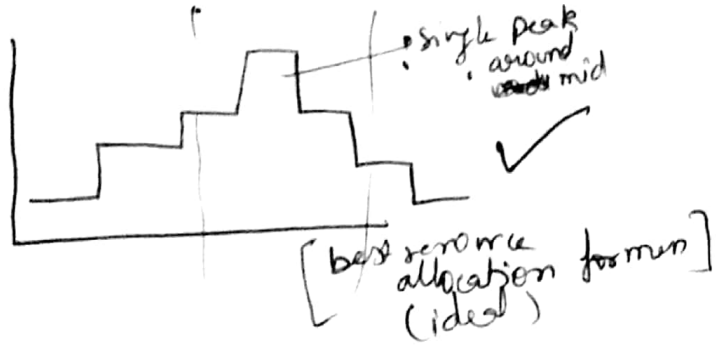
Resource Allocation
(Men)

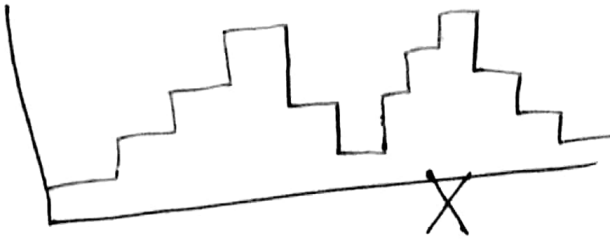
(LST may be less than EST)

Single resource (Helper, Carpenter, Plumber, Engineer ... +)
Multiple resource (Helper + Carpenter + Plumber + Engineer ... +)

Unlimited resources : Based on EST, Based on LST
Limited resources : Serial method, parallel method



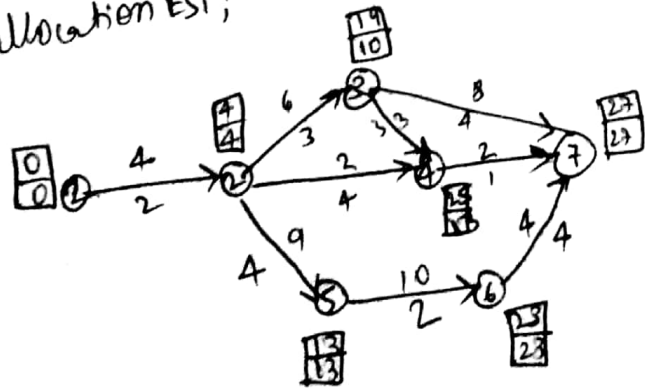
2 peaks

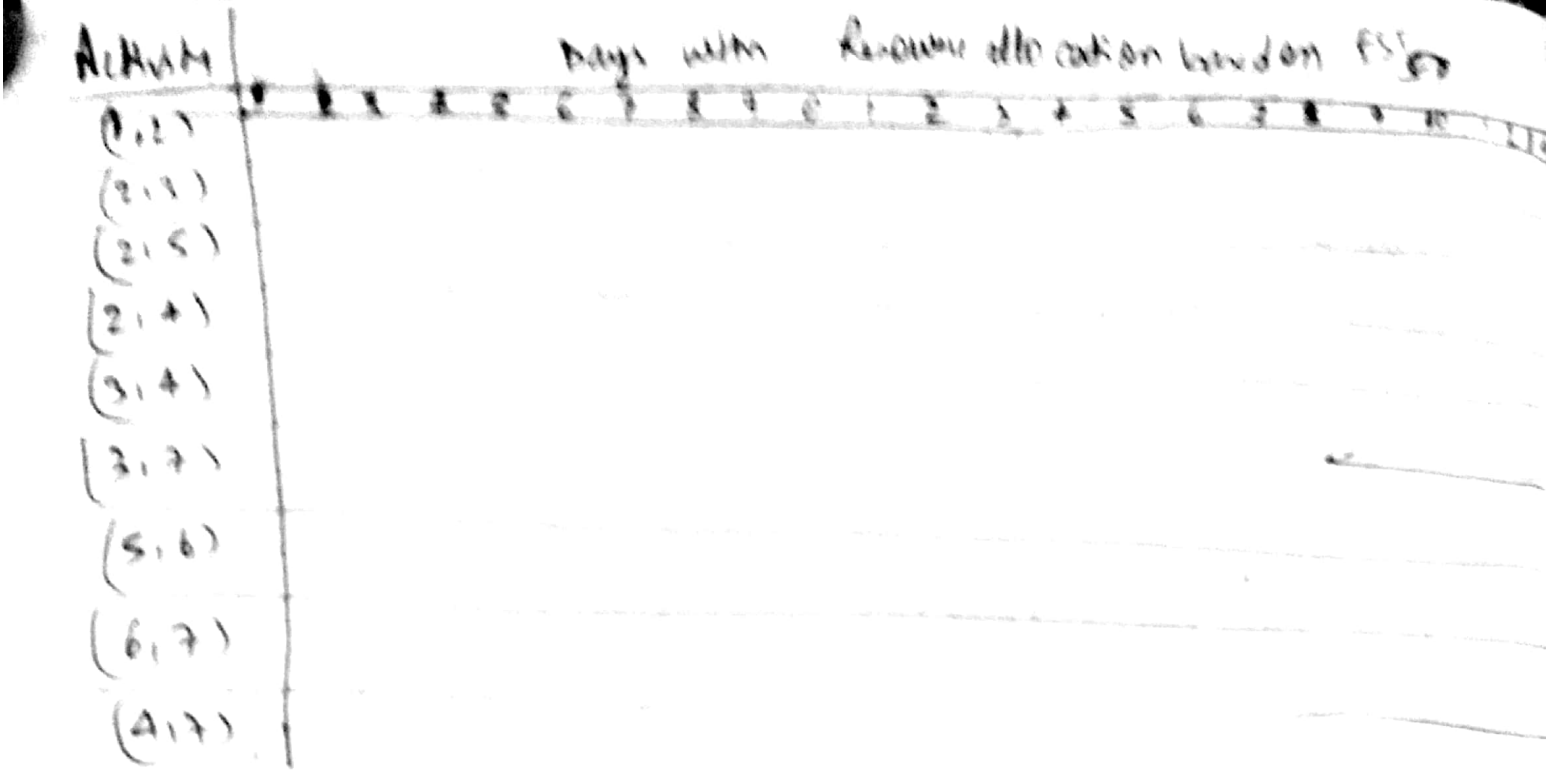


Single, Unlimited resource

Activity	Duration (days)	Resources (per days)	EST	LST
(1,2)	4	2	0	0
(2,3)	6	3	4	13
(2,5)	9	4	4	4
(2,4)	2	4	4	23
(3,4)	3	3	10	22
(3,7)	8	4	10	19
(5,6)	10	2	13	13
(6,7)	4	4	23	23
(4,7)	2	1	13	25

Resource allocation EST;





Levelling

1st Priority → first allocate the resources for all critical activities (1-2-5-6-7)

2nd Priority → then allocate to the ~~paths~~ activities (on path with max^m duration, (1-2-3-7)

I st for critical path (1-2-5-6-7)

2 (4 times)	4-(9 times)	2-(10 times)	2-(4 times)	
(1,2)	(2,5)	(5,6)	(6-7)	CAs

II nd for (1-2-3-7)

2(~~dot~~ x4)	3(x6)	4(x8)	
(1-2)	(2-3)	(3-7)	II PR

III rd → 3-4, 2-4, 4-7

Resource levelling
- only one peak
- peak at middle
- CA first
- adjust

Un-Lim. → Sig. Res. → EST, LST, CA

Lim. → Sig. Res. → Series, Parallel

36
18
10
28
30
64
16

Allocation of Limited Resources

Limited Resources → max^m no of Resources/Activity is req.

Series method → Resources are allocated for complete duration of activity. → for bigger project ; → Project may get delayed

Parallel method → only for unit duration.
→ normally done for small project (smaller duration)
→ care can be taken for any CA generated.

Series method :

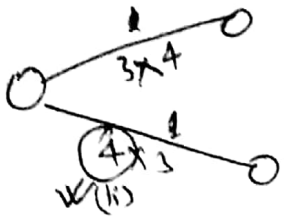
1st priority → activity with least total float

tie → i) with largest no. of resource days

resources req/day × duration

tie,

ii) activity with largest no. of resources/unit time.



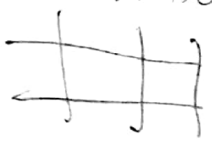
node no.

tie,

iii) activity with lower (i,j)

(if (1,2) & (1,4) → (1,3) ✓)

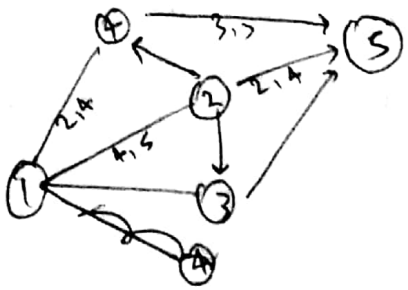
(horizontal then vertical)



Q. allocate min no of resources using series method.

Activity	Duration	Resource
(1,2)	4	5
(1,3)	2	6
(1,4)	2	4
(2,3)	3	5
(2,4)	2	3
(2,5)	2	4
(3,5)	3	3
(4,5)	3	3

Ans → 9 (from 8.7)

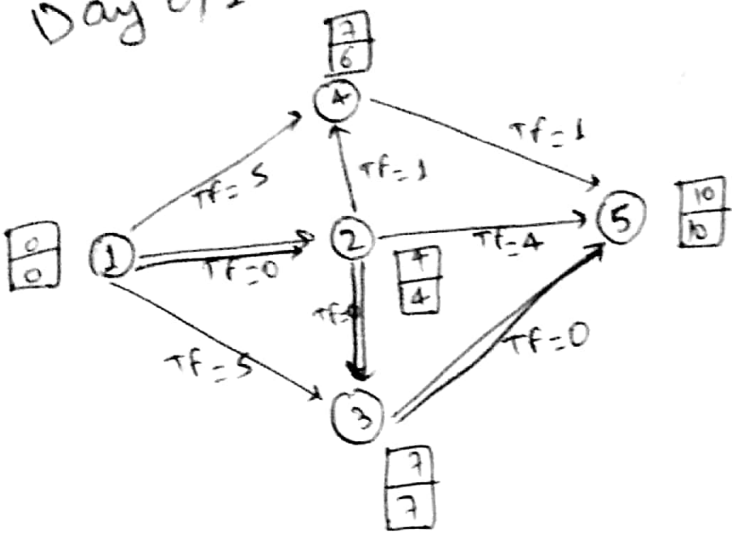


Total resource days / duration

$= \frac{87}{10} \approx 9$

87

Day 0/1



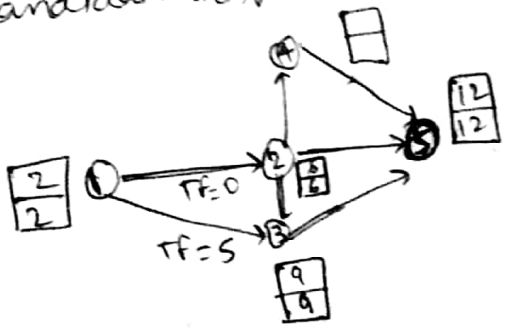
so, 9 resources,

1-2 → ① → Tf is least (=0) → 4 → 4 PR → 1, 2, 3

1-3 → ② { 2×6=12 ✓ } TF=5

1-4 → ③ { 2×4 }

Q candidate activities after 2-days; 1-2 & 1-3



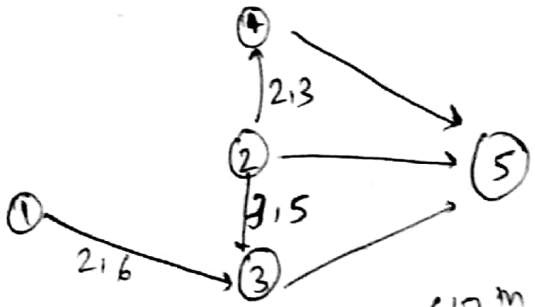
PR candidate activities after on 4/5th day (completion of 1-2)

② → 1-3 →

① → 2-3 → (TF=0) allocate 5 ⇒ 9-5 = 4 left

③ → 2-4 → allocate 3

④ → 2-5 →



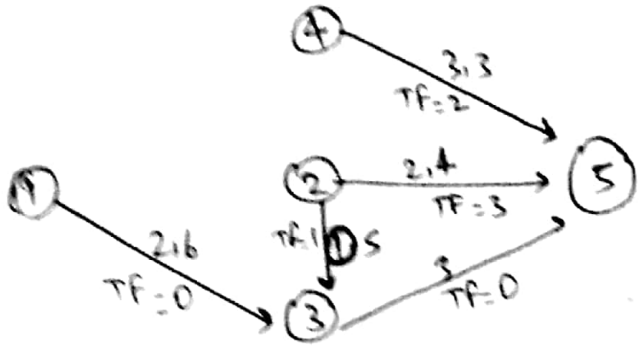
PR candidate activities after on 6/7th day (completion of 2,4);

① → 1-3

2-3

2-5

4-5



then completion of 2-3

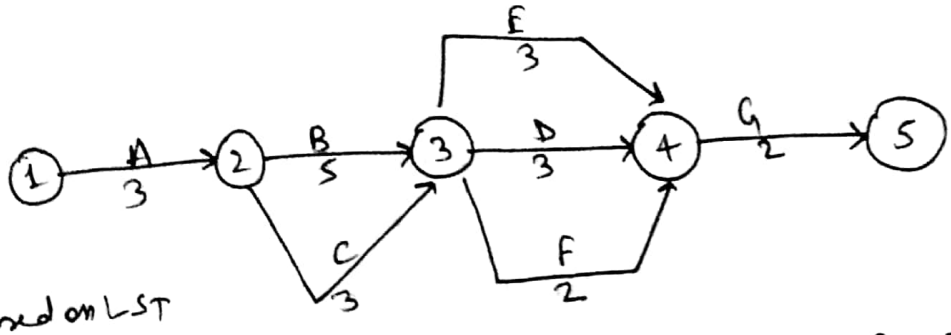
Parallel method (reviewed after each day)

→ TOP priority → activity with least TF

- tie → activity in progress → first
- tie → with largest no. of resource days
- tie → with largest no of resources per day
- tie → with lower (i,j) is allocated

MULTI-RESOURCE ALLOCATION

	Description	Duration	Beldars	Carpenters	Plumbers
A	Door/window fix	3	2	2	0
B	Glazing	5	2	0	0
C	White wash	3	4	0	0
D	Painting	3	2	0	0
E	Sanitary fittings	3	4	0	2
F	fitting of door/window	2	2	2	0
G	Site cleaning	2	6	0	0



Based on LST

Act	Duration	EST	1	2	3	4	5	6	7	8	9	10	11	12	13
A	3	0	2b	2b	2b										
			2c	2c	2c										
						2b	2b	2b	2b						
B	5	3				4b	4b	4b							
C	3	3										2b	2b	2b	
D	3	8													

Based on LST

for Resource levelling, other resources are also considered (like
↳ carpenters, boilers ....

Seates method

Beldars = $3\times2 + 2\times5 + 4\times3 + 2\times3 + 2\times2 + 6\times2 = 62/13 = \sim 5$;
max (5, 6) = 6

Carpenters = $2\times3 + 2\times2 = 10/13 = \sim 1$; max (1, 2) = 2
→ min^{m} no req. in given activities

Plumbers = $3\times2 = 6/13 \approx 1$; max (1, 2) = 2

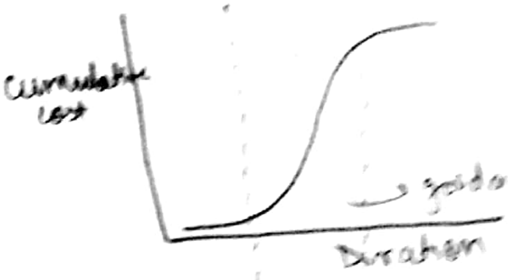
Beldars (B) = 6, carpenters (C) = 2, plumbers (P) = 2

* In limited resource, extra resources can be introduced only after analysing the indirect cost. → to complete earlier or on time

* in parallel method, project may be completed earlier also.

CASH FLOW

1. Activity
Monitoring



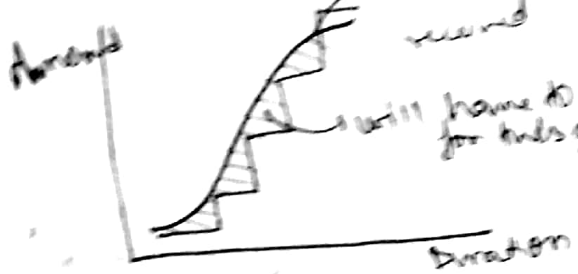
S-curve

→ fundamental of cash flow planning

→ over expenditure
→ mismanagement

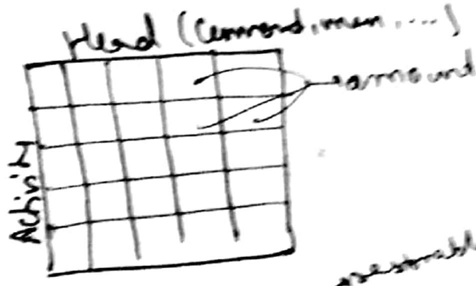
2. Contract → Client
→ Contractor

Terms & conditions

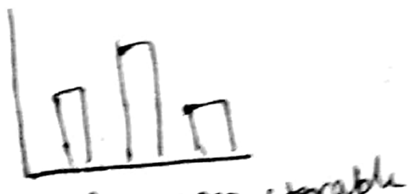


→ will have to pay interest for this amount if borrowed

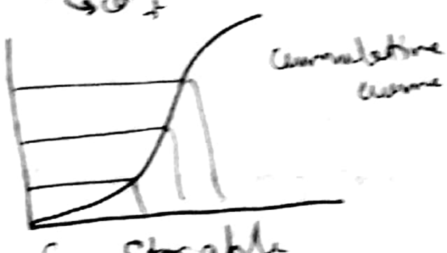
3.



⇒ Resources → Storable (Eg. money) → Histogram not suitable ; cumulative curve (as can be + used)
→ Non-storable (Eg. man) → can't be + used



for non-storable



for Storable

for S-curve → Draw barchart ⟶ Find cumulative cost ⇒ S-curve (after each week/day)

Conditions of contract

Contract → a advertisement (tender) → opening/closing date
→ Appx. cost

→ Tender document → diff. project related specifications
(Eg - length, width, type of material)
→ min^m cost (to be paid to purchase this doc.)

→ Earnest money
submit doc.'s

→ L1, L2, L3 (3-candidates) → Technical (if found suitable technically then only)
→ Econ

↳ Security money

→ take advance money + liquidity money → submit bills → money returned / some more handed over
→ liability period

if not his/her earnest money is returned

Cash

Sale of tenders: 1L : 150 ; 50L : 500 ; 2C : 1500

Earnest Money: assurance in form of cash ; submitted with bid & returned without interest after 1 week

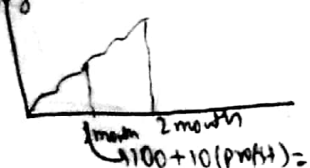
Item	Quantity (Kg/no/cum/sqm)	Total cost
1- Excavation		
a) hard rock - lead - 300m	1500 m	Rs 2,00,100.0
depth =	200 m	Rs 2 lacs & one hundred

Earnest money: 2 % of Total cost (10 Crore)
(contractor's money)
more than 10C → 1 % + 50L

Security deposit: - deposited with acceptance to sure that the work will be carried out as per specifications
- taken from the running money (5% of running bill)
- earnest money is part of security deposit

security money = retention money + Earnest money

5% of tendered money



1100 + 10 (profit) = 110

#[running bills are cumulative]

security money is paid after liability project (on basis of performance in 3-seasons of a yr.)

Performance guarantee: FDR (Fixed deposits), Bank guarantee, 5-10% of estimated cost

Liquidity damage: In case of delay in completion of the contract,
Rs 10 Lakh - 1% of contract value/week for all other works
0.5% of contract value per week of delay subject to a max^m of 10% of contract value.

BONUS: 1% of the contract value per month subject to a max^m of 5% of contract value.
(based on accelerated work)

(Problems on P. no. 205)

Q. retention = 5% to be paid to contractor after a month.
1st bill after 30 days & after that every month.
Retention money → to be released after 6 months of completion.
Annual interest rate is 15% on locked up capital
Calculate the total profit of contractor if he earns 10% profit on quoted cost.

Activity	Starting month	Duration (months)	Cost/month	cost	cum cost
A	0	2	45000	0.90	0.92
B	1	3	40000	1.2 L	2.1
C	3	1.5	1.2L	1.8 L	3.9
D	3	1	1.5L	1.5 L	5.4 L
E	3.5	1.5	40000	0.6 L	6 L
F	5	1	2L	2 L	8 L

Steps → Draw Bar chart with cost

Monthly value	45000	85000	~~120000~~ 40000	330000	100000	200000
Cumulative value	45000	130000	1.7L	5L	6L	8L
(Cumulative profit 10%)	4500	13000	17000	50000	60000	80000
Cumulative cost (bill)	49500	143000	187000	550000	660000	880000
Cumulative value less retention (5%)	47025	135850	177650	522500	627000	836000
Cum money received after 1 months	0	47025	135850	177650	522500	627000

836000 after 6 months

profit after 6 months = 880000

money retained after 6 months:

total profit = 880000 − 800000 − 17500 = 62500 (net profit)

area b/w 2 curves = interest to be paid

*max^m amount to be borrowed = max^m vertical diff b/w curves (expenditure − given)

Finance area (area blw cash in & cash out) ← Simple interest
$= 14 \times 10,000 \times 15 / (100 \times 12) = 17500$
↳ 4 years (if quarterly → 1/4)

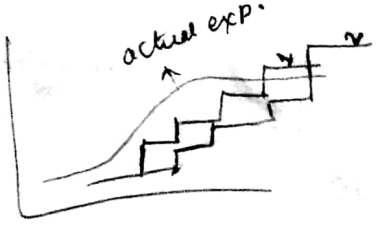
8. Contractor 1 : payment after 1 month
Retention money after 6 months of completion
Retention amount 8%.

Contractor 2 : payment after 2 months
Retention money with last running bill
Retention amount = 10%.

	1	2	3	4	5	6	7	8	9
Value/month (in crores)	2	3	4	8	9	8	5	6	8
% profit	10	12	10	15	12	10	8	10	10

Value/month	2	3	4	8	9	8	5	6	8	
Cum. value	2	5	9	17	26	34	39	45	53	
Profit/month	0.2	0.36	0.4	1.2	1.08	0.8	0.4	0.6	0.8	
Cum. profit	0.2	0.56	0.96	2.16	3.24	4.04	4.44	5.04	5.84	
Cum. cost	2.2	5.56	9.96	19.16	29.24	38.04	43.43	50.04	58.84	✓
Cum. cost - retent. (cost·2) (10%)	1.98	5.004	8.964	17.244	26.316	34.236	39.087	45.036	52.956	
Bill amount (value + profit)	2.2	3.36	4.4	9.2	10.08	8.8	5.4	6.6	8.8	
cont. 1 Cum. cost - retent (8%)	0	2.024								
Pay 1	0	2.02	5.12	9.16	12.63	26.90	34.99	39.96	46.04	56.49	58.84
Pay 2	0	0	1.98	5.00	8.96	17.24	26.32	34.24	39.10	45.04	58.8

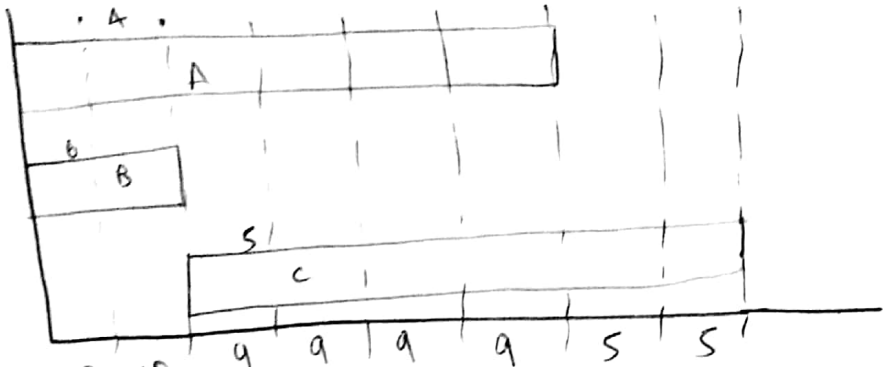
Diff. → 0 | 2.02 | 3.14 | 4.16 | 8.07 | 9.65 | 8.68 | 5.73 | 6.94 | 11.45 | -2.35 | -2.35 | -2.35 | -2.35 | -2.35 | 0 | / 4....



Q.

	cost	Profit	Duration
A	4/m	10%	6
B	6/m	8%	2
C	5/m	4%	6

→ 44
→ 648
→ 520



	10	10	9	9	9	9	5	5
Cum. val	10	20	29	38	47	56	61	66
Billing	10.88	10.88	9.60	9.60	9.60	9.60	5.20	5.20
	10.88	21.76						

S-Curve

Budget values → (profit of contractor is included)

Activity	Cost (×10³)	Week started	Duration (weeks)
A	141	0	15
B	171	4	18
C	195	15	21
D	98	22	24
E	161	23	25
F	122	12	24
G	66	12	36

Total = 954

Activity / Heads	1 materials	2 Labour	3 travel	4 salary	5 Supervision	6	7	8	Total (rs)
A	112	—	—	—	—	—	—	29	141
B	—	30	—	72	—	34	—	35	171
C	—	48	—	79	—	28	—	40	195
D	—	20	—	42	—	30	—	6	98
E	—	30	—	54	—	43	—	34	161
F	30	—	32	—	20				

Draw bar chart → calculative cum. cost.

Progress report at the end of week 32 (field Report)

Activity	Date started	Projected completion week ending	Completed (%)	As per planned completed (%)
A	1	15	100	100
B	4	22	100	100
C	15	36	100	81

Cumulative

Budget

monthly

cum.

value (value cost of that activity)

higher is better ⇒ more effectively that activity was performed

Actual