Software Engineering ( Hashi mam - Class-01)
CSE 3105

V.V.V.I^∞ chap-02.

Syllabus : Chap 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 17, 29.

## Chapter - 03
## Project Management Concepts

- 4-P concept / Project Management Concepts.
  → (People, Product, Process, Project)

3.1.1 : The People : Skilled people

3.1.2 : The Product : Objectives & scope

3.1.3 : The Process : (Process model, framework activities, umbrella activities

3.1.4 : The Project : controlled way তে project টা manage করতে হবে যাতে fail না করে। Success rate increase করতে হবে।

- People : 3.2.1 : The Players : [Categorized into five constituents]

1. Senior managers : who define the business issues / Commercial thinking যে/যারা করে থাকে।

2. Project (technical) managers :

Exam : Difference bet^n Senior managers & Project (technical) managers ?

3. Practitioners : Development কাজের সাথে সরাসরি যুক্ত।

4. Customers : একটা party / client যারা software form থেকে কোনো একটা কাজ করায় নেয়। Example : Banking software.
   example: bank owner

5. End-users :

Exam - Difference bet$^n$ Customers & End-users ?

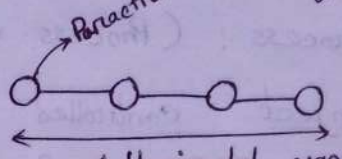
MOI model :

An effective project manager emphasizes four key traits :

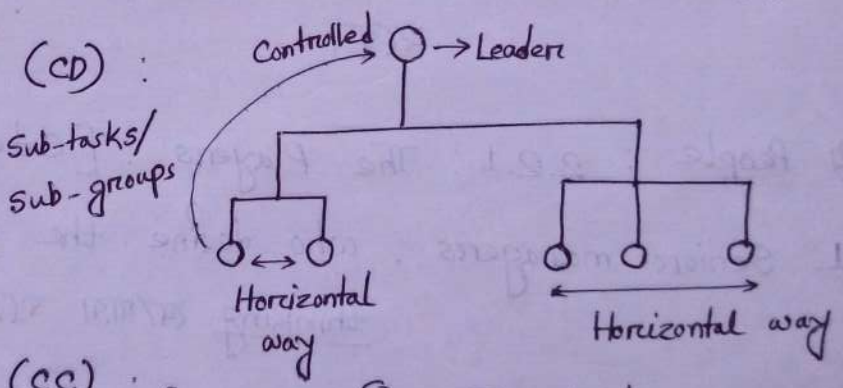
- Problem Solving
- Managerial identity
- Achievement
- Influence and team building

Team Organization :

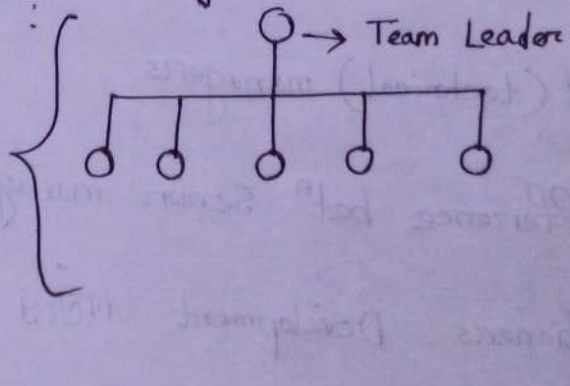
Democratic decentralized (DD) :




Controlled decentralized (CD) :




Controlled Centralized (CC) :




Exam : A ~~scenario~~ scenario দেওয়া থাকবে। আমরা কোনটাকে pick করব (valid), Show Logic.

- Seven Project factors : (For answering Questions)

Centralized structure completes tasks faster (for simple problems/ project)

Decentralized " ⟶ Difficult/ Complex Problem (for getting better solutions than individuals, time duration না বেশি হলে ভালো)

Larger Project ⟶ CD

3.2.4 : Coordination and Communication Issues :

Communication rate/↑ ⟶ CD

Volume/modularity of communication issues.

- Project coordination techniques : Figure 3.1 (Book)

Formal, impersonal approaches.

Formal, interpersonal approaches. procedures

Informal, interpersonal procedures

Electronic communication

Interpersonal networking

3.3 : The Product :

3.3.1 : Software Scope

3.3.2 : Problem Decomposition (Divide & Conquer Strategy)

3.4 : The Process : (Exam v.v.v.I^o) + Communication approach

3.4.1 :

বইয়ের example :

3.5: The Project : In order to manage a successful software project, we must understand what can go wrong.

⊡ five-part common sense approach :

1. Start on the right foot :

2. Maintain momentum :

3. Track progress : (quality assurance activities)

4. Make smart decisions :

5. Conduct a postmortem analysis :

⊡ 3.6 : ১ম project এর outline planning → W⁵HH principles

5 টা Questions & Answers ?

Chap-4 (V.V.V.I^mp for exam) → 1 set Questions

## Software Process and Project Metrices

Figure 4.1 → Software quality and organizational

4.3: Software Measurement:
↳ fundamental complete view

Direct Measurement: line of codes, execution speed, memory size

Indirect " : functionality, quality, complexity, efficiency, reliability.

4.3.1: Size-oriented metrices: (For exam → Direct measurement এর example)

LOC → Line of code.

Effort → Person x month

$ → cost
(000) এটার পরে 3টা zero আছে/থাকবে।

Pp. doc. → Per Page Documentation.

Errors → একটা software product release দেওয়ার আগে যে সম্ভাব্য error গুলো record করা হয়েছে & correct " "

Defects → " " " " " পরে (প্রথম ১ বছরের মধ্যে) customer feedback এর মাধ্যমে যেসব error/problem encounter করা হয়েছে।

Size-oriented metrices universally সবসময় excepted হবে না।

LOC ⟶ Language dependent

4.3.2 : Function-Oriented metrices : (Goal ⟶ Function point টা Base Parameter calculate করা)
(Indirect measurement)

Figure 4.5 :

Direct Parameters from the projects :

| | Count | | Simple | Average | Complex | |
|---|---|---|---|---|---|---|
| Number of user inputs | 10 | × | ③ | | | = |
| " " " outputs | 15 | × | | | ⑦ | = |
| " " " inquiries | 20 | × | ③ | | | = 60 |
| " " " files | 30 | × | ⑦ | | | = 21 |
| " " external interfaces | 5 | × | | | ⑦ | = 35 |

Count total ⟶ 440

Weighting factors : Simple Average Complex

Software Engineer এর weighting factors গুলা define করে দিবে/ দিয়ে থাকবে।

For exam : Count দেওয়া থাকবে, কোনটা কোন Type ছিল, Count total বের করব,

Function Point :

$$FP = \text{count total} \times [0.65 + 0.01 \times \Sigma(F_i)]$$

(Constant) ⟶ Universal Equation

$F_i$ = ($i$ = 1 to 14) are "complexity adjustment values"

14 টা Question এর Answer এর মাধ্যমে :

yes/No Answer.

Fuzzy " [14 টা term মনে রাখতে হবে]

0-5 এর মধ্যে Answer হবে।

Average → 3 (Assume করে exam এ থাকে/থাকবে most of the time)

1. System এর backup and recovery essential ?

No → 0

yes → 5

↓

Project এর description অনুযায়ী Answer vary করবে।

Book : Page - 130 :

Example : Assumption করে। 1. backup and recovery → 2

(A painting software)

2. 0

3. 0 Value গুলো fractional হতে পারবে না।

4. 1

5. 2

6. 1

7. 5

8. 4

9. 3

10. 3

11. 5 ⊗ 5

12. 2

13. 2

14. 4

$\Sigma F_i = 34$

Function Point : $FP = 440 \times [0.65 + 0.01 \times 34]$

$\therefore FP = 435.6$

FP এর value-র উপর depend করে আমরা বলব : Errors per F

Defects "

$ per "

4.5.2 : Measuring Quality :

Correctness : Encounting errors গুলো correct করা হয়েছে কী না

Maintainability :

CSE 3107 (Faruk Sir - Class-03) Date : 23.02.2020

Populations and Samples :

Statistics এ sample এর উপর random sampling করা হয়।

Good Sampling : Whole population কে represent করে/করে থাকে।

A good sampling is a sign where whole population (a set of values) are represented. & biased হওয়া যাবে না এক্ষেত্রে।

Population Mean $\mu = \frac{\Sigma X}{N}$ ⟶ Total number of population/observations

In Statistic, what is the difference betn Mean & Average ?

Population থেকে Sub set করে ফেললে :

Sample Mean, $\bar{X} = \frac{\Sigma X}{n}$

Averge ⟶ Arithmetic Mean বলব,

↓

Centre Tendency

Arithmetic Mean Properties :

• Arithmetic mean obviously outlier নিয়ে কাজ করবে/করে থাকে।

→ এটা শুধুমাত্র numerical value এর উপর applicable হবে।

Arithmetic Mean: • The most common

Extreme values (outliers)

Example: Consider the set: 3, 8, 4

Weighted Mean:

$$\bar{X}_w = \frac{(\omega_1 X_1 + \omega_2 X_2 + \ldots\ldots + \omega_n X_n)}{(\omega_1 + \omega_2 + \ldots\ldots \omega_n)}$$ → (Sum of weight & value)

Example: (GPA system), CGPA (Grade Point Average)

Geometric Mean → (Outliers কে কিছুটা হলেও কমানোর overcome করতে পারে) → nth root of the product

→ Consecutive numbers এর ক্ষেত্রে

Properties of Roots: • Root এর সাথে summation এর সম্পর্ক

" " " multiplication " "

~~A root~~

## The Median

• The median is the midpoint (ascending order) → for overcoming the problem of outliers (Extreme values)

সবচেয়ে ভালো dataset when Arithmetic mean, Harmonic mean & Geometric mean same হবে/হয়ে থাকে।

Example:

Properties of the Median:

If dataset is uniformly distributed then mean = median = mode হবে/হয় থাকে।

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Software Design Date: 23.02.2022

Design concepts and principles

General definition of design :

Goal : To produce a model or representation that will later be built.

- Major Areas of concerns :

DFD ⟶ Data Flow Diagram., Structured Chart ⟶ Architectural Design -এ থাকে/থাকবে।

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Chapter – 05

Software Project Planning

SDLC এর অনেকগুলো steps ছিল।

Observations:

- Complexity
  - Relative
- Size
  - Interdependency
- Uncertainty
  - Hierarchy (info.)
  - Compartmentalization (fn)/ module

SDLC এর ৯৯ দিকের steps গুলোতে complexity-র কোনো Quantitative measurement করা possible ছিল না।

Resource


1. Human
   - Skills (Primary Resource)
     - Tech.
     - Organizational (For management purposes)
2. Reusable s/w Resources
   - Off-the-Shelf components
     - Full-exp. Components
     - Partial-exp. "
     - New "
3. Environmental
   - Tool/ Frame-works
   - Support
   - Time Window

Off-the-Shelf components: Already existing software

Comercial-off-the " " : টাকা পয়সা দিয়ে কিনে নিয়ে আসলে

2. Full-experience components:

New components: Scratch থেকে

1. এম ছোটা থাকবে ⟶ off-the-shelf component আনা (cost ও comparatively কম হয়)

2. Then we will choose Full-exp. Components. Then next দুইটার মধ্যে যেটা সবচেয়ে optimal সেইটা choose করব।

## COCOMO [Constructive Cost Model]

| 3 categories of Project | Size | Innovation | Deadline | Dev. Env. | KLOC |
|---|---|---|---|---|---|
| Organic | S (Small) | L | NT (Not tight) | St (Stable) | 2-50 |
| Semi detached | M | M | M | M | 51-300 |
| Embedded | L | Gr (Greater) | T (Tight)/ Strict deadline | Cx (Complex) | >300 |

Thousand Line of codes ⟶ KLOC

KLOC এর পরে table ২: (KLOC

3 Stages

- Basic
- Intermediate
- Detail

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COCOMO

Organic, Semi-detached
Embedded

Basic COCOMO model:

$Effort = a_1 (KLOC)^{a_2}$ PM

$Time = 2.5 (Effort)^{b}$ M

$People = \frac{Effort}{Time}$

| | $a_1$ | $a_2$ | $b$ |
|---|---|---|---|
| O→ | 2.4 | 1.05 | 0.38 |
| S→ | 3 | 1.12 | 0.35 |
| E→ | 3.6 | 1.2 | 0.32 |

এই মানগুলো fixed

সাধারণত KLOC দেওয়া থাকে।
In case না দেওয়া থাকলে estimation করে নিতে হবে।

Effort এর unit - Person Month (pm)

2.4

Average staff size $= \frac{Effort}{Time}$ persons

Productivity $= \frac{KLOC}{Effort} = KLOC/pM$

Consider an (Embedded) project with (700 KLOC). Calculate the Effort, development time, avg. staff size, (People) productivity to develop the product.

Soln:

$$E = (3.6)(700)^{1.2} \text{ PM}$$

$$= 9341.58 \text{ PM}$$

$$T = 2.5(9341.58)^{0.32} \text{ M} \rightarrow (\text{Months})$$

$$= 46.61 \text{ M}$$

Average Staff Size/ per unit সময় ধরে কত effort লাগছে = $\frac{E}{T} = \frac{9341.58}{46.61}$

= 201 Person

$$\text{Productivity} = \left(\frac{E}{KLOC}\right)^{-1} = \left(\frac{9341.58}{700}\right)^{-1}$$

= 13.34 PM/KLOC

$$\boxed{\text{Productivity} = \frac{KLOC}{E}}$$

Consider a project with approx. 7000 LOC. Calculate the staff size, productivity to develop the product.

Avg. Staff size $= \frac{E}{T}$

7000 LOC

7 KLOC →

Organic

$E = 2.4(7)^{1.05}$

$= 18.52$ PM

$T = 2.5 \cancel{(0.35)} (18.52)^{0.35}$ M

$= 7.58$ M

Avg. staff size $= \frac{E}{T} = 2.44$ P

Productivity $= \frac{KLOC}{E} = \frac{7}{18.52} = 0.38$

COCOMO

(cost drivers)

Intermediate : ~~15~~ KLOC ছাড়াও 15 টা আলাদা parameter আসবে।

এবং

Changes আসবে $a_1$ & Error Adjustment Factor (EAF)

| $a_1$ | $a_2$ | b |
|---|---|---|
| 3.2 | 1.05 | 0.38 |
| 3.0 | 1.12 | 0.35 |
| 2.8 | 1.2 | 0.32 |

$$\text{Effort} = a_1 (\text{KLOC})^{a_2} \times \text{EAF}$$

$$\text{Time} = 2.5 (\text{Effort})^{b} \text{ M}$$

$$\text{People} = \frac{\text{Effort}}{\text{Time}}$$

| Product Attributes | Very Low | Low | Nominal | High | V. High |
|---|---|---|---|---|---|
| Required Software Reliability | 0.75 | 0.88 | 1 | 1.15 | 1.40 |
| Size of App. DB | | 0.94 | 1. | 1.08 | 1.16 |
| Capacity of the Product | 0.7 | 0.85 | 1 | 1.15 | 1.3 |
| Hardware Attributes<br>Runtime Performance Constraints | | | 1 | 1.11 | 1.3 |
| Memory | | | 1 | 1.06. | 1.21 |
| Volatility of Env. VM / Virtual Machine | | .87 | 1 | 1.15 | 1.3 |

| | | | | | |
|---|---|---|---|---|---|
| Programming Language Exp. | | .94 | 1 | 1.07 | 1.15 |

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Date: 17.05.22

COCOMO Intermediate Cost Drivers

| | VL | L (Low) | N (Nominal) | H | VH (High) |
|---|---|---|---|---|---|
| Personnel Att. Analysis Capability | 1.46 | 1.19 | 1 | 0.86 | 0.71 |
| App. Exp. | 1.29 | 1.13 | 1 | 0.91 | 0.82 |
| S/W. Engg. Cab Capability | 1.42 | 1.17 | 1 | 0.86 | 0.70 |
| VM Exp. (Virtual Machine) | 1.21 | 1.10 | 1 | 0.9 | |
| PL Exp. (Programming Language) | 1.14 | 1.07 | 1 | 0.95 | |
| App. of S/W Eng. Methods | 1.24 | 1.1 | 1 | 0.91 | 0.82 |
| Use of S/W Tools | 1.24 | 1.1 | 1 | 091 | 0.83 |
| Required Device Schedule | 1.23 | 1.08 | 1 | 1.04 | 1.1 |

$E = a_1 (KLOC)^{a_2} \times EAF$ (Error Adjustment Factor)

$T = 2.5 (E)^b$

| $a_1$ | $a_2$ | $b$ | |
|---|---|---|---|
| 3.2 | 1.05 | 0.38 | |
| 3 | 1.12 | 0.35 | ← |
| 2.8 | 1.2 | 0.32 | |

# Consider a project with m estimation of 250 KLOC. Although the Application DB(DataBase) is nominal, it has high memory constraints. The Tech. team has developers who have high App. Exp. but very low exp. in programming. The required dev. schedule for the project is low. Calculate the effort, development time, average staff size required.

Soln:

$$E = 3(250)^{1.12} \times \underbrace{(1 \times 1.06 \times 0.91 \times 1.14 \times 1.08)}_{(EAF)}$$

$$= 1727.78 \quad PM \text{ (Person Month)}$$

$$T = 2.5(1727.78)^{0.35}$$

$$= 33.967$$

$$P = \frac{1727.78}{33.967} = 51$$

Detail model এর ক্ষেত্রে ⟶ individual intermediate model এর থেকে calculate কৃত efforts

- All characteristics of intermediate গুলোর summation হবে ($\Sigma E, \Sigma T, \Sigma P$)
- Divided into different modules required ans. of the effort.
- Apply cocomo in each modules
- Sum all efforts.

Software Equation

$$E = \left[\frac{LOC \times B^{0.333}}{P}\right]^3 \times \frac{1}{t^4}$$

$$t = 8.14\left(\frac{LOC}{P}\right)^{0.43}$$

] Pratically most used

$E = 180\,\beta t^{B}$ ← in yrs

$B$ = B[Special Skills Factor]

= 0.16 [5 − 15] KLOC

= 0.39 [> 70]

→ [Skill বাড়ার সাথে সাথে বাড়ে]

P [Productivity Parameter]

= 2000 [RT → Real time Embedded S/W]

= 10000 [TeLc Q] → (Telecommunication)

= 12000 [Scientific]

= 28000 [Business]

A scientific s/w with approx. 75000 LOC is to be developed. Calculate the time, Effort

Sol$^n$:

$$t = 8.14\left[\frac{75000}{12000}\right]^{0.43} = 17.89 \text{ Months/M}$$

$$E = 180 \times 0.39 \times \left[\frac{17.89}{12}\right]^3 = 233 \text{ PM (person Month)}$$

A s/w for using in the Micro wave (embedded software chap 1) with approx. 15000 LOC. is to be developed. Calculate the time, Effort.

Sol$^n$: $t = 8.14\left(\frac{15000}{28000\ 2000}\right)^{0.43} = 19.36$ M

$$E = 180 \times 0.16 \times \left[\frac{19.36}{12}\right]^3 = 120.. \text{ PM}$$

কোন process ধরে আগাবো : Software Equation / Cocomo model

Specific info cocomo ⟶ organic, semi-detached

scientific s/w, telecommunication ⟶ soft eq

A scientific s/w with approx. 75000 LOC is to be developed. Calculate the time, Effort

Soln:

$$t = 8.14\left[\frac{75000}{12000}\right]^{0.43} = 17.89 \text{ Months/M}$$

$$E = 180 \times 0.39 \times \left[\frac{17.89}{12}\right]^{3} = 233 \text{ PM (person Month)}$$

A s/w for using in the Micro wave (embedded software chap 1) with approx. 15000 LOC. is to be developed. Calculate the time, Effort.

Soln: $t = 8.14\left(\frac{15000}{28000\ 2000}\right)^{0.43} = 19.36 \text{ M}$

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কোন process বিবে আগাবো : Software Equation / Cocomo model

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যুক্ত LOC / Generic value দেওয়া থাকলে যেটায় possible way সেটাই ধরে আলাবো।

CT Question Solve:

Effort = $a_1(KLOC)^{a_2}$ PM × EAF

$= 3.2(40)^{1.05} \times (0.85 \times 1.15 \times 1.30 \times 1.46 \times 1.00 \times 1.24)$

$= 354.118$ PM

Exam: Software Equation.

Time = $2.5(E)^b$

$= 2.5 \times (354.118)^{0.38}$

$= 23.2604$ M

∴ Average Staff Size = $\frac{E}{T}$

$= \frac{354.118}{23.2604}$

$= 15.22 \cong 15$ Persons

Date : 24.5.2022

## Project Scheduling and Tracking :

Major parts : ☐ CPM ( Critical Path Method) ⟶ For Project Completion time.
- Unique Start (tail)
- Unique End (head)

Activity → class/function/methods/feasibility study.

একটা Graphical View/Network তৈরি করতে হবে ;

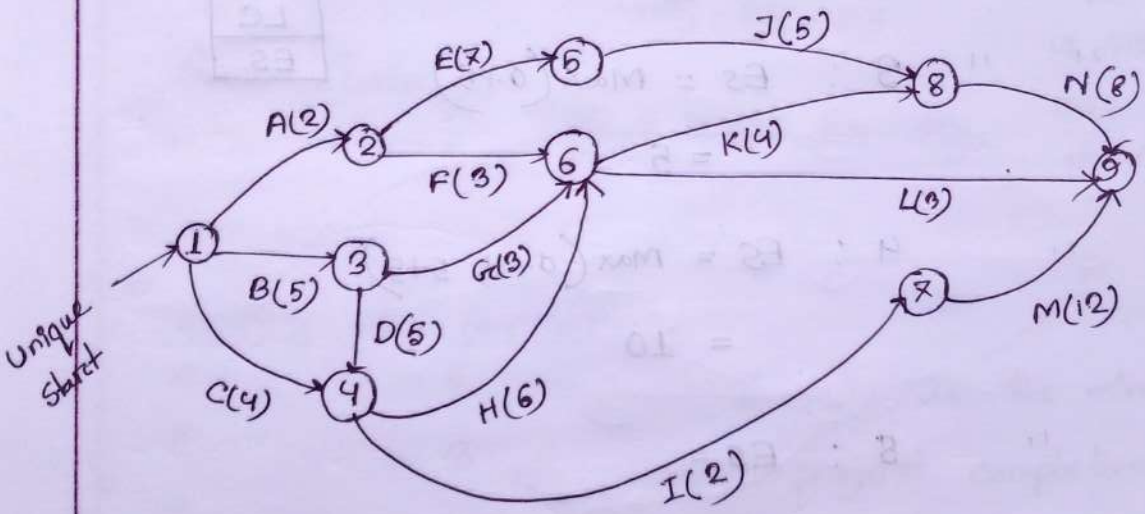


Figure 3: CPM Network

Ending এ L, M, N add করলাম cause এদের কোনো predecessor নাই।

Date : 24.5.2022

## Project Scheduling and Tracking :

Major parts : CPM (Critical Path Method) → For Project Completion time.
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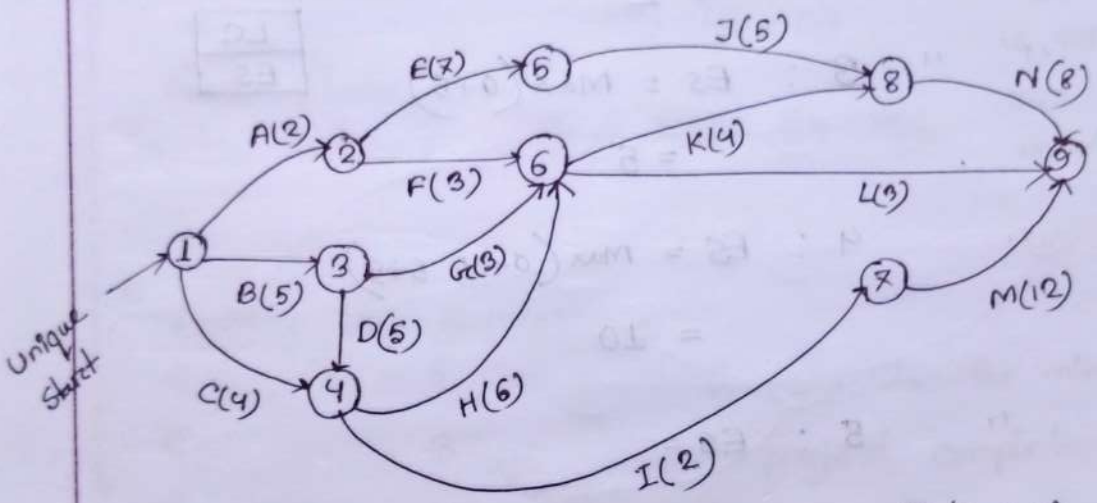



Figure 3: CPM Network

Ending এ L, M, N add করলাম cause এদের কোনো predecessor নাই।

⊕ Critical Path : Longest distance between start and end.

Earliest start time (ES) [forward pass] → Node 1 থেকে শুরু করে সামনের দিকে proceed করব]

$ES_j = \max_i (ES_i + D_{ij})$

Representation for each node

| LC |
|---|
| ES |

ES for Node 1 : 0

" " " 2 : $ES = \max(0+2)$

$= 2$

" " " 3 : $ES = \max(0+5)$

$= 5$

" " 4 : $ES = \max(0+4, 5+5)$

$= 10$

" " 5 : ES =

$LC_i = \min_j (LC_j - D_{ij})$

Latest Completion time (LC) [backward pass]

LC for Node 9 : Last node এর $L = E = 28$

Outgoing calculate করব

" " " 8 : $LC = \min(28-8)$

$= 20$

" " 4 7 : LC = Min

● Critical Path: Longest distance between start and end.

Earliest start time (ES) [forward pass] → Node 1 থেকে শুরু করে সামনের দিকে proceed করব]

$ES_j = \max_i (ES_i + D_{ij})$

Representation for each node

| LC |
|---|
| ES |

ES for Node 1 : 0

" " " 2 : ES = Max(0+2)
= 2

" " " 3 : ES = Max(0+5)
= 5

" " 4 : ES = Max(0+4, 5+5)
= 10

" " 5 : ES =

Latest Completion time (LC) [backward pass]

LC for Node 9 : Last node এর L = E = 28

" " " 8 : LC = Min(28-8)
= 20

" " " 7 : LC = Min

Outgoing calculate করব

$LC_i = \min_j (LC_j - D_{ij})$

Critical Path : $ES_i = LC_i$

$ES_j = LC_j$

Path : B – D – H – K – N

Distance Time : 5 + 5 + 6 + 4 + 8 = 28 months [expected project completion time]

Total floats : → একটা activity নিজে কতটুকু delay করা যায়, যেন total completion time delay না হয়

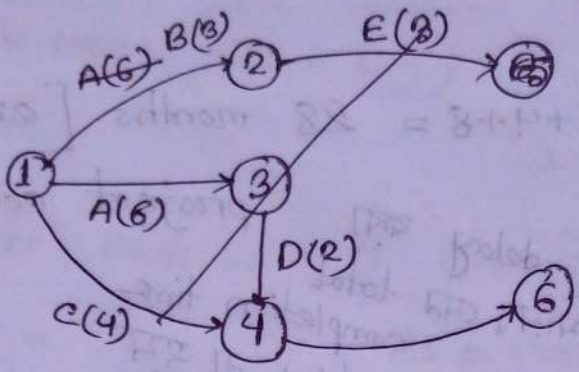
$TF_{ij} = LC_j - ES_i - D_{ij}$

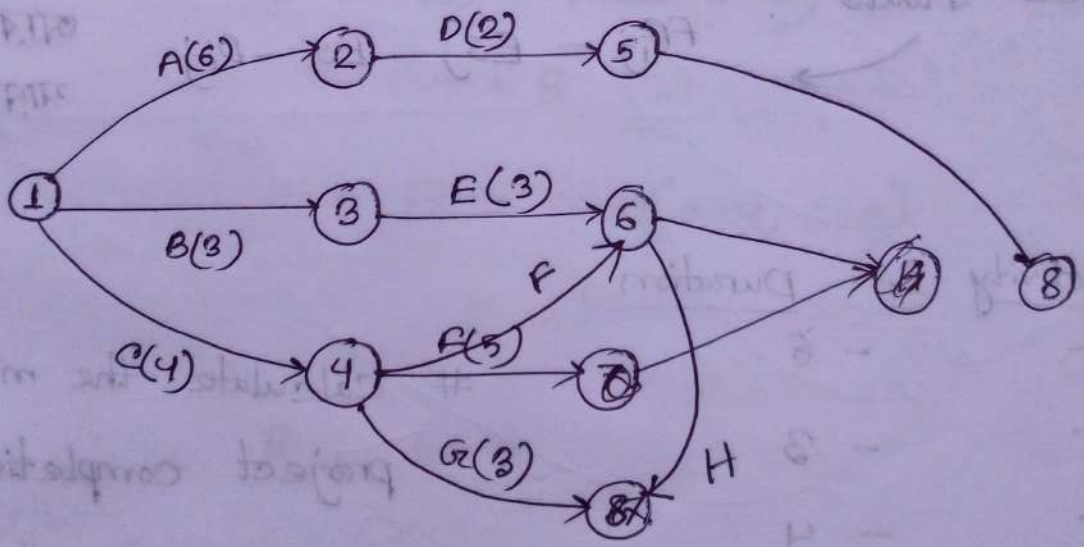
কিন্তু critical path এ যারা আছে তাদেরকে আর delay করা যায়/যাবে না।

Free floats : $ff_{ij} = ES_j - ES_i - D_{ij}$

| Activity | IP | Duration |
|---|---|---|
| A – | | – 6 |
| B – | | – 3 |
| C – | | – 4 |
| D – | A | – 2 |
| E – | B | – 3 |
| F – | C | – 5 |
| G – | C | – 3 |
| H – | E, F | – 5 |
| I – | D | – 5 |
| J – | H, G | – 3 |

# Calculate the minimum project completion time using




PERT:

PERT:

- Mean (expected duration) : $t_e = \frac{t_o + 4t_m + t_p}{6}$
- Variance : $\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$

- PERT : Project Evaluation and Review Technique.

Probability of completing the work on before 19 months

$P(\leq 19)$

CPM : Each activity — One estimate

PERT : Each activity — Three estimates (optimistic, most likely, pessimistic)

Slide - 17 months

$$P(x \leq 19)$$

$$= P\left(\frac{x - \mu}{\sigma} \leq \frac{19 - 17}{\sqrt{4.78}}\right) = P(z \leq 0.91)$$

$$= 0.3186 \quad [\text{Normal distribution}]$$

∴ Probability of completing the work on before 19 months is 31.86% (Answer)