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Understaffing - low quality deliverables
overstaffing - Increase quality of deliverables

Programs are written line by line which is called size of program.
- LOC
- KLOC
- function point Analysis (FPA)

FPA

Requirement | Project Size

The final no. of functional point arrives by multiplying the UFP by adjusting the factor that is determined by considering 14 aspects of processing complexity.

* FP is calculated as:

FP = UFP * CAF.

↓

complexity adjustment factor

Case Study for FPA :-

- Consider the project with following functional units :

no. of user i/p = 50
no. of user o/p = 40
no. of user enquires = 35
no. of user files = 06
no. of external interfaces = 04.

Soln: Compute function points for project.

$$UFP = \sum i=1 \text{ to } 5 \quad \sum i=1 \text{ to } 3 \; zij \; Wij$$

$$= 50*4 + 40*5 = 35*4 + 6*10 + 4*7$$

$$= 200 + 200 + 140 + 60 + 20$$

$$\therefore \boxed{UFP = 628}$$

$$CAF = (0.65 + 0.01 \sum Fi)$$

$$= (0.65 + 0.01(14*3))$$

$$= 0.65 + 0.42$$

$$\therefore \boxed{CAF = 1.07}$$

$$FP = UFP * CAF$$

$$= 628 * 1.07$$

$$\therefore \boxed{FP = 672}$$

COCOMO model :-

CO Constructive
CO Cost
MO Model.

Basic cocomo model

Intermediate cocomo model

Detailed Cocomo model

* model :-
Used to estimate effort, cost, development time, Average staff, size, productivity, etc.

* Different models are used to estimate cost of software
- static
- single variable model.

* It takes equation:

$$C = aL^b$$

- C is the cost (effort expressed in any unit of manpower, e.g - person-month).
- L is the size generally gives no. of lines of code.
- a & b are constants derived from historical data of applications

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LOC can be KLOC = 1000 line of code.
KDLOC
~~KLOC~~ = 1000 developer / development LOC.

* It estimates the S/W roughly & quickly & mostly used for organic small-medium sized software.

(Organic) [Effort] = $a(KLOC)^b$ [Person-month]

(Semi-detached) [Development time] = $c(Effort)^b$

(Embedded) [Average staff size] = $\frac{Effort}{Development\ time}$

[Productivity] = $\frac{KLOC}{Effort}$

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Type	a (a_b)	b (b_b)	c (c_b)	d (d_b)
Organic	2.4	1.05	2.5	0.38
Semi-detached	3.0	1.12	2.5	0.35
Embedded	3.6	1.20	2.5	0.32

↑
∴ To calculate effort & development time check for project-size.

organic mode (small team + Good experienc
- developed in familiar, stable environment
- similar to previously developed projects
- relatively small & require little innovatio

* semi-detached mode (medium team + mixed experience)
- tight, inflexible constraints & interface requirements.
- The product requires great innovation.

* Embedded mode (combination of organic & semi-detached)
- Intermediate bet^n organic & embedded.

* mode — project size in KLOC
1) organic - 2-50 KLOC
2) semi-detached - 50-300 KLOC
3) Embedded - over 300 KLOC

* $E = a_b (KLOC)^{b_b}$ [Person-months]

* $D = c_b (E)^{d_b}$ [months]

* people required = effort applied / development time

Time [count]

* Average Staff size (SS) = E/D (persons)

* productivity (P) = KLOC/E (KLOC/PM)

KLOC - project size
E - Effort
D - Development time.

* limitations:
- lack of factors which have significant influence.

Q. Suppose the project was estimated to be 4 million LOC, calculate effort & time for each 3 modes of development.

soln: 4M = ? KLOC
1M = 10L ∴ 4M = 40,0000
∴ 4M = 400 KLOC. - [Range over 300]
∴ Embedded mode is used.
Effort = a (KLOC)^b person-month
= 3.6 (400)$^{1.20}$
∴ Effort = 3.6 4,772.8137.

Development time = c (Effort)^d
= 2.5 (4,772.8137)$^{0.32}$
∴ Development time = 37.5965

Organic,

KLOC = 400, a = 2.4, b = 1.05, c = 2.5, d = 0.38.

Effort = $a(KLOC)^b$

$= 2.4(400)^{1.05}$

$\approx$ 1295 (1295.3115)

development time = $c(Effort)^d$

$= 2.5(1295)^{0.38}$

$= 38.0717$.

Semi-detached:

KLOC = 400 a = 2.4 b = 3 c = 2.5 d = 0.35.

$\therefore$ effort = $a(KLOC)^b$

$= 2.4(400)^3$

$\approx$ 2462 153,600,000

$\therefore$ Development Time = $c(Effort)^d$

$= 2.5(2462)^{0.35}$

$= 38.4$ 1833.0610

If LOC abe > 1000 then convert to KLOC.

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Average Staff size for organic (SS)
= E/D
= 1295 / 38.0717
= 34.0147.

Average staff size for semi-detached (SS)
= E/D
= 153,600,000 / 1833.0610
=

Average staff size for embedded (SS)
= E/D
= 4772.8137 / 37.5965
≅ 126.

productivity for embedded (P) =
= KLOC / E
= 400 / 4772.8137
= 0.08.

KLOC = LOC / 1000.

Q2] calculate for given LOC is 120 lines.
→ 120 LOC = 120/1000.
120 has range 50-300
∴ semi-detached
∴ KLOC = 120, a = 3.0 b = 1.12 C = 2.5
d = 0.35
Effort = a(KLOC)^b
= 3.0(120)^1.12
E = ~~937.8615~~ 639.446

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development time = c (Effort)^d

$= 2.5(639.446)^{0.35}$ ~~$= 2.5(937.8615)^{0.35}$~~

D = 23.986 ~~$= 27.4276.23.986$~~

Average staff size (SS)

= E/D

= 639.446/23.986

SS = 26.6591

productivity = KLOC/E

= 120/639.446

P = 0.1876

Q3] Give LOC = 250

→ LOC has range 5-300 so, we calculate for semi-detached mode.

Effort = $a(KLOC)^b$

$= 3.0(250)^{1.12}$

E = 1454.8360

Development Time = $(Effort)^d$

$= 2.5(1454.8360)^{0.35}$

D = 31.9834.

Average staff size = E/P

= 1454.8360/31.9834

SS = 45.4872

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productivity = KLOC/E
= 250/1454.8360
∴ p = 0.1718

The intermediate model estimates the software development effort by using fifteen cost drives variables besides the size variables used in.

Four areas of drives :
1) Product Attributes
2) Computer Attributes
3) Personnel Attributes
4) Project Attributes.

1] Product Attribute
- RELY Reliability
- DATA database
- CPLX Software complexity.

2] Computer Attributes.
- ~~Time~~ TIME - execution time constrain
- ~~#~~ STOR Storage
- VIRT virtual machine volatility
- TURN Turnaround time.

3] Personnel Attributes.
ACAP - Analyst capability
AEXP - Application Experience