Resaerch results

# Software Metrics for Software Engineering based on the Empirical Approach

# EASE (Empirical Approach for Software Engineering)

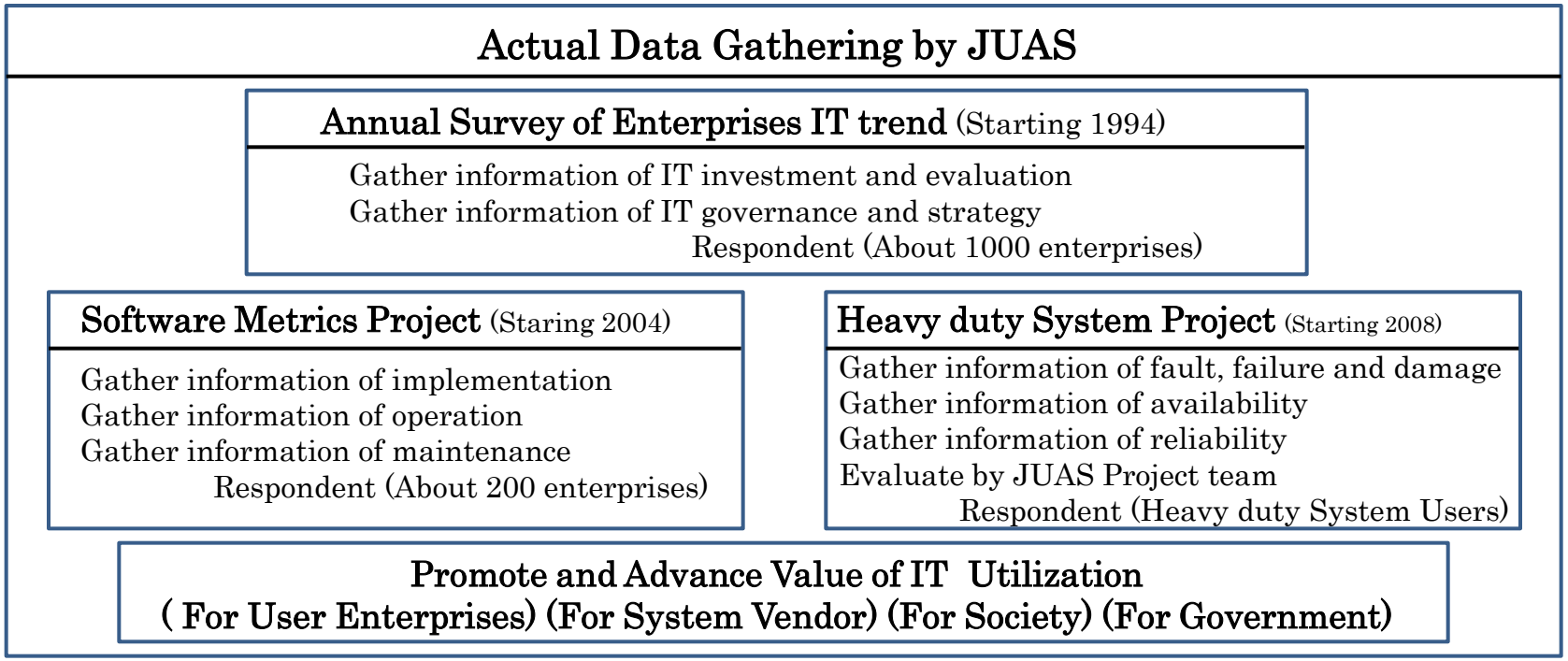
Objective of EASE

The gathering and analyzing the actual results of software implementation (Design, Production, Testing) projects are prerequisite condition for the mutual understanding of assessment to actual results of software engineering.

Based on the gathered and analyzed actual results, the fundamental information of size, period, man-month, productivity, quality in software engineering related the characteristic of project are offered for project estimation, project management, project execution and project evaluation.

The gathered quantitative actual data are handled based on statistics, and offer the measure or the index for estimate, guidance and evaluation of software engineering project.

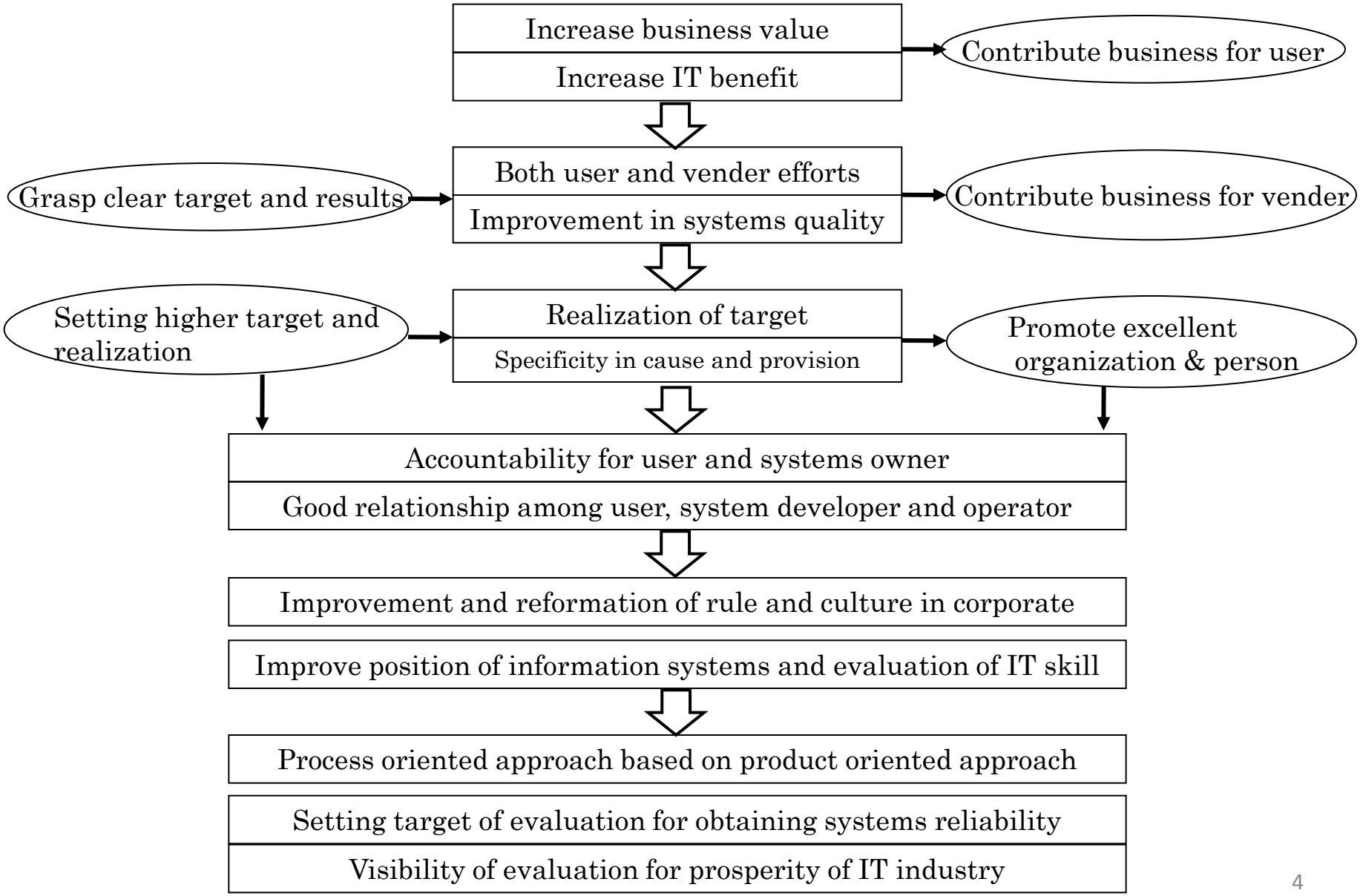
## JUAS-EASE Approach



# Characteristic of Software Metrics Generation

| | Progress of Research Work | | | Generation | | |
|---|---|---|---|---|---|---|
| | Development | Maintenance | Operation | 1st Generation | 2nd generation | 3rd generarion |
| 2004 | Period,<br>Quality,<br>Productivity | | | Find the outline of property | | |
| 2005 | Expansion of gathering date and dependence | Organization,<br>Scope of work,<br>Quality | | | | |
| 2006 | Expansion of search | Expansion of gathering date and dependence | Organization,<br>Goal of execution<br>(Pre-research) | | | |
| 2007 | Expansion of search | Expansion of search | Preliminary reserch | | | |
| 2008 | Find new knowledge based on increased data | Expansion of search | Preliminary reserch | | | Start 2014 |
| 2009 | Find new knowledge based on stratified sampling method | Expansion of search | Reserch operation for cloud computing | | Search property<br>Find annual change | Find Property for similar project |
| 2010 | Search knowledge with survey Heavy duty systems and IT trend | Search for cost of maintenance | Search reasonable operation cost | | Utilize for Project | Relative analysis with foreign data |
| Forward | | | | | Until 2013 | |

# Meaning of Property for Software Implementation and Operation



# Estimation of Total Period of Implementation

## ■ Scope of period

Including design, production and testing with management as implementation.

## ■ Estimation of period

(1) Estimate the total period (Statistical period) of implementation form total man-month.
(2) Estimate the period difference from statistical period vs actual period.
(3) Estimate the period delay from planned period vs actual period.

## ■ Evaluation of period

Analyze viewpoint among difference and delay of period.

## ■ Calculation formula of period

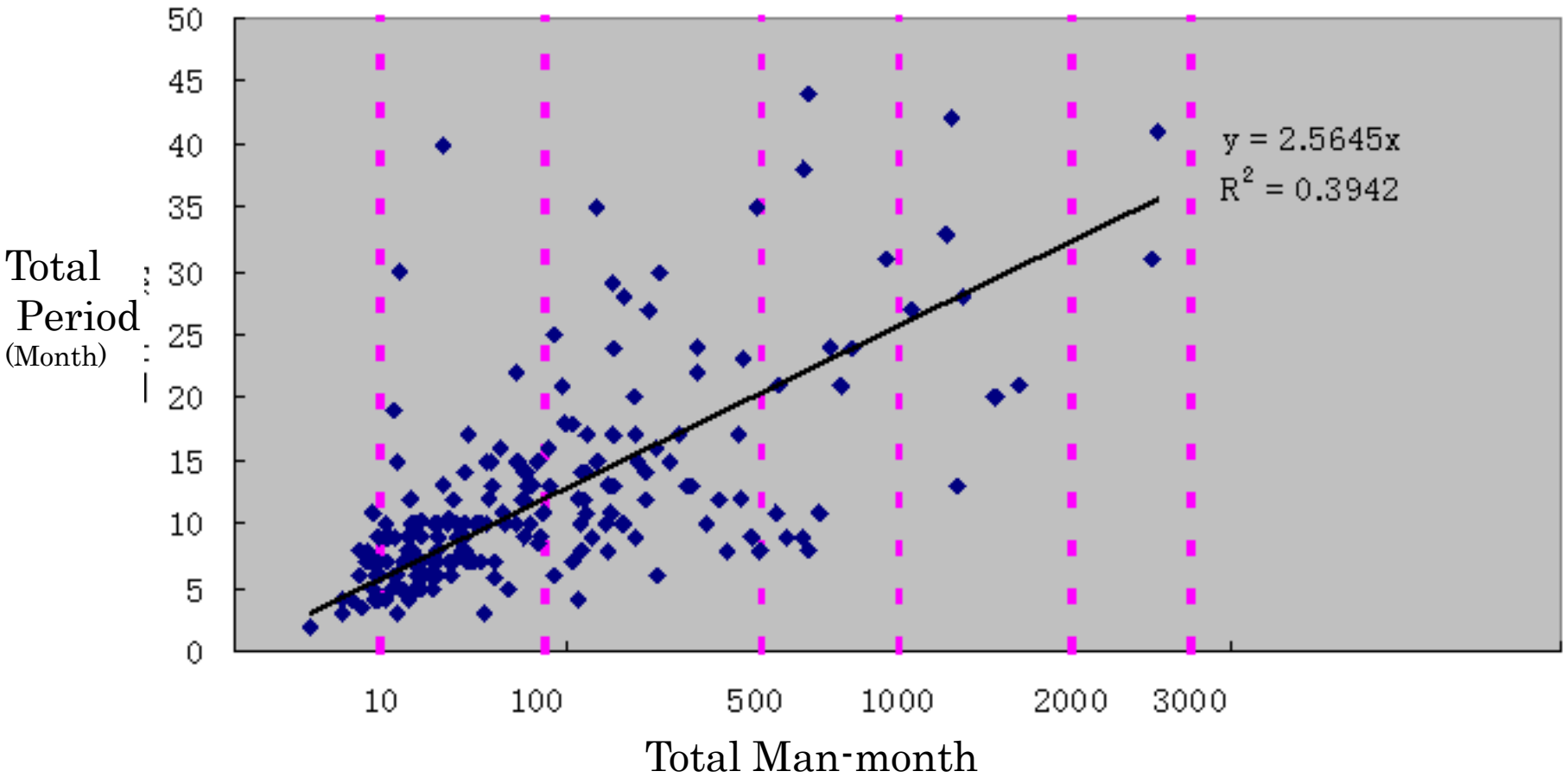
「Statistical total period」= a × $\sqrt[b]{\text{「Total man-month」}}$
JUAS uses b = 1/3 instead of 0.32 of COCOMO model because easiness of calculation.

## ■ Calculation formula of period based on JUAS-EASE

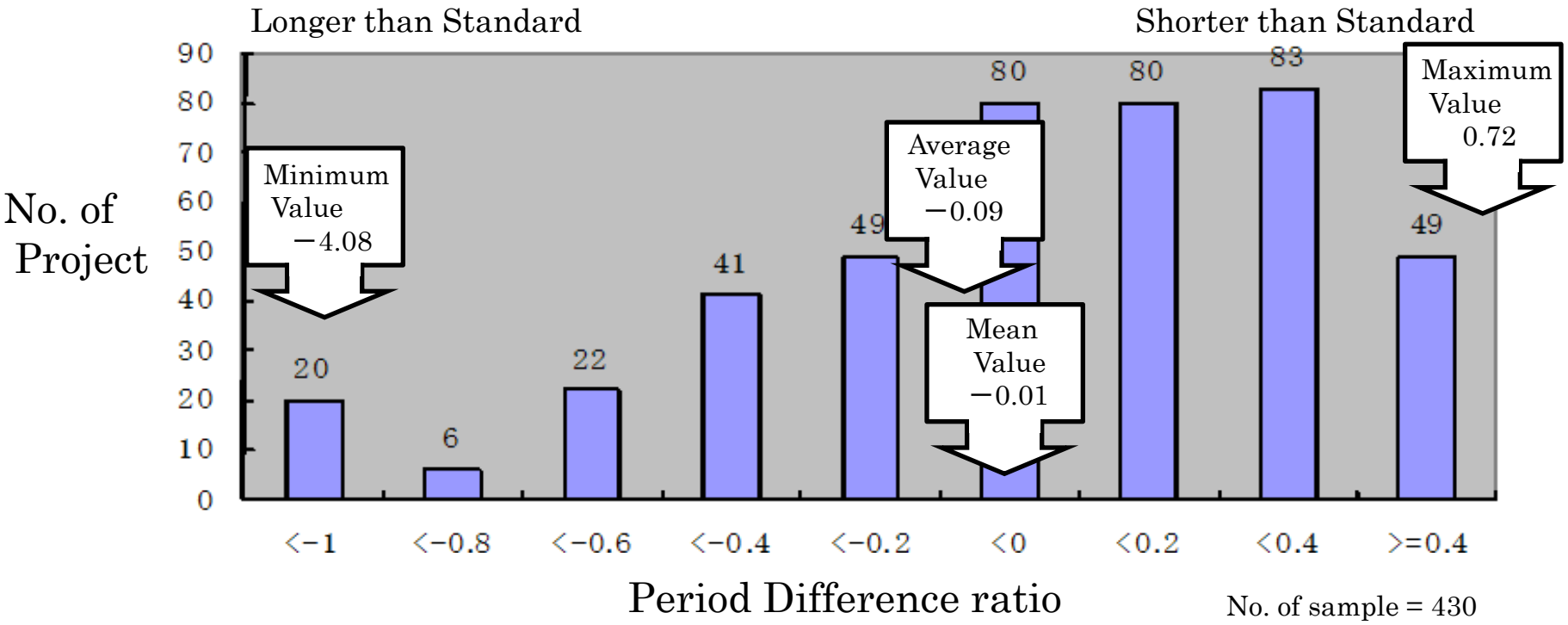
「Statistical total period」$= 2.51 \times \sqrt[3]{\text{「Total man-month」}}$

Correlation coefficient = 0.66  No. of project = 430

# Statistical total period based on JUAS-EASE



# Difference between Statistical Period vs Actual Preriod




■ Period difference ratio = 1 – ( Actual period ÷ Statistical period )

| | Shorten standard period | Standard period | Extended standard period | Total |
|---|---|---|---|---|
| Difference ratio | 0.25 > X | 0.25 > X > −0.32 | X > −0.32 | |
| No. of Project | 112 | 210 | 108 | 430 |
| Ratio | 26.05 % | 48.84 % | 25.12 % | 100 % |

# Apply the Statistical Period as Standard Period

■ Setting the proposed period based on the period difference

Standard period =Calculated statistical period
Extended standard period =Longer calculated statistical period
Shorten standard period= Short calculated statistical period

| Selection and setting the schedule (period) | | | | |
|---|---|---|---|---|
| | Extended standard period | Standard period | 25%Shorten standard period | More than 25% Shorten std period |
| Concept of setting period | Respect for quality | Usual case | Depend user desire | Meet business chance |
| | In case of high reliable systems project such as banking systems. | Based on implementation project. | Catch up business plan and target such as retail or manufacturing business. | Satisfy commitment of business strategy such as to meet competition M&A or business model. |
| Scheduling policy | Secure enough testing time | WBS base weekly scheduling | Critical path scheduling | Mobilization scheduling |
| | Set schedule to prepare enough testing skill and environment. | Set WBS (work breakdown structure ) and optimum schedule. | Priority scheduling to meet prerequisite condition. | Mobilization scheduling to meet the assigned date. |
| Significant Provision | Reliability of systems design | Define WBS clearly | Same as standard period and add the following.<br><br>・Assign skilled talent<br>・Modular design<br>・Rapid application develop.<br>・Pre-performance test<br>・Partial cut-over of system | Same as standard period and add the following<br><br>・Assign experienced PM<br>・Full backup by company<br><br>・Shift operation scheduling<br>・Re-use of existing packages<br>・System test by user-side |
| | Prepare test cases | Reviewing completely | | |
| | Quality control plan | Fix design specification | | |
| | Testing for stable operation | Prepare test cases | | |
| | | Prepare date conversion | | |
| | | Engineering change control | | |

# Ratio of Phasing Period for Software Engineering

## 【Total Implementation Man-month】

| Total Man-month | No. of Project | Phasing Period | | | | Phasing Period Ratio | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Requirement | Design | Production | Testing | Requirement | Design | Production | Testing |
| < 10 Man-month | 11 | 1.07 | 0.85 | 2.48 | 1.23 | 18.95 | 15.12 | 44.06 | 21.86 |
| < 50 Man-month | 67 | 2.46 | 5.38 | 10.25 | 6.41 | 10.05 | 21.97 | 41.84 | 26.14 |
| < 100 Man-month | 40 | 6.90 | 16.18 | 27.35 | 16.84 | 10.25 | 24.05 | 40.66 | 25.04 |
| < 500 Man-month | 67 | 21.84 | 46.13 | 72.68 | 60.38 | 10.86 | 22.95 | 36.15 | 30.04 |
| >= 500 Man-month | 23 | 88.84 | 237.00 | 392.86 | 290.33 | 8.80 | 23.49 | 38.93 | 28.77 |
| Total | 208 | 19.03 | 45.96 | 75.55 | 56.92 | 9.64 | 23.27 | 38.26 | 28.83 |
| Design Period Base Rate | | 0.41 | 1.00 | 1.61 | 1.24 | | | | |

## 【 Planning Phase Man-month 】

| Item | Man-month category | | | | | |
|---|---|---|---|---|---|---|
| | < 10 MM | < 50 MM | < 100 MM | < 500 MM | ≧ 500 MM | Total |
| No. of Project | 6 | 24 | 23 | 40 | 14 | 107 |
| Average Planning Phase Man-month | 0.92 | 3.83 | 4.50 | 11.02 | 46.93 | 12.14 |
| Average Planning Phase Man-month Ratio | 20.94 % | 16.88 % | 6.42 % | 5.68 % | 2.49 % | 8.79 % |
| Planning Phase Man-month (Median) | 1 | 1.5 | 2.5 | 6 | 15 | 4 |
| Planning Phase Man-month Ratio (Median) | 12.68 % | 7.04 % | 3.69 % | 3.08 % | 1.83 % | 3.85 % |

# Ratio of Phasing Period by Application Type

| | Total Man-month | No. of Project | Phasing Period | | | Phasing Period Ratio | | |
|---|---|---|---|---|---|---|---|---|
| | | | Design | Production | Testing | Design | Production | Testing |
| New Application | < 10 Man-month | 10 | 0.81 | 1.00 | 0.48 | 35.43% | 43.63% | 20.95% |
| | < 50 Man-month | 54 | 0.70 | 1.00 | 1.58 | 31.05% | 44.11% | 24.84% |
| | < 100 Man-month | 19 | 0.84 | 1.00 | 0.53 | 35.80% | 42.16% | 22.24% |
| | < 500 Man month | 38 | 0.74 | 1.00 | 0.92 | 27.85% | 37.55% | 34.50% |
| | ≧ 500 Man-month | 13 | 0.99 | 1.00 | 0.98 | 33.23% | 33.67% | 33.10% |
| | Non-answer | 2 | 0.32 | 1.00 | 0.54 | 17.13% | 53.78% | 29.09% |
| | Total | 136 | 0.76 | 1.00 | 0.59 | 31.12% | 40.73% | 28.15% |
| Re-Modeling and Revise | < 10 Man-month | 7 | 0.09 | 1.00 | 1.27 | 23.27% | 33.80% | 42.93% |
| | < 50 Man-month | 37 | 0.81 | 1.00 | 1.17 | 21.92% | 38.04% | 42.04% |
| | < 100 Man-month | 26 | 0.05 | 1.00 | 1.04 | 24.15% | 37.21% | 38.64% |
| | < 500 Man month | 40 | 1.02 | 1.00 | 1.25 | 31.08% | 30.61% | 38.31% |
| | ≧ 500 Man-month | 12 | 0.62 | 1.00 | 0.70 | 26.68% | 43.20% | 30.12% |
| | Non-answer | 2 | 0.76 | 1.00 | 0.54 | 32.93% | 43.57% | 23.49% |
| | Total | 124 | 0.76 | 1.00 | 1.12 | 28.31% | 34.80% | 38.69% |
| Total | < 10 Man-month | 17 | 0.76 | 1.00 | 0.81 | 28.88% | 38.86% | 31.38% |
| | < 50 Man-month | 91 | 0.67 | 1.00 | 0.81 | 28.88% | 40.43% | 32.68% |
| | < 100 Man-month | 45 | 0.73 | 1.00 | 0.82 | 28.64% | 39.15% | 32.21% |
| | < 500 Man month | 78 | 0.88 | 1.00 | 1.09 | 29.71% | 33.84% | 36.64% |
| | ≧ 500 Man-month | 25 | 0.81 | 1.00 | 0.85 | 30.49% | 37.66% | 31.85% |
| | Non-answer | 4 | 0.54 | 1.00 | 0.54 | 25.88% | 48.14% | 26.00% |
| | Total | 260 | 0.76 | 1.00 | 0.88 | 28.84% | 37.67% | 33.69% |

# Period Delay by Project Size

| Size of project | | Period delay | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Early Schedule | Keep Schedule | ＜10% | ＜20% | ＜50% | ≧50% | Total | More than 20% delay |
| ＜ 10 Man-month | No. of Project | 2 | 25 | | 2 | 2 | 4 | 35 | |
| | Ratio (%) | 5.71 | 71.43 | 0.00 | 5.71 | 5.71 | 11.43 | 100.00 | 17.14% |
| ＜ 50 Man-month | No. of Project | 12 | 89 | 3 | 13 | 13 | 8 | 136 | |
| | Ratio (%) | 8.82 | 65.44 | 2.21 | 9.56 | 9.56 | 5.88 | 100.00 | 15.44% |
| ＜ 100 Man-month | No. of Project | 5 | 43 | 3 | 9 | 9 | 5 | 70 | |
| | Ratio (%) | 7.14 | 61.43 | 4.29 | 12.86 | 12.86 | 7.14 | 100.00 | 20.00% |
| ＜ 500 Man month | No. of Project | 10 | 89 | 8 | 2 | 2 | 5 | 122 | |
| | Ratio (%) | 8.20 | 72.95 | 6.56 | 1.84 | 1.64 | 4.10 | 100.00 | 5.74% |
| ≧ 500 Man-month | No. of Project | 3 | 27 | 7 | 8 | 8 | 2 | 48 | |
| | Ratio (%) | 6.25 | 56.25 | 14.58 | 16.67 | 16.67 | 4.17 | 100.00 | 20.83% |
| No-answer | No. of Project | 2 | 25 | 3 | 8 | 8 | | 46 | |
| | Ratio (%) | 4.44 | 55.56 | 6.67 | 17.78 | 17.78 | 0.00 | 100.00 | 17.78% |
| Total | No. of Project | 34 | 298 | 24 | 42 | 42 | 24 | 456 | |
| | Ratio (%) | 7.46 | 65.35 | 5.26 | 9.21 | 9.21 | 5.26 | 100 | 14.47% |

# Relationship between Period Delay and Period Difference

| Project differnce | | Period delay | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Early Schedule | Keep Schedule | ＜10% | ＜20% | ＜50% | ≧50% | Total | More than 20% delay |
| Extended Standard period | No. of Project | 5 | 57 | 9 | 7 | 8 | 14 | 100 | |
| | Average Delay | −0.1666 | 0 | 0.0581 | 0.1433 | 0.2633 | 0.8708 | 0.1499 | |
| | Ratio (%) | 5.00 | 57.00 | 9.00 | 7.00 | 8 | 14.00 | 100.00 | 22.00% |
| Standaard Period | No. of Project | 10 | 140 | 11 | 14 | 19 | 9 | 203 | |
| | Average Delay | −0.194 | 0 | 0.0697 | 0.1458 | 0.3002 | 0.6675 | 0.062 | |
| | Ratio (%) | 4.93 | 66.97 | 5.42 | 6.90 | 9.36 | 4.43 | 100.00 | 13.79% |
| Shorten Standard Period | No. of Project | 17 | 76 | 1 | 6 | 7 | 1 | 108 | |
| | Average Delay | −0.311 | 0 | 0.0625 | 0.1449 | 0.2948 | 0.625 | −0.015 | |
| | Ratio (%) | 15.74 | 70.37 | 0.93 | 5.56 | 6.48 | 0.93 | 100.00 | 7341% |
| Total | No. of Project | 32 | 273 | 21 | 27 | 34 | 24 | 411 | |
| | Average Delay | −0.252 | 0 | 0.0644 | 0.1449 | 0.2904 | 0.7843 | 0.063 | |
| | Ratio (%) | 7.79 | 66.42 | 5.11 | 6.57 | 8.27 | 5.84 | 100.00 | 14.11% |

# Reason of Implementation Period Delay

| | Reason of Implementation Period Delay | Total Man-month | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | <10MM | <50MM | <100MM | <500MM | ≧500MM | No.Res | Total | Ratio (%) |
| 1 | Unsuitable object of systematization | | 2 | 1 | | 1 | | 4 | 0.76 |
| 2 | Unsuitable content of RFP (Request for Proposal) | 2 | 3 | 3 | 8 | 1 | 2 | 19 | 3.59 |
| 3 | Delay of finalization of requirement specification | 9 | 30 | 19 | 30 | 14 | 10 | 112 | 21.17 |
| 4 | Insufficient work for analyzing requirement specification | 9 | 18 | 12 | 19 | 12 | 12 | 82 | 15.50 |
| 5 | Increase scope of design and production | 5 | 12 | 12 | 30 | 13 | 7 | 79 | 14.93 |
| 6 | Unsuitabale assignment of project member | 1 | 7 | 3 | 7 | 3 | 1 | 22 | 4.16 |
| 7 | Misjudge vender selection | | 4 | 4 | 6 | 4 | 2 | 20 | 3.78 |
| 8 | Lack of skill for design and production | 3 | 6 | 10 | 17 | 6 | 4 | 46 | 8.70 |
| 9 | Insufficient test planning | 3 | 11 | 11 | 5 | 6 | 4 | 40 | 7.56 |
| 10 | Insufficient acceptance inspection | 1 | 1 | | 6 | 3 | 3 | 14 | 2.65 |
| 11 | Shortage of integrated systems test | 2 | 8 | | 6 | 5 | 5 | 26 | 4.91 |
| 12 | Lack of management by project manager | 2 | 5 | 6 | 7 | 6 | 4 | 30 | 5.67 |
| 13 | Other | 1 | 9 | 9 | 8 | 3 | 5 | 35 | 6.62 |
| | Total | 38 | 116 | 90 | 149 | 77 | 59 | 529 | 100.00 |

# Estimation of Total Period of Implementation

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Including design, production and testing with management as implementation.

## ■ Estimation of period

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Analyze viewpoint among difference and delay of period.

## ■ Calculation formula of period

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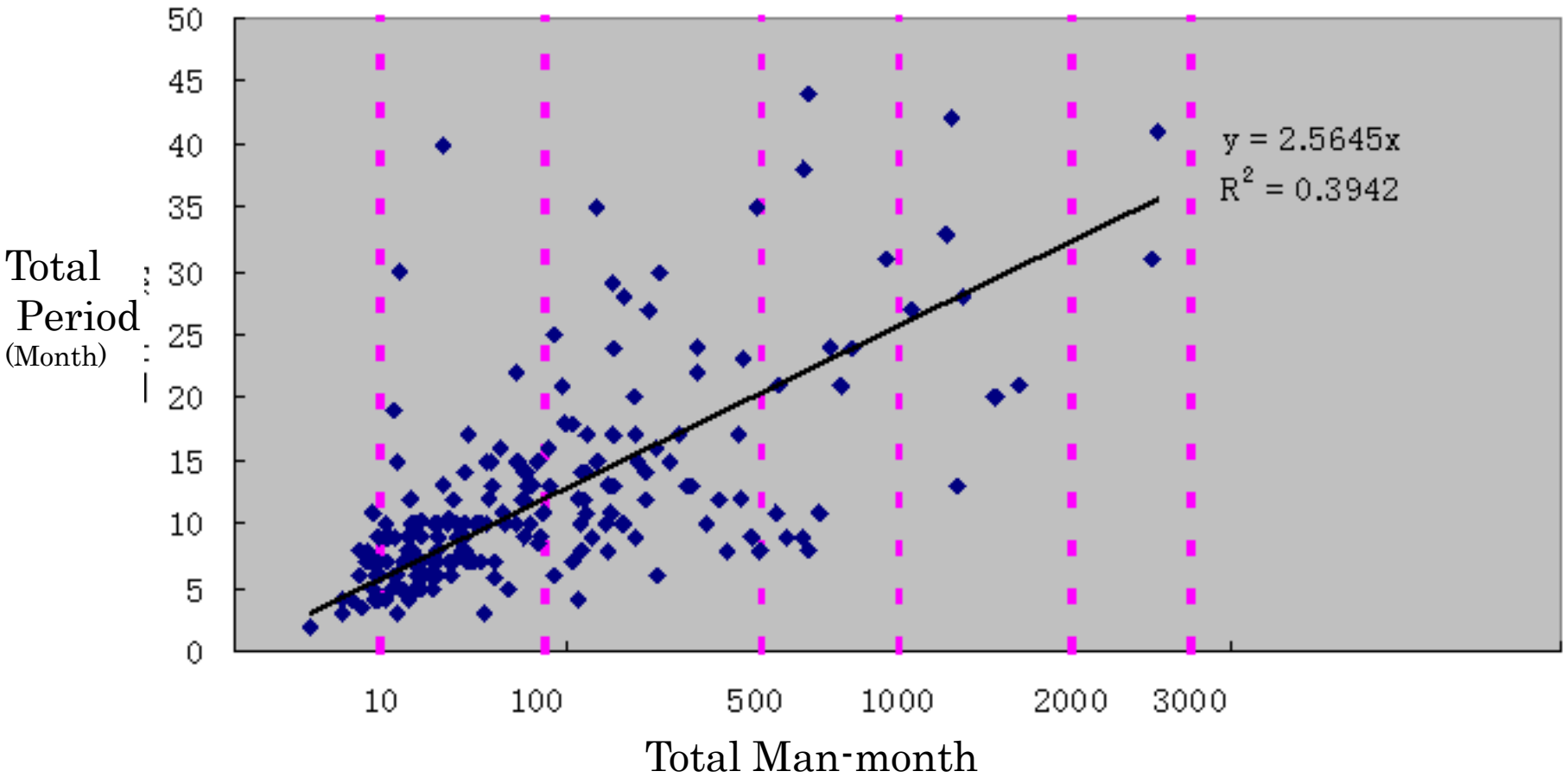
JUAS uses b = 1/3 instead of 0.32 of COCOMO model because easiness of calculation.

## ■ Calculation formula of period based on JUAS-EASE

$$\text{「Statistical total period」} = 2.51 \times \sqrt[3]{\text{「Total man-month」}}$$

Correlation coefficient = 0.66  No. of project = 430

# Statistical total period based on JUAS-EASE



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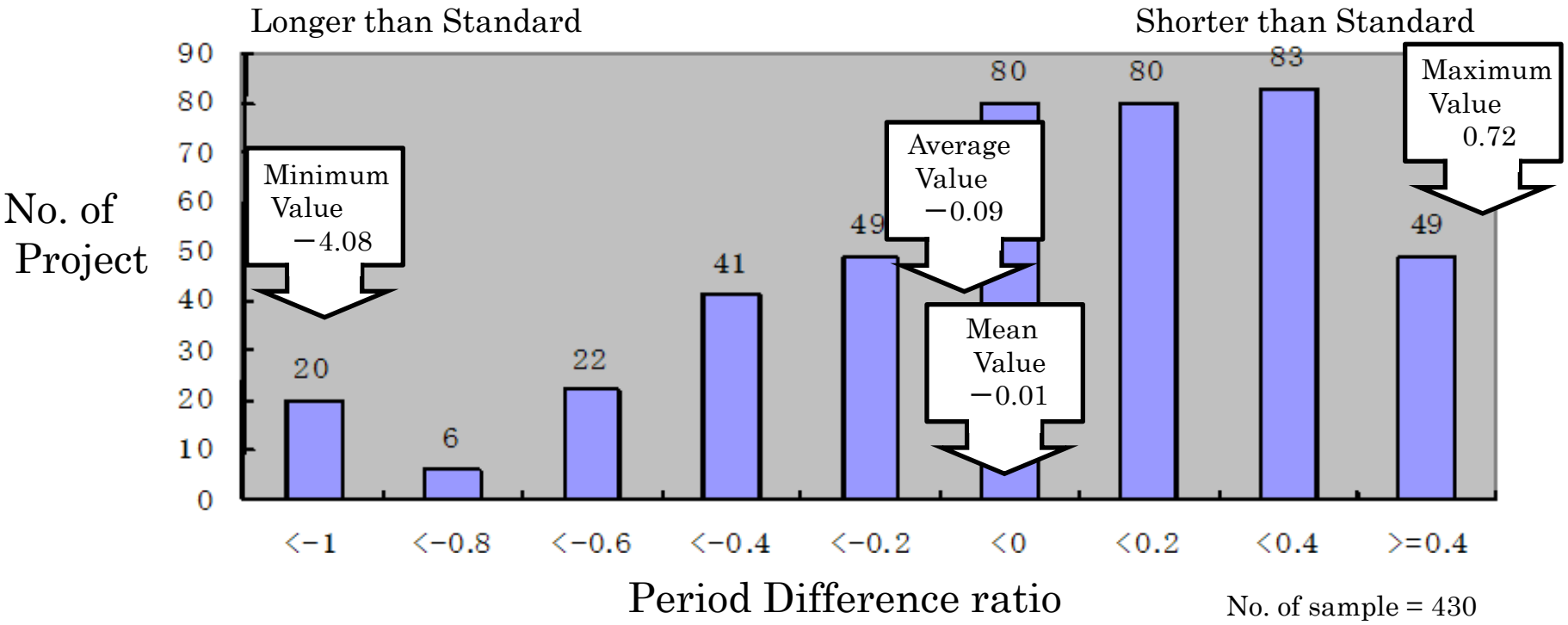


■ Period difference ratio = 1 – ( Actual period ÷ Statistical period )

| | Shorten standard period | Standard period | Extended standard period | Total |
|---|---|---|---|---|
| Difference ratio | 0.25 > X | 0.25 > X > −0.32 | X > −0.32 | |
| No. of Project | 112 | 210 | 108 | 430 |
| Ratio | 26.05 % | 48.84 % | 25.12 % | 100 % |

# Apply the Statistical Period as Standard Period

■ Setting the proposed period based on the period difference

Standard period =Calculated statistical period
Extended standard period =Longer calculated statistical period
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| Selection and setting the schedule (period) | | | | |
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| | Extended standard period | Standard period | 25%Shorten standard period | More than 25% Shorten std period |
| Concept of setting period | Respect for quality | Usual case | Depend user desire | Meet business chance |
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| | Prepare test cases | Reviewing completely | | |
| | Quality control plan | Fix design specification | | |
| | Testing for stable operation | Prepare test cases | | |
| | | Prepare date conversion | | |
| | | Engineering change control | | |

# Ratio of Phasing Period for Software Engineering

## 【Total Implementation Man-month】

| Total Man-month | No. of Project | Phasing Period | | | | Phasing Period Ratio | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Requirement | Design | Production | Testing | Requirement | Design | Production | Testing |
| < 10 Man-month | 11 | 1.07 | 0.85 | 2.48 | 1.23 | 18.95 | 15.12 | 44.06 | 21.86 |
| < 50 Man-month | 67 | 2.46 | 5.38 | 10.25 | 6.41 | 10.05 | 21.97 | 41.84 | 26.14 |
| < 100 Man-month | 40 | 6.90 | 16.18 | 27.35 | 16.84 | 10.25 | 24.05 | 40.66 | 25.04 |
| < 500 Man-month | 67 | 21.84 | 46.13 | 72.68 | 60.38 | 10.86 | 22.95 | 36.15 | 30.04 |
| >= 500 Man-month | 23 | 88.84 | 237.00 | 392.86 | 290.33 | 8.80 | 23.49 | 38.93 | 28.77 |
| Total | 208 | 19.03 | 45.96 | 75.55 | 56.92 | 9.64 | 23.27 | 38.26 | 28.83 |
| Design Period Base Rate | | 0.41 | 1.00 | 1.61 | 1.24 | | | | |

## 【 Planning Phase Man-month 】

| Item | Man-month category | | | | | |
|---|---|---|---|---|---|---|
| | < 10 MM | < 50 MM | < 100 MM | < 500 MM | ≧ 500 MM | Total |
| No. of Project | 6 | 24 | 23 | 40 | 14 | 107 |
| Average Planning Phase Man-month | 0.92 | 3.83 | 4.50 | 11.02 | 46.93 | 12.14 |
| Average Planning Phase Man-month Ratio | 20.94 % | 16.88 % | 6.42 % | 5.68 % | 2.49 % | 8.79 % |
| Planning Phase Man-month (Median) | 1 | 1.5 | 2.5 | 6 | 15 | 4 |
| Planning Phase Man-month Ratio (Median) | 12.68 % | 7.04 % | 3.69 % | 3.08 % | 1.83 % | 3.85 % |

# Ratio of Phasing Period by Application Type

| | Total Man-month | No. of Project | Phasing Period | | | Phasing Period Ratio | | |
|---|---|---|---|---|---|---|---|---|
| | | | Design | Production | Testing | Design | Production | Testing |
| New Application | < 10 Man-month | 10 | 0.81 | 1.00 | 0.48 | 35.43% | 43.63% | 20.95% |
| | < 50 Man-month | 54 | 0.70 | 1.00 | 1.58 | 31.05% | 44.11% | 24.84% |
| | < 100 Man-month | 19 | 0.84 | 1.00 | 0.53 | 35.80% | 42.16% | 22.24% |
| | < 500 Man month | 38 | 0.74 | 1.00 | 0.92 | 27.85% | 37.55% | 34.50% |
| | ≧ 500 Man-month | 13 | 0.99 | 1.00 | 0.98 | 33.23% | 33.67% | 33.10% |
| | Non-answer | 2 | 0.32 | 1.00 | 0.54 | 17.13% | 53.78% | 29.09% |
| | Total | 136 | 0.76 | 1.00 | 0.59 | 31.12% | 40.73% | 28.15% |
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| | Total | 124 | 0.76 | 1.00 | 1.12 | 28.31% | 34.80% | 38.69% |
| Total | < 10 Man-month | 17 | 0.76 | 1.00 | 0.81 | 28.88% | 38.86% | 31.38% |
| | < 50 Man-month | 91 | 0.67 | 1.00 | 0.81 | 28.88% | 40.43% | 32.68% |
| | < 100 Man-month | 45 | 0.73 | 1.00 | 0.82 | 28.64% | 39.15% | 32.21% |
| | < 500 Man month | 78 | 0.88 | 1.00 | 1.09 | 29.71% | 33.84% | 36.64% |
| | ≧ 500 Man-month | 25 | 0.81 | 1.00 | 0.85 | 30.49% | 37.66% | 31.85% |
| | Non-answer | 4 | 0.54 | 1.00 | 0.54 | 25.88% | 48.14% | 26.00% |
| | Total | 260 | 0.76 | 1.00 | 0.88 | 28.84% | 37.67% | 33.69% |

# Period Delay by Project Size

| Size of project | | Period delay | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Early Schedule | Keep Schedule | ＜10% | ＜20% | ＜50% | ≧50% | Total | More than 20% delay |
| ＜ 10 Man-month | No. of Project | 2 | 25 | | 2 | 2 | 4 | 35 | |
| | Ratio (%) | 5.71 | 71.43 | 0.00 | 5.71 | 5.71 | 11.43 | 100.00 | 17.14% |
| ＜ 50 Man-month | No. of Project | 12 | 89 | 3 | 13 | 13 | 8 | 136 | |
| | Ratio (%) | 8.82 | 65.44 | 2.21 | 9.56 | 9.56 | 5.88 | 100.00 | 15.44% |
| ＜ 100 Man-month | No. of Project | 5 | 43 | 3 | 9 | 9 | 5 | 70 | |
| | Ratio (%) | 7.14 | 61.43 | 4.29 | 12.86 | 12.86 | 7.14 | 100.00 | 20.00% |
| ＜ 500 Man month | No. of Project | 10 | 89 | 8 | 2 | 2 | 5 | 122 | |
| | Ratio (%) | 8.20 | 72.95 | 6.56 | 1.84 | 1.64 | 4.10 | 100.00 | 5.74% |
| ≧ 500 Man-month | No. of Project | 3 | 27 | 7 | 8 | 8 | 2 | 48 | |
| | Ratio (%) | 6.25 | 56.25 | 14.58 | 16.67 | 16.67 | 4.17 | 100.00 | 20.83% |
| No-answer | No. of Project | 2 | 25 | 3 | 8 | 8 | | 46 | |
| | Ratio (%) | 4.44 | 55.56 | 6.67 | 17.78 | 17.78 | 0.00 | 100.00 | 17.78% |
| Total | No. of Project | 34 | 298 | 24 | 42 | 42 | 24 | 456 | |
| | Ratio (%) | 7.46 | 65.35 | 5.26 | 9.21 | 9.21 | 5.26 | 100 | 14.47% |

# Relationship between Period Delay and Period Difference

| Project differnce | | Period delay | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Early Schedule | Keep Schedule | ＜10% | ＜20% | ＜50% | ≧50% | Total | More than 20% delay |
| Extended Standard period | No. of Project | 5 | 57 | 9 | 7 | 8 | 14 | 100 | |
| | Average Delay | −0.1666 | 0 | 0.0581 | 0.1433 | 0.2633 | 0.8708 | 0.1499 | |
| | Ratio (%) | 5.00 | 57.00 | 9.00 | 7.00 | 8 | 14.00 | 100.00 | 22.00% |
| Standaard Period | No. of Project | 10 | 140 | 11 | 14 | 19 | 9 | 203 | |
| | Average Delay | −0.194 | 0 | 0.0697 | 0.1458 | 0.3002 | 0.6675 | 0.062 | |
| | Ratio (%) | 4.93 | 66.97 | 5.42 | 6.90 | 9.36 | 4.43 | 100.00 | 13.79% |
| Shorten Standard Period | No. of Project | 17 | 76 | 1 | 6 | 7 | 1 | 108 | |
| | Average Delay | −0.311 | 0 | 0.0625 | 0.1449 | 0.2948 | 0.625 | −0.015 | |
| | Ratio (%) | 15.74 | 70.37 | 0.93 | 5.56 | 6.48 | 0.93 | 100.00 | 7341% |
| Total | No. of Project | 32 | 273 | 21 | 27 | 34 | 24 | 411 | |
| | Average Delay | −0.252 | 0 | 0.0644 | 0.1449 | 0.2904 | 0.7843 | 0.063 | |
| | Ratio (%) | 7.79 | 66.42 | 5.11 | 6.57 | 8.27 | 5.84 | 100.00 | 14.11% |

# Reason of Implementation Period Delay

| | Reason of Implementation Period Delay | Total Man-month | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | <10MM | <50MM | <100MM | <500MM | ≧500MM | No.Res | Total | Ratio (%) |
| 1 | Unsuitable object of systematization | | 2 | 1 | | 1 | | 4 | 0.76 |
| 2 | Unsuitable content of RFP (Request for Proposal) | 2 | 3 | 3 | 8 | 1 | 2 | 19 | 3.59 |
| 3 | Delay of finalization of requirement specification | 9 | 30 | 19 | 30 | 14 | 10 | 112 | 21.17 |
| 4 | Insufficient work for analyzing requirement specification | 9 | 18 | 12 | 19 | 12 | 12 | 82 | 15.50 |
| 5 | Increase scope of design and production | 5 | 12 | 12 | 30 | 13 | 7 | 79 | 14.93 |
| 6 | Unsuitabale assignment of project member | 1 | 7 | 3 | 7 | 3 | 1 | 22 | 4.16 |
| 7 | Misjudge vender selection | | 4 | 4 | 6 | 4 | 2 | 20 | 3.78 |
| 8 | Lack of skill for design and production | 3 | 6 | 10 | 17 | 6 | 4 | 46 | 8.70 |
| 9 | Insufficient test planning | 3 | 11 | 11 | 5 | 6 | 4 | 40 | 7.56 |
| 10 | Insufficient acceptance inspection | 1 | 1 | | 6 | 3 | 3 | 14 | 2.65 |
| 11 | Shortage of integrated systems test | 2 | 8 | | 6 | 5 | 5 | 26 | 4.91 |
| 12 | Lack of management by project manager | 2 | 5 | 6 | 7 | 6 | 4 | 30 | 5.67 |
| 13 | Other | 1 | 9 | 9 | 8 | 3 | 5 | 35 | 6.62 |
| | Total | 38 | 116 | 90 | 149 | 77 | 59 | 529 | 100.00 |