirement phase= ((29 / 156) \* 100) % = 18.60%

1. **Analysis phase:**

Defect Removal Effectiveness for Analysis phase= ((76 / ((156-29) + 185)) \* 100) % = 24.36%

1. **Design phase:**

Defect Removal Effectiveness for Design phase= ((138 / (((156 + 185) - (29 + 76)) + 186)) \* 100) % = 32.70%

1. **Coding phase:**

Defect Removal Effectiveness for Coding phase= ((331 / (((156 + 185 + 186) - (29 + 76 + 138)) + 392)) \* 100) % = 48.96%

1. **Unit Testing phase:**

Defect Removal Effectiveness for Unit Testing phase= ((180 / (180 + (124+56+11))) \* 100) % = 48.51%

1. **Integration Testing phase:**

Defect Removal Effectiveness for Integration Testing phase= ((124 / (124 + (56 + 11))) \* 100) % = 65%

1. **System Testing phase:**

Defect Removal Effectiveness for System Testing phase= ((56 / (56 + 11)) \* 100) % = 83.58%

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Phases** | **Defects Removal/120 KLOC** | **Defect Injection/120 KLOC** | **Defect Escape rate per 120 KLOC (Defects at Exit of Phase per 120 KLOC)** | **Defect Escaped from Previous Phase per 120 KLOC** | **Defect Removal Effectiveness** |
| **Requirement** | 0.2 | 1.3 | 1.1 | - | 18.60% |
| **Analysis** | 0.6 | 1.5 | 2 | 1.1 | 24.36% |
| **Design** | 1.2 | 1.6 | 2.4 | 2 | 32.70% |
| **Coding** | 2.8 | 3.3 | 3.0 | 2.4 | 48.96% |
| **Unit Testing** | 1.5 | - | 1.5 | 3.0 | 48.51% |
| **Integration Testing** | 1 | - | 0.5 | 1.5 | 65% |
| **System Testing** | 0.5 | - | 0.1 | 0.5 | 83.58% |
| **Field** | - | - | - | 0.1 | - |

From the above calculation, **“System Testing” phase is the most effective in removing defects** as it’s Defect Removal Effectiveness is approximately 83.58% and rest of the phases i.e. “Requirement”, “Analysis”, “Design”, “Coding”, “Unit Testing”, “Integration Testing” has Defect Removal Effectiveness less than the Defect Removal Effectiveness of “System Testing” phase. Highest Defect Removal Effectiveness means “System Testing” phase has removed significant or more number of defects compared to rest phases in the entire process.

**Answer 6:**

Referring “Total” column values from “Figure 1” showed above for the following calculation.

Overall Inspection Effectiveness = (((26 + 76 + 138 + 331) / 945) \* 100) % = 60.42%

Overall Test Effectiveness = (((180 + 124 + 56) / (180 + 124 + 56 + 11)) \* 100) % = 97.04%

According to above calculation, Yes, reviews and inspections were effective because reviews and inspection has removed “60.42%” defects. If reviews and inspections were not there then all the defects would have been escaped from the “Requirement”, “Analysis”, “Design” and “Coding” phases and if defects are caught in the later phases then defect costs more as compared to defects caught and fixed in the earlier phases i.e. during development phase. Defects removal at earlier development phases is generally less expensive. The closer the defects are found relative to where and when they are injected or created, the less the removal and rework effort.

Because of the reviews and inspections, there would be less number of defects in the testing phase as many of the defects got detected and fixed in the earlier stages i.e. during development phase.