

Mandate Re-estimation in project life cycle: For assessing project health.

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Agenda

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What is Estimate?

- Rough number not the final number
- Iterative and evolving process based on the information available /aligned with progressive elaboration
- A quantitative assessment of the likely amount or output
- Vital for successful planning, execution and delivery
- Helps in assessing the activity resources, cost and activity durations.
- Directly linked with all the Knowledge areas of project management defined by PMI: Integration, Scope, Time, Cost, Quality, Human Resources, Communication, Risk, Procurement.

Estimation Life Cycle

Estimation Life cycle contains the following steps:

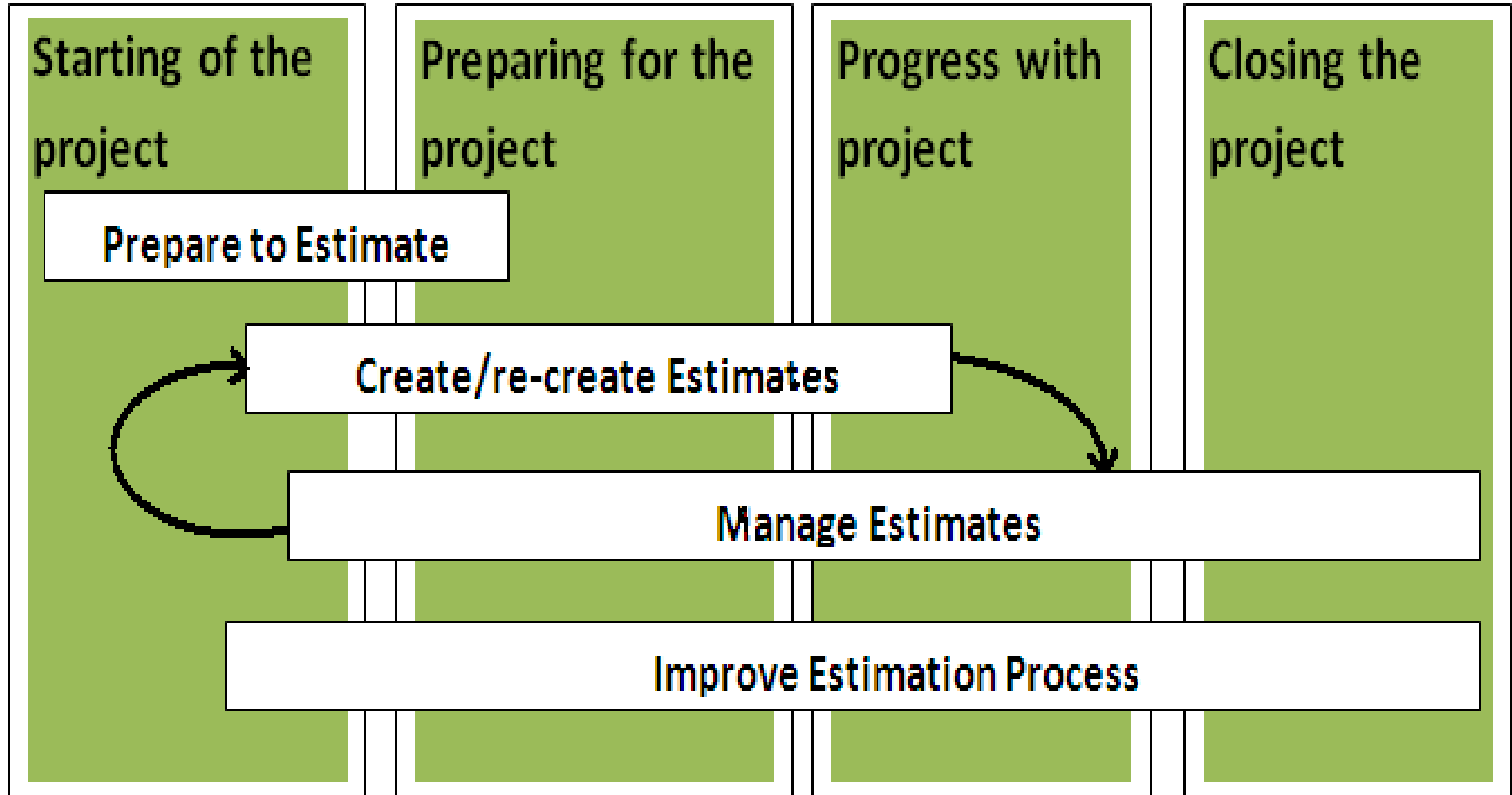
Prepare to Estimate: Selection of estimation approach, includes identify techniques, identify tasks, identify resources, documenting any assumptions and constraints

Create Estimates: Estimate activity resources, activity durations, activity costs

Manage Estimates: manage estimates including change controls, calibrating the forecast, compare actuals with baseline

Improving Estimation Process: Lessons learned are applied to the estimating life cycle, including calibrating the models based on actual values and maintain the checklists of the components

Estimation Life Cycle cont'd



Estimation life cycle with respect to Project life cycle

Inputs to estimation

Inputs to estimate:

- ✓ **Project documents:** SOW, Requirements documents, Scope baseline, Activity list, Risk Register, Resource calendar
- ✓ **Experts:** Experts on different estimation techniques
- ✓ **Estimation techniques:** Different techniques included in organizational process assets
- ✓ **Constraints and Assumptions:** Constraints and assumptions to be documented clearly
- ✓ **Additional factors:** Environmental factors, Organization assets
- ✓ **Historical project information:** Historical project information gathered in organizational repository from similar projects in the organization

Estimation methods and usage in project life cycle

There are different estimation methods available to choose based the type of project and availability of input required to estimate. Few of them are: Expert Judgment, Analogous Estimation, Parametric Estimation, Three-Point Estimation, Top-Down estimation, Bottom-Up Estimation, Size based estimation (Function Points) etc.

	Business Requirements → Requirements Gathering	→	Design	→ ←	Coding and Test	→	Implementation
Level of Estimate	<i>Feasibility</i>		<i>High-Level</i>				<i>Detailed</i>
Basis for Estimation	<i>Organizational benchmark data</i>		<i>Approved and baselined requirements</i>				<i>Detailed design of requirements</i>
Estimation Model	<i>Top Down</i>		<i>Top Down or Bottom Up</i>				<i>Bottom Up</i>
Accuracy in Estimation	<i>lower (more than 100% contingency sometimes)</i>		<i>Average (30% contingency)</i>				<i>High (10 to 20% contingency)</i>

Effort Distribution between phases

- ✓ Proper effort distribution to different phases in project life cycle is important as faults found in later phases require a significant amount of rework
- ✓ In traditional structured Software Development Life Cycles (SDLC) the effort is distributed in at least four phases; planning, design, build and testing phase.
- ✓ As per Zelkowitz, Requirement analysis 10%, Specification 10%, Design 15%, Coding 20% and Testing 45%.
- ✓ As per Boehm, Requirements analysis and design 60%, implementation 15% and 25% for testing.
- ✓ As per Brooks, Planning $\frac{1}{3}$, coding $\frac{1}{6}$; $\frac{1}{4}$ for component tests $\frac{1}{4}$, and system test $\frac{1}{4}$

Phase	% Efforts distribution
Plan	8.2
Specify	7.9
Design	11.9
Build	36.8
Test	15.5
Implementation	5.6
Unphased	14

Average phase percentage effort distribution based on ISBSG (R10)

Studies on phase-wise estimation

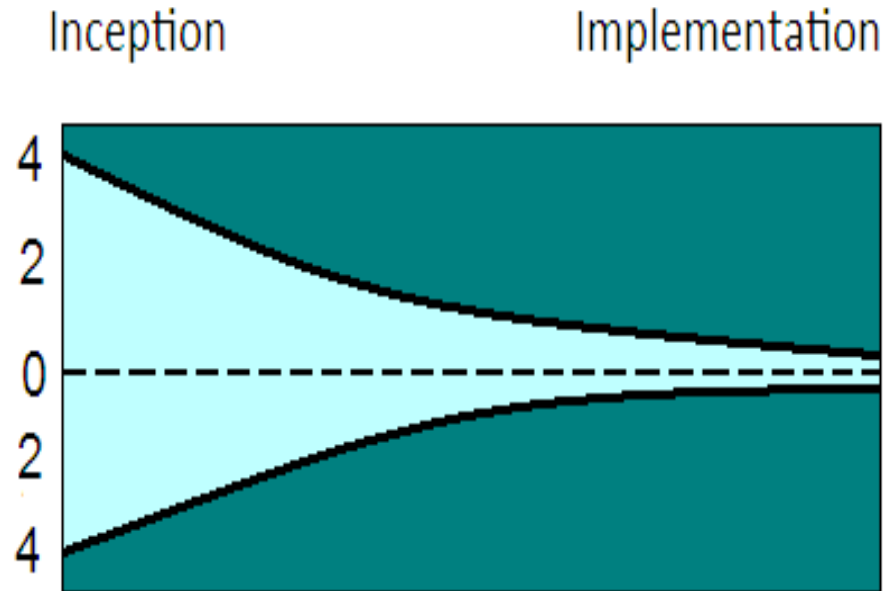
- ✓ Few studies done phase wise estimation by some researchers and few of them are summarized below:
- ✓ Ohlsson and Wohlin studied effort during the progress of a project and used phase-based data, such as the number of requirements, flowcharts, etc., to estimate effort for the subsequent phases . Even though their results showed that the metrics used did not correlate particularly well with effort, in a holistic sense they were useful to managers in acquiring an outline for the progression of the project.
- ✓ Gray and MacDonell proposed the use of logic principles in a varying degree throughout the software development phases . The different levels of available information, uncertainty and required effort estimate precision in the respective project phases suggested that a single estimation model can be used for consistency with different levels of uncertainty according to the time of the estimate.
- ✓ Jiang et al. proposed a model to predict development effort based on the software size estimated with function points. The authors utilized the software projects dataset ISBSG, generalized the average amount of effort spent for each phase of the development and provide estimates for the effort used in Building, Testing and Implementation.

What causes re-estimation?

Uncertainty in the estimations at the beginning of the project continues till the close of the project.

Cone of Uncertainty is the concept explains how the estimates by experts may vary with high degree of error (i.e., -4x to +4x) at the beginning of the project.

The degree of variance decreases with progressive elaboration and nullifies at the end of the project.



Few more examples where re-estimation is important to take control of the project:

- ✓ Change of requirements
- ✓ Major change in the assumptions made for initial estimates
- ✓ A decision to change the technology after execution started
- ✓ A new version release of the product where application is already developed
- ✓ Experienced resources left the project
- ✓ Phase end in the project life cycle
- ✓ Huge variance in Baseline efforts and Actual efforts

Inputs to re-estimation

Other than inputs to estimation which are already discussed, the following factors are very important to consider in re-estimation:

- ✓ **Scope Change:** It is important to identify if there is any scope change between start and end of previous phase.
- ✓ **Risk factor:** Risk identified in the previous phase
- ✓ **Prior phase efforts:** Look at the actual efforts spent in the previous phases and validate the efforts against the baseline efforts. The actual efforts from the prior phase would be the base for the re-estimation and future projections as well.
- ✓ **Other information if any:** Lessons learned , assumptions and constraints identified

Case Study: When to do re-estimation?

A software company receives a web based development project from renowned client to develop vehicle tracking system for their organization.

The software company is well set to start the project and preparing the ground work. They have done the sizing exercise based on the requirements shared by the client using Function Point methodology and arrived the size of 200 FP. It is JAVA based technology and by using their organization productivity of 0.8 FP/day (of high skilled resource), the efforts required to complete the development of the project is 250 Person days.

Project manager started the project unfortunately he didn't get skilled resources. When the PM generates EV metrics for 1st week of the project, realized that the project is not going on track and there is 5% variance due to requirements delay from client.

At the end of the 2 weeks PM found that variance is increased to 40%. The reasons added here are resources are not skilled enough to understand the requirements and prepare design documents.

Case Study: When to do re-estimation? Cont'd

No of days estimated to complete the project = 250 Person Days

No of Months to complete the project allocating 4 resources= $250/(20*4) = 3.125$ PMs

After 2 weeks , when the project manager generates the following metrics:

PV	AC	EV	CV = EV - AC	SV = EV - PV	CPI = EV/AC	SPI = EV/PV
40	50	20	-30	-20	0.40	0.50

The project is **over budget** and **behind the schedule** (please refer to appendix – A for details on metrics)

PM able to calculate above metrics as he **baselined the estimates and plan**, compared **actuals against baselined efforts**.

The remaining size of the application to be developed = 184 **FP**

To complete 184 **FP** in **210 person days** require = $184/210 = 1.14$ against the **0.8** productivity assumed for initial estimation.

Once the re-estimation done and baseline the Estimation, re-planning should follow and plan need to be baselined.

Case Study: Re-estimation at end of the project phase

An MNC awarded to develop employee leave details Portal

Initially project is sized to 100 FP. It is JAVA based technology and by using their organization productivity of 0.8 FP/day, the efforts required to complete the development of the project is 125 Person days.

At the end of the Requirements phase the size of the project is increased by 50 FP due to scope creep.

Now the efforts required for 150 FP development , the efforts required are 187.5 person days. Re-planned based on the new estimates is required and adjust the efforts for the remaining phases appropriately.

This needs to be repeated after each phase of the project till the end of the project.

Estimation cycle at each project phase



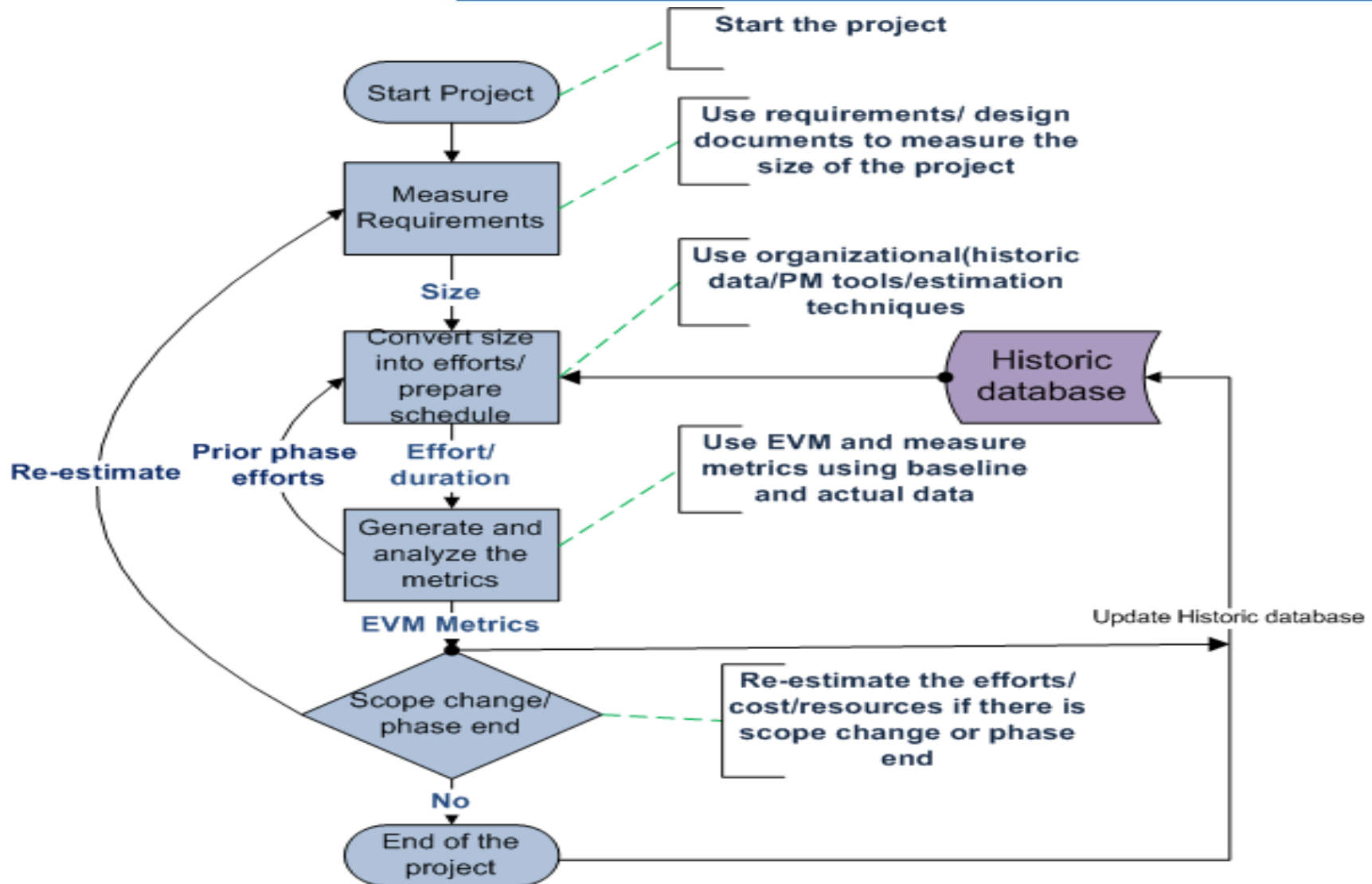
Case Study: Re-estimation at end of the project phase cont'd

	% of Efforts Distribution in project phases	Requirements phase			Design phase		
		FP Size	Person days	Person Hours	FP Size	Person days	Person Hours
Requirements	15	100	18.75	150	150	28.125	225
Design	18		22.5	180		33.75	270
Coding	35		43.75	350		65.625	525
Testing	24		30	240		45	360
Implementation	8		10	80		15	120
Total	100	100	125	1000	150	187.5	1500

Drawbacks if the re-estimation is not done and do not revise the estimation baseline

1. With the existing estimates and schedule, it is difficult to deliver the project for the asked functionalities.
2. The quality of the work may effect if the timelines are not changed.
3. Credibility is lost at the client.
4. Getting skilled resources may be a challenge.
5. If more resources are added, the productivity may reduce as the communicate channels increases and new resources may need time to understand application.

Approach for better assessment



Approach for better assessment cond..

An application is sized using Function Points and it's size is 200 FP. By using organizational productivity the effort estimation is calculated and distributed the efforts to it all project phases accordingly.

Size of the application

: 200 FP

Organizational Productivity

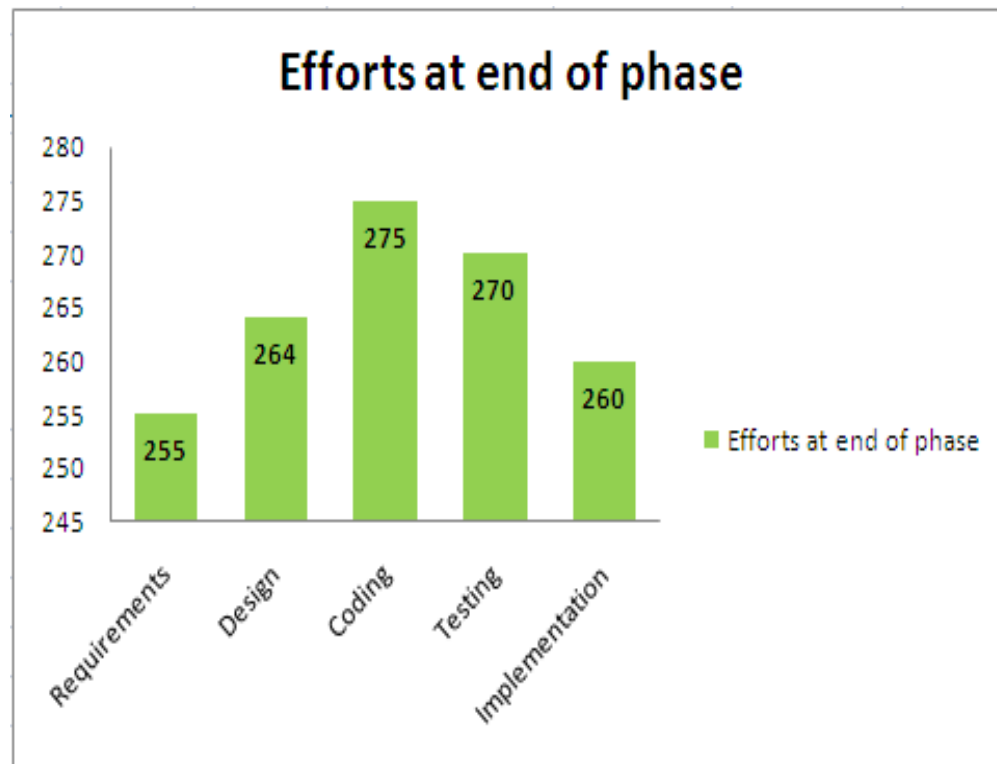
: 0.8 FP/Person day

Effort estimated

: $200/0.8 = 250$ Person Days

Project Phase	Efforts at end of phase	Productivity
Requirements	255	0.78
Design	264	0.76
Coding	275	0.73
Testing	270	0.74
Implementation	260	0.77

Average productivity at end of the project is **0.76**. The organizational productivity need to be updated to **0.76 from 0.8**



Advantages of re-estimation

Some of the advantages by re-estimating the project throughout project life cycle are listed below:

- ✓ Keeping the project the agile throughout the life cycle helps track the progress effectively
- ✓ Decreases the uncertainty in estimations as project progress and increases the accuracy in estimates
- ✓ Rippling effect will be addressed properly
- ✓ Re-estimation helps the project manager to schedule the project based on the actual progress
- ✓ The stakeholders can be communicated ahead about the risks/issues in the schedule
- ✓ Re-estimation helps to assess the skills of the resources at each phase and helps to improve the skills by providing trainings
- ✓ Gathering the efforts re-estimation data from different projects helps to understand the relation between efforts of different phases.

Reasons for Estimation failures

The following factors are some of the major issues which make projects fail

- ✓ The initial estimation is final value in spite of change in the scope of project
- ✓ Initial understanding of customer requirements is not correct
- ✓ Estimations are done in Silos
- ✓ Project team is not involved in Estimation process
- ✓ Estimates are not revisited during the project execution to track change requests
- ✓ Assumptions and risks are not identified during initial estimation
- ✓ Following the similar kind of estimation methodology for all projects.
- ✓ Resource skill mismatch in actual project progress
- ✓ Communication is not effective between all stakeholders

Best practices for better estimates

- ✓ Allow enough time for preparing estimates.
- ✓ Use organization information instead of industry standards where ever possible
e.g., productivity
- ✓ Use more than one method
- ✓ Involve project team and at least one professional estimator
- ✓ Take into account and document all appropriate assumptions and risks
- ✓ Add efforts for re-estimation at end of different phases
- ✓ Revisit estimates as and when required, e.g.: change request, phase change etc
- ✓ Use prior phase actual efforts as base to re-estimate the remaining phases
- ✓ Always provide estimates in range
- ✓ Use at least one scientific method while preparing estimation e.g., Function Point Estimate, Complexity point Estimate etc
- ✓ Create baseline of estimates to measure against the actual efforts/cost
- ✓ Document all the lessons learned for future reference

Conclusions

- ✓ Estimating is important phase of project even though it is small part of total project
- ✓ Estimation need to be done by experts with project team involvement
- ✓ Try different estimation methods appropriately instead of following same method for all kinds of projects
- ✓ Estimation Baselines are important to track the project progress against actual efforts spent on the project
- ✓ After each project phase, re-estimation of the effort is important to understand the size of the work performed and to be performed in the next phase.
- ✓ Proactively appraise all the stakeholders regarding identified risks instead of waiting for the last minute.
- ✓ Important to document the lessons learned and refine the estimation techniques. Gather the correct quantitative data to update the history databases which helps the organization in refining the estimation techniques accurately.



Appendix - A

Earned Value Analysis (EVA) is powerful tool for measurement and reporting :

- ✓ Integrates scope, cost and schedule measures to help the project team evaluate the project's performance
- ✓ Enables the Project Manager to know the % of work completed and the value of the completed work
- ✓ Quantitative technique for assessing and predicting progress

Base measures:

- ✓ **Earned Value(EV):** Baselined effort of the task which is completed within the reporting period
- ✓ **Planned Value(PV):** Baselined effort of the task which is planned to be completed within the reporting period
- ✓ **Actual Cost (AC):** Actual effort of the task which is completed within the reporting period

Control measures:

- ✓ **Schedule Variance (SV):** Difference between earned value and planned value
- ✓ **Schedule Performance Index (SPI):** Ratio of earned value and planned value
- ✓ **Cost Variance (CV):** Difference between earned value and actual cost
- ✓ **Cost Performance Index (CPI):** Ratio of earned value and actual cost

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- ✓ A Progressive Software Effort Estimation Model by Efi Papatheocharous, Stamatia Bibi, Ioannis Stamelos, Andreas S. Andreou