

Principle of Management System

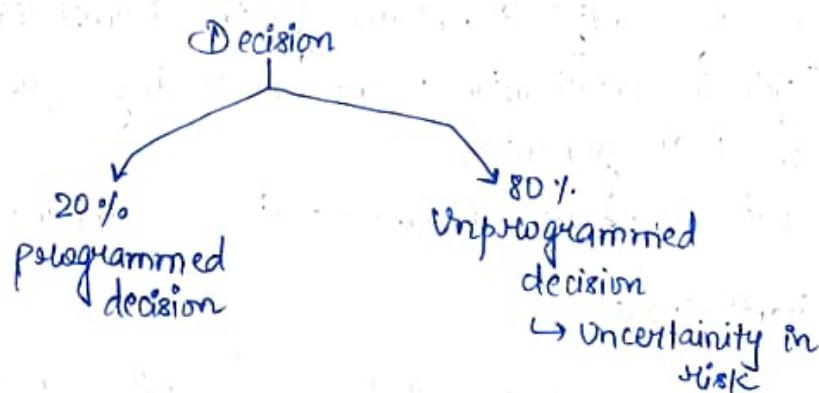
→ Key factors of any organization:

- Planning
- Organizing
- Staffing
- Directing
- Motivating
- Controlling

→ When a manager changes, policies might change, but the rules of management do not change.

→ Any project involves resources, money, time and efficient planning.

Primary function of manager : Decision making



Management:

① Pre-industrial Revolution Era:

↳ Before industrial revolution, agriculture and related sectors were main occupation.

$$\text{Variety} \uparrow \Rightarrow \frac{\text{Volume}}{\cancel{\text{Variety}}} \downarrow$$

↳ e.g., craft production

↳ Industrial revolution: variety ↓, volume ↑

↳ Everyone had land of their own.

② Industrial Revolution Era: Till late 1700

↳ Machines started replacing humans.

↳ Conquering of land started (building of factories).

↳ Rich started becoming richer.

↳ Trade union started arising for the poorer to enquire their grievances.

③ Scientific Management Phase: Late 1800

↳ Use of scientific techniques for the industrial revolution.

↳ Taylor's contribution in the questioning of use of science for management.

④ Operation Research + Quantitative Techniques: Late 1900

Gantt chart

⑤ Computer Integrated and Automated Phase: Till late 1980s

↳ Computer started coming into play.

↳ Evolution: $\frac{\text{Vacuum}}{\text{Tube}}$ → Transistor → ICs

↳ Automation of things

Management and Administration:

Management ? same;
 Administration but the level of work is different
 ↳ policy formation process initial stages.

Strategic

↳ policy formation process

Initial stages.

→ used interchangeably during initial stages.

High
Medium
Low

Tactic
Operational level

High
Medium
Low

Function of management

→ Oliver Sheldon raised terminological conflict in his seminal book 'The Philosophy of Management'.

↳ Admin. → decision making
 Manage. → execution function

Schools of Thought:

- ① Administration is above management.
- ② Management is part of administration.
- ③ Management and administration are the same.

Management is science → Scientific Management.

→ Management is 'pseudo science' or 'inexact science'.

→ Management requires experience, know-how, intuition.

→ Management is Art.

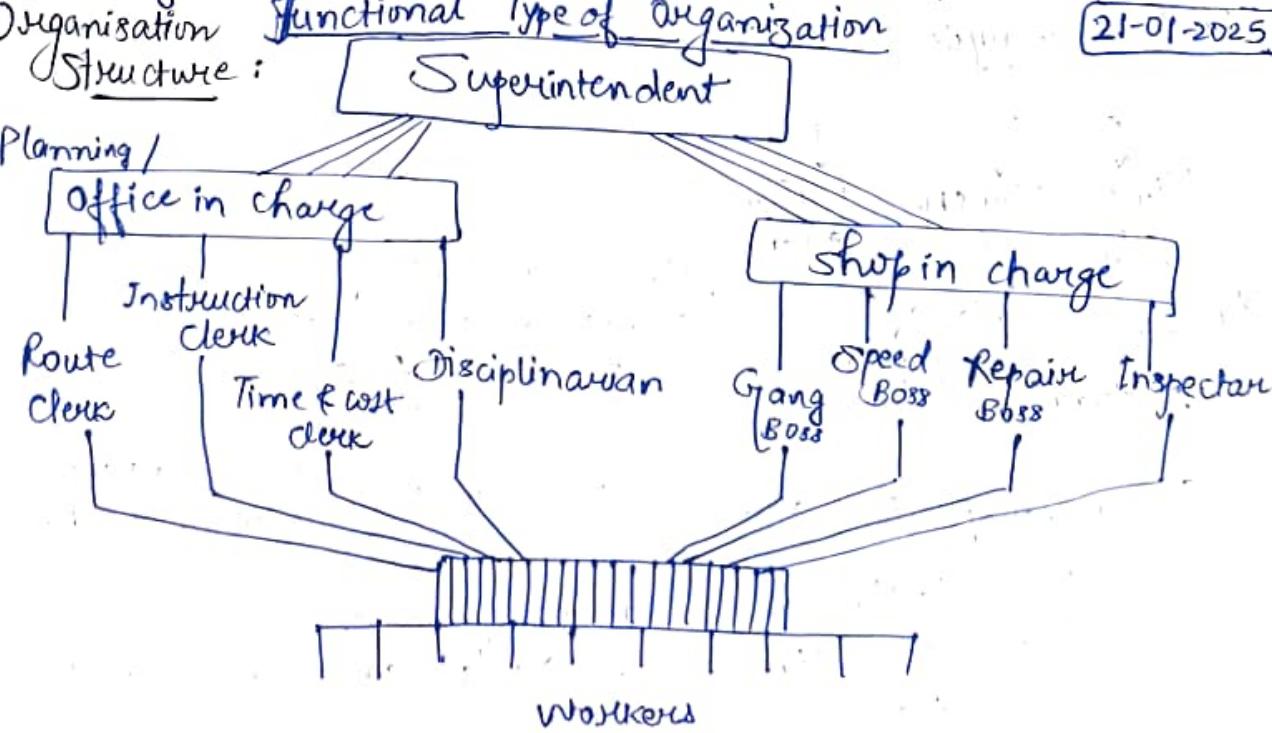
Arthashastra

↳ Tax people like bees extract nectar from flowers.
 ↳ satisfies both

Functional Type of Organization

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Structure:

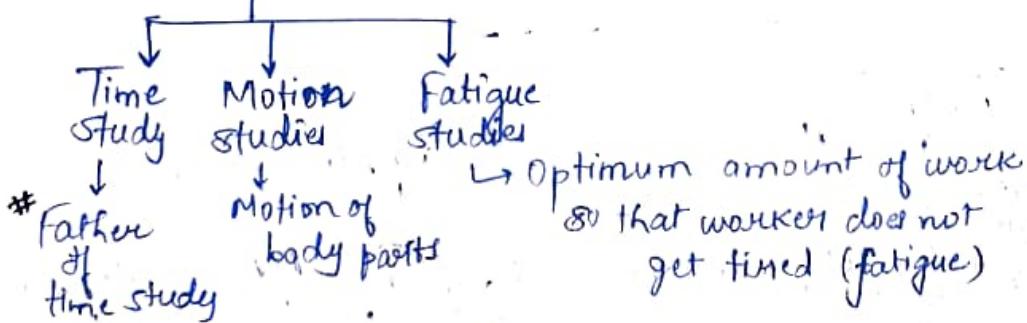


- Time a person takes to do the work : standard time
- Approximate method : Rule of 72
Investment doubles in $\frac{72}{r\%}$ years, if invested with $r\%$ /year.
- Duty of Managing:
- ① → Route clerk: Provides work plan (routing of materials in factories)
- ② → Instruction clerk: Gives instruction (how to operate equipment)
- ③ → Time & cost cleric: Look over timing of work and cost.
- ④ → Disciplinarian: Maintains discipline.
 - | office-in-charge:
↳ exclusively planning of operations.
- ① → Gang Boss: Keeps everything ready before the work starts.
- ② → Speed Boss: Work pace.
- ③ → Repair Boss: Repairs equipments.
- ④ → Inspector: Maintains quality check.

Unity of command: A person should receive a command from a single boss.

Scientific Management by Frederick Taylor: Principles

- ① Separation of planning and doing.
- ② functional type of organization (functional formanship)
- ③ Job analysis



↳ Optimum amount of work
so that worker does not
get tired (fatigue)

- ④ Standardization ↳ important b/c if things stop working, can use other std. parts.
- ⑤ Scientific selection and training of workers
- ⑥ Financial incentives ↳ for people going above std. time.
↳ Differential wage system

⑦ Economy

↳ Reduce cost at every point of time.

⑧ Mental Relaxing / Mental Revolution

↳ Mutual cooperation b/w management and workers

↳ Productivity ↑↑

Profit ↑↑

↳ Wrote book "Principle of Scientific Management" in 1911.

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Inventory

Economic order quantity: Minimizing the ordering and holding cost of inventory.

Operation Research: Research in the military.

↳ Developed faster after the war.

↳ Art of taking good decision in mathematical ways.

↳ Art of taking bad answers by which otherwise we will get worst answer.

PMS Blackett

↳ Took multi-disciplinary approach to (war) management (in UK)

Principles of Scientific Management:

① Science, not rule of thumb (estimation)

② Harmony in group action (not discord)

③ Cooperation ~~etc~~, not Individualism

④ Maximum output in case of restricted output

↳ Continuous increase in productivity (no inefficiency and deliberate curtailment).

⑤ Development of workers to their fullest efficiency.
(by scientific selection and training).

Linear Programming

Eg. Consider a manufacturer making two products A and B.

Two resources R_1 and R_2 are required to make the products.

Each unit of product A requires one unit of R_1 and 3 units of R_2 .
each unit of product B requires one unit of R_1 and 2 units of R_2 .

The manufacturer has 5 units of R_1 and 12 units of R_2 available. The manufacturer makes a profit of £ 6/unit of product A sold and £ 5/unit of product B sold.

Formulate the above as linear programming problem to solve for the no. of products A and B sold for maximizing his profit.

Sol:

	R_1	R_2	Profit
A	1	3	6
B	1	2	5

Available: 5 12

Let x_1 be the no. of units of product A to be produced.

Let x_2 be

$$\text{Maximize } Z = 6x_1 + 5x_2 \quad \} \text{② Objective function}$$

$$\text{Subject to } x_1 + x_2 \leq 5$$

$$3x_1 + 2x_2 \leq 12, \quad \} \text{③ constraints of the problem}$$

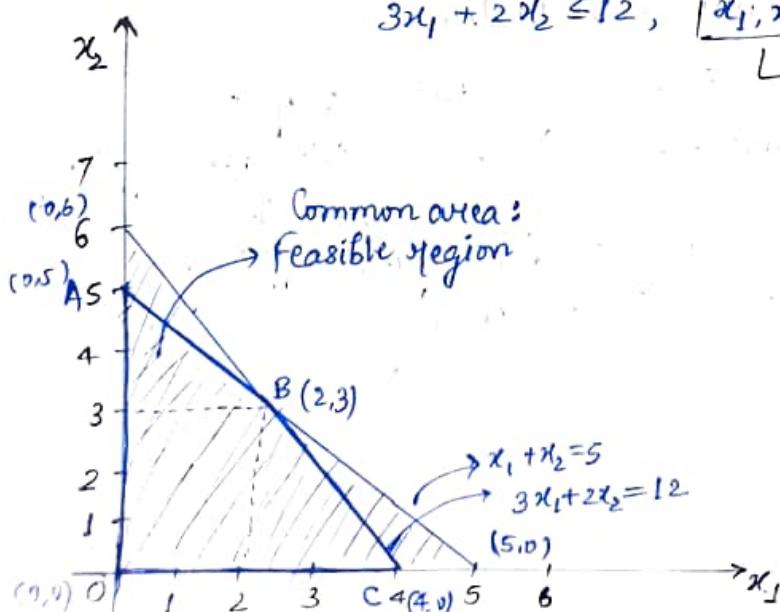
① Decision variables

② Objective function

③ constraints of the problem

④ Non-negativity restriction

→ Solution lies along the corner point.



Point	Coordinate	Z-value
O	(0,0)	0
A	(0,5)	25
B	(2,3)	27 ✓
C	(4,0)	24

→ 2 units A, 3 units of B.

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Graphical method → not feasible for more than 2 variables.
Algebraic Method:

$$\text{Maximize } 6x_1 + 5x_2 + 0s_1 + 0s_2$$

$$\text{Subject to } x_1 + x_2 + s_1 = 5$$

$$3x_1 + 2x_2 + s_2 = 12$$

$$x_1, x_2, s_1, s_2 \geq 0.$$

| s_1, s_2 : slack variables

$$\left(\begin{array}{ccc|cc} x_1 & x_2 & s_1 & s_2 \\ 1 & 1 & 1 & 0 \\ 3 & 2 & 0 & 1 \end{array} \right) \quad \text{identity matrix}$$

4 variables } Make 2 variables 0
 2 equations }

| m^n variables
 C_n solutions possible
 constraint

↪ $4C_2 = 6$ solutions possible.

Sl. No.	Fixed variables	Solve for	Z-value
1	$x_1 = x_2 = 0$	$s_1 = 5, s_2 = 12$	$Z = 0$
2	$x_1 = s_1 = 0$	$x_2 = 5, s_2 = 2$	$Z = 25$
3	$x_1 = s_2 = 0$	$x_2 = 6, s_1 = -1$	Infeasible solution
4	$x_2 = s_1 = 0$	$x_1 = 5, s_2 = -3$	Infeasible solution
5	$x_2 = s_2 = 0$	$x_1 = 4, s_1 = 1$	$Z = 24$
6	$s_1 = s_2 = 0$	$x_1 = 2, x_2 = 3$	$Z = 27$

→ Not feasible
 ($\because s_2 < 0$)

↪ Non-Basic Variables

↪ Basic Variables = no. of constraints

Manager performing works:

→ Value added activity: Actual work

→ Non-value added activity: Waiting for equipments, meeting, discussion, strike.

Simplex Method :

- ↳ Not give infeasible solution
- ↳ Progressively give better results.
- ↳ Signals when the result is calculated.

Mathematics behind simplex Method :

Iteration - 1:

$$\text{Maximize } 6x_1 + 5x_2$$

$$\text{s.t. } x_1 + x_2 \leq 5$$

$$3x_1 + 2x_2 \leq 12$$

$$x_1, x_2 \geq 0$$

$$\text{Maximize } 6x_1 + 5x_2 + 0s_1 + 0s_2$$

$$\text{s.t. } x_1 + x_2 + s_1 = 5$$

$$3x_1 + 2x_2 + s_2 = 12$$

x_1, x_2 : Non-basic

s_1, s_2 : Basic

Write basic in
form of non-
basic variables

$$\left\{ \begin{array}{l} s_1 = 5 - x_1 - x_2 \dots \textcircled{1} \quad (x_1 \text{ limited by } 5) \\ s_2 = 12 - 3x_1 - 2x_2 \dots \textcircled{2} \quad (x_2 \text{ limited by } 6) \end{array} \right.$$

$$Z = 6x_1 + 5x_2$$

$$x_1 = x_2 = 0 \Rightarrow s_1 = 5, s_2 = 12 \Rightarrow Z = 0$$

Increase $Z \Rightarrow$ Increase x_1

Iteration - 2:

$$s_2 = 12 - 3x_1 - 2x_2$$

$$\Rightarrow 3x_1 = 12 - 2x_2 - s_2$$

$$\Rightarrow x_1 = 4 - \frac{2}{3}x_2 - \frac{1}{3}s_2 \dots \textcircled{3}$$

(x_2 limited by 6)

x_1, s_1 : basic

x_2, s_2 : Non-basic

Substitute x_1 in eqn ①,

$$s_1 = 5 - x_1 - x_2$$

$$\Rightarrow s_1 = 5 - (4 - \frac{2}{3}x_2 - \frac{1}{3}s_2) - x_2$$

$$\Rightarrow s_1 = 1 - \frac{1}{3}x_2 + \frac{1}{3}s_2 \quad \dots \textcircled{4} \quad (x_2 \text{ limited by 3})$$

$$Z = 6x_1 + 5x_2$$

$$= 6(4 - \frac{2}{3}x_2 - \frac{1}{3}s_2) + 5x_2$$

$$= 24 + 2x_2 - 2s_2$$

$$Z \uparrow \Rightarrow x_2 \uparrow$$

Iteration-3:

$$s_1 = 1 - \frac{1}{3}x_2 + \frac{1}{3}s_2$$

$$\Rightarrow x_2 = 3 - 3s_1 + s_2 \quad \dots \textcircled{5}$$

Put x_2 in eqn ③,

$$x_1 = 4 - \frac{2}{3}x_2 - \frac{1}{3}s_2$$

$$\Rightarrow x_1 = 4 - \frac{2}{3}(3 - 3s_1 + s_2) - \frac{1}{3}s_2$$

$$\Rightarrow x_1 = 2 + 2s_1 - s_2$$

$$Z = 6x_1 + 5x_2$$

$$= 6(2 + 2s_1 - s_2) + 5(3 - 3s_1 + s_2)$$

$$= 12 + 12s_1 - 6s_2 + 15 - 15s_1 + 5s_2$$

$$\therefore Z = 27 - 3s_1 - s_2.$$

limiting value = 27.

Maximize

$$Z = 6x_1 + 5x_2$$

$$\text{s.t. } x_1 + x_2 \leq 5$$

$$3x_1 + 2x_2 \leq 12$$

$$x_1, x_2 \geq 0$$

$$\text{Maximize } Z = 6x_1 + 5x_2 + 0.s_1 + 0.s_2$$

$$\text{s.t. } x_1 + x_2 + s_1 = 5$$

$$3x_1 + 2x_2 + s_2 = 12$$

$$x_1, x_2, s_1, s_2 \geq 0$$

(x₁, x₂, s₁, s₂) ← Initial basic feasible solution

pivot element
↳ intersection of
pivot row and
pivot column

		B	C	x ₁	x ₂	s ₁	s ₂	RHS	$\theta = \frac{\text{RHS}}{\text{pivot column}}$
		s ₁	0	1	1	1	0	5	
		s ₂	0	3	2	0	1	12	4 (lowest leaves)

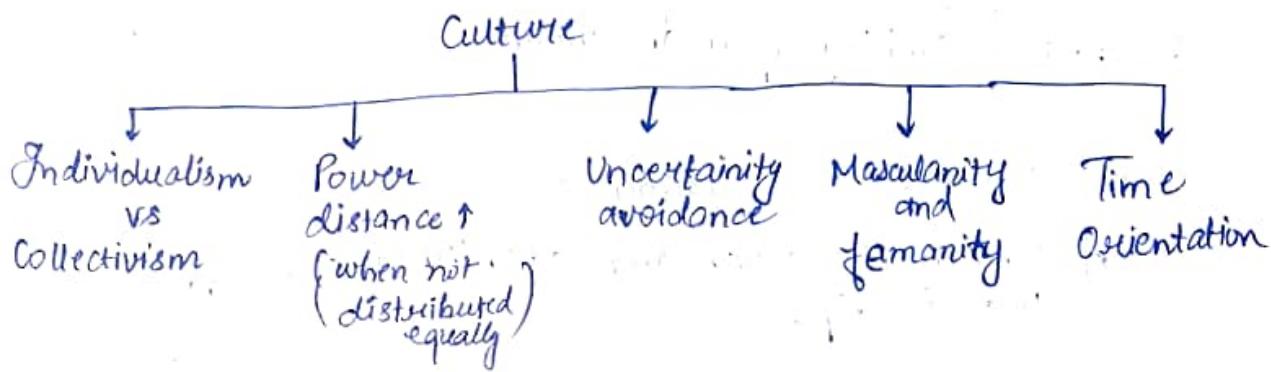
		B	C	x ₁	x ₂	s ₁	s ₂	RHS	
Iteration -1		s ₁	0	1	1	1	0	5	
		s ₂	0	3	2	0	1	12	4 (lowest leaves)
		c _j	6	5	0	0	0		
		Z _j	6 = (6/3) * 1	5	0	0	0		
		A _j	6 = (6/3) * 2	0	2	1	-1	1	
		s ₁	0	0	0	1	-1/3	1	
		x ₁	6	1	2/3	0	1/3	4 → (s ₂ ÷ 3)	6

		B	C	x ₁	x ₂	s ₁	s ₂	RHS	
Iteration -2		s ₁	0	1	2/3	0	1/3	4 → (s ₂ ÷ 3)	6
		x ₁	6	1	2/3	0	1/3		

		B	C	x ₁	x ₂	s ₁	s ₂	RHS	
Iteration -3		s ₁	1	0	0	0	0		
		x ₂	5	0	1	3	-1	3	→ (s ₁ ÷ p.e.)
		x ₁	6	1	0	-2	1	2	→ (x ₁ - x ₂ × 2/3)
		c _j	6	5	0	0	0		
		Z _j	6 = (6/1) * 1	5	3	1			
		A _j	6 = (6/1) * 0	0	0	-2	-1		
		s ₁	1	0	0	0	0		
		x ₂	5	0	1	3	-1	3	
		x ₁	6	1	0	-2	1	2	
		c _j	6	5	0	0	0		
		Z _j	6 = (6/1) * 1	5	3	1			
		A _j	6 = (6/1) * 0	0	0	-2	-1		
		s ₁	1	0	0	0	0		
		x ₂	5	0	1	3	-1	3	
		x ₁	6	1	0	-2	1	2	
		c _j	6	5	0	0	0		
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		A _j	6 = (6/1) * 0	0	0	-2	-1		
		s ₁	1	0	0	0	0		
		x ₂	5	0	1	3	-1	3	
		x ₁	6	1	0	-2	1	2	
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		x ₂	5	0	1	3	-1	3	
		x ₁							

Universality of Management

- ↳ Things working in one institution may or may not work in the other.
- According to Hofstede (Dutch scholar), culture has five dimensions.



12-02-2025

Fayol's Administrative Management

- ↳ Published book: 'Administration Industrielle et Générale' in French in 1916.
- ↳ Looked at problems of managing an organization from the top management point of view.
- ↳ Preferred the use of term 'administration' instead, ~~for~~ emphasizing unity of science and administration.
- Activities in an industrial management:
 - ① Technical
 - ② Commercial
 - ③ Financial
 - ④ Security
 - ⑤ Accounting
 - ⑥ Managerial (planning, organization, command, coordination and control)
 - ↓ changed to lead (today)
- Managerial qualities and training:
 - ① Physical (health, vigour and address)
 - ↳ active

- ② Mental (ability to understand and learn, judgement)
- ③ Moral (energy, firmness, initiative, loyalty, tract and dignity)
- ④ Educational (general acquaintance with matters not belonging exclusively to the function performed).
- ⑤ Technical (peculiar to the function being performed)
- ⑥ Experience (arising from the work).

General principles of management:

↳ A fundamental truth and established cause-effect relationship.

Arguments for universality of Management:

- ① Functions of management (planning, organizing, staffing, directing and controlling) are needed for every organization irrespective of country, culture or size, etc. → Universally applied
- ② Management fundamental: Basic principles and theories on which an organization work.
Management techniques: Tools available to managers for performing managerial functions.
↳ Specific management techniques may differ from country to country as per situation, while managerial fundamentals remain the same. → Proper distinction b/w the two terms.
- ③ Management fundamentals remain the same, practice of them may vary differ according to the nature of organizations.

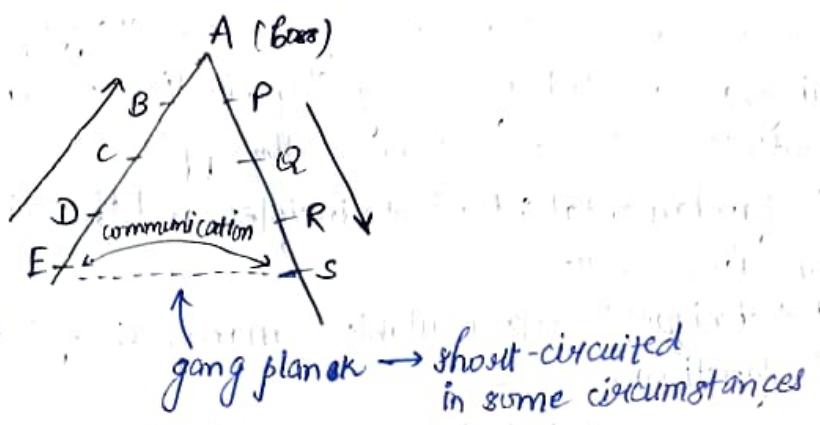
Arguments against universality of Management:

- ① Management is culture bound and its application are determined by culture prevailing in that particular place.
- ② Every org. has unique philosophy of doing business and thus requires different kinds of management principles.
- ③ Objectives of an enterprise determine the type of manag. required.

Fayol's administrative management principles

- ① Division of labour → specialized people should work in a particular task.
- ② Authority and responsibility
- ③ Discipline
- ④ Unity of command
- ⑤ Unity of direction
- ⑥ Subordination of individual interest to general interest.
- ⑦ Remuneration of personnel
- ⑧ Centralization

⑨ Scalar chain



- ⑩ order → Arrangement of things and people
 - ↳ Right man in right place
- ⑪ Equity → Justice + Kindness
- ⑫ stability of tenure → security of jobs
- ⑬ Initiative → Thinking out and execution of a plan.
- ⑭ Esprit de corps (Union is strength)
 - ↳ Synergy

Bureaucratic Type of Organization

- ↳ Proposed by Max Weber, a German sociologist.
- ↳ Three types of power in organization:
 - Traditional, charismatic and bureaucratic.

power passed on by heredity	a leader comes out naturally	best one; equal opportunity for everyone
-----------------------------------	------------------------------------	------------------------------------------------
- ↳ Authority is based on the position rather than the person who occupy it.
- ↳ A ~~bureaucratic~~ organization has high complexity, high formalization and high centralization.
- Division of labour: Each person's job is broken down into simple, routine and well-defined tasks.
- Well-defined authority hierarchy:

A multi-level hierarchical formal organization structure with well-defined authority exists in a bureaucratic organization with each of lower offices under the control and supervision of a higher one.

Formal guides to behaviour:

Formal policies, rules and procedures are followed to ensure uniformity and to regulate the behaviour of people in the organization.

Impersonal nature: Decision are governed by rational factors than personal factors.

Employee decisions based on merit:

Selection and promotion of employees are based on education, experience and other qualifications of the candidates.

Social Systems Approach

- ↳ Synthesized by Chester Bernard.
 - ↳ According to him, an organization is a cultural system composed of people working in co-operation.
 - ↳ Defined formal organization as a system of consciously coordinated activities of 2 or more persons.
- ↳ Both formal and informal org.s co-exist in an enterprise.
 - ↳ ~~Informal~~ Informal organization exists to overcome the problems of formal organization.
- ↳ organisational equilibrium: Matching of individual efforts and organizational efforts to satisfy individuals.
 - ↳ Depends on individuals, org., and society.

Decision Theory Approach

- ↳ Herbert Simon → imp. contributor.
- ↳ Management is decision making.
- ↳ Members are decision makers and problem solvers.
- ↳ Organization as ~~various~~ combination of various decision centres.
- ↳ Quality of decision affects organizational effectiveness.
- ↳ Described organization as a complex network of decisional processes all pointed towards their influence upon the behaviour of the operatives.
- ↳ Advocated for bounded rationality.
- ↳ Administrative man as the model of decision making.
- ↳ Communication in organization:
 - ↳ 3 stages:
 - Initiation
 - Transmittal
 - Receipt of information.
 - ↳ Blockade of information → overcome by informal comm.

Assignment Problems : Hungarian Method

(18-02-2025)

	M ₁	M ₂	M ₃	M ₄
P ₁	15	13 ✓	14	17
P ₂	11 ✓	12	15	13
P ₃	13	12	10 ✓	11
P ₄	15	17	14 ✓	16

time (hours) \Rightarrow Minimize

M_i : Managers

P_i : Projects

\rightarrow Add dummies rows/columns, if it is not a square matrix.

man hour \rightarrow One manager cannot take more than one project.

Row Reduction:

	M ₁	M ₂	M ₃	M ₄
P ₁	2	0	1	4
P ₂	0	1	4	2
P ₃	3	2	0	1
P ₄	1	3	0	2

\rightarrow Get max zeros.

\rightarrow Ensure that there is a zero in each row and each column

\rightarrow ~~Get max~~

Column Reduction:

	M ₁	M ₂	M ₃	M ₄
P ₁	2	0	1	3
P ₂	0	1	4	1
P ₃	3	2	X	0
P ₄	1	3	0	1

$\square \rightarrow$ Allocated

P₁ \rightarrow M₂

P₂ \rightarrow M₁

P₃ \rightarrow M₄

P₄ \rightarrow M₃

\therefore Total 49 man hours.

Eg.

	M ₁	M ₂	M ₃	M ₄
P ₁	12 ✓	30	21	15
P ₂	18	33	9 ✓	31
P ₃	44	25	21 ✓	21
P ₄	14 ✓	30	28	19 ✓

\rightarrow

0	18	9	3
9	24	0	22
23	4	0	0
0	16	14	0

\rightarrow

0	14	9	3
9	20	0	22
23	0	X	X
X	12	4	0

\therefore Total man hours = 60

19-02-2025

Ex-

	M ₁	M ₂	M ₃	M ₄
P ₁	8	6	2	4
P ₂	6	7	11	10
P ₃	3	5	7	6
P ₄	5	10	12	9

Row reduction:

	M ₁	M ₂	M ₃	M ₄
P ₁	6	4	0	2
P ₂	0	1	5	4
P ₃	0	2	4	3
P ₄	0	5	7	4

Column reduction:

	M ₁	M ₂	M ₃	M ₄
P ₁	6	3	0	4
P ₂	0	1	5	2
P ₃	0	1	4	1
P ₄	0	4	7	2

L₃ trace

②

Unallocated
(mark & check)(mark '0'
while tracing
& check 2
then trace along column
and mark & check ③)Draw line through unmarked rows
and marked columnsGiven the minimum no. of lines
passing through all zeros.

(less than order of the matrix)

Case-I: +8

Case-II: No change

Case-III: | No change

Case-IV: No line -8

→ Lowest of uncovered cells : S = 1

	M ₁	M ₂	M ₃	M ₄
P ₁	7	3	0	4
P ₂	1	0	5	2
P ₃	0	0	3	0
P ₄	0	3	6	1

P₁ → M₃P₂ → M₂P₃ → M₄P₄ → M₁

∴ Total man hours = 20.

	A	B	C	D	E	F
P ₁	12	10	15	22	18	8
P ₂	✓ 10	18	25	15	16	12
P ₃	11	10	3 ✓	8	5	9
P ₄	✓ 6	14	10	13	13	12
P ₅	8	12	11	✓ 7	13	10
P ₆	0	0	0	0	0	0

→ Add a row to make square matrix.

↓
Row and column reduction:

	A	B	C	D	E	F
P ₁	4	2	7	14	10	0
P ₂	0	8	15	5	6	2
P ₃	8	7	0	5	2	6
P ₄	✓ 0	8	4	7	7	6
P ₅	1	5	4	0	6	3
P ₆	✓ 0	✓ 0	✓ 0	✓ 0	✓ 0	✓ 0

②

$\delta = 2$: lowest/least value of uncovered cells

✓① → 4th row unallocated

↓ Trace along 4th row

↓ Mark ✓② column with first zero & trace col-I.

↓ Mark ✓③ row with allocated zero

↓ Draw line across unmarked rows and marked columns

✓① → 4th row unallocated

↓ Trace along 4th row

↓ Mark ✓② & 1st column with zero

↓ Mark ✓③ 2nd row with allocated zero

↓ Trace across 2nd row & find allocated zero
1st column already marked; mark 6th column

P₁ → B

P₂ → F

P₃ → C

P₄ → A

P₅ → D

(E didn't get any project)

	A	B	C	D	E	F
P ₁	6	2	7	14	10	0
P ₂	0	6	13	3	4	✓ 0
P ₃	✓ 0	7	0	5	2	6
P ₄	✓ 0	6	2	5	5	4
P ₅	3	5	4	0	6	3
P ₆	2	✓ 0	✓ 0	✓ 0	✓ 0	✓ 0

$\delta = 2$

	A	B	C	D	E	F
P ₁	6	0	5	12	8	✓ 0
P ₂	✓ 0	4	11	1	2	✓ 0
P ₃	12	7	0	5	2	8
P ₄	✓ 0	4	0	3	3	✓ 0
P ₅	5	5	9	0	6	5
P ₆	4	0	✓ 0	✓ 0	✓ 0	2

Total man hours = 38.

Ex.

	T ₁	T ₂	T ₃	T ₄	T ₅
W ₁	32	26 ✓	35	38	40
W ₂	27	24 ✓	26	32	35
W ₃	28	22 ✓	31	34	37
W ₄	10 ✓	10 ✓	17	16	22
W ₅	11	7 ✓	14	16	21

↓

	T ₁	T ₂	T ₃	T ₄	T ₅
W ₁	6	0	9	12	14
W ₂	3	0	2 ✓	8	11 ✓
W ₃	6	0	9	12	15
W ₄	0	0	7	6 ✓	12
W ₅	4	0	7	9	14

↓

	T ₁	T ₂	T ₃	T ₄	T ₅
W ₁	6	0	7	6	3 ✓④
W ₂	3	✗	0	2	0
W ₃	6	✗	7	6	4 ✓①
W ₄	0	✗	5	✗	1
W ₅	4	✗	5	3	3 ✓②

✓③

 $\delta = 3$

↓

	T ₁	T ₂	T ₃	T ₄	T ₅
W ₁	4	✗	4	4	0
W ₂	3	3	0	2	✗
W ₃	3	0	4	3	1
W ₄	0	3	5	0	1
W ₅	2	✗	2	0	✗

✓①, ✓② → 3rd & 5th row unallocated
 ↓
 Trace along row
 ↓
 Mark ✓③ column with unallocated zero
 ↓
 Mark ✓④ row with allocated zero
 ↓
 Line through unmarked rows & marked columns

+ + s

- } No change

No line → -s

$W_1 \rightarrow T_5$
 $W_2 \rightarrow T_3$
 $W_3 \rightarrow T_2$
 $W_4 \rightarrow T_1$
 $W_5 \rightarrow T_4$
}

Total hours = 114

Eg.

	N	S	E	W
M ₁	16	10	14	11
M ₂	4	11	15	11
M ₃	15	15	13	12
M ₄	13	12	14	15

[Minimization B, unless until specified]

→ Maximize the sales

↳ Convert to minimization problems by multiplying each value by (-1).

OR

Take highest and subtract others from it.

	N	S	E	W
M ₁	0✓	6	2	5
M ₂	2	5	1✓	1✓
M ₃	✓	1	3	4
M ₄	3	4	2	1✓

↓ Row 3-4

	N	S	E	W
M ₁	0	6	2	5
M ₂	1	4	0	✗
M ₃	✗	0	2	3
M ₄	2	3	1	0

M₁ → N } Total sales
 M₂ → E.
 M₃ → S
 M₄ → W = 61

↓ Proceed as prev.

PLANNING

18-03-2025

Forecasting: Involves historical data; sees seasonings, trends.

Prediction: Involves intuition.

~~Plan~~

→ Forecasting involves error : Error ↓ ⇒ Prediction ↑

Levels of planning:

Top : Long-range planning (1-15 years)
↳ Strategic level

Middle : Middle-range planning (1-5 years)
↳ Tactical level

Lower : Short-range planning (upto 1 year)-
↳ Operational level.

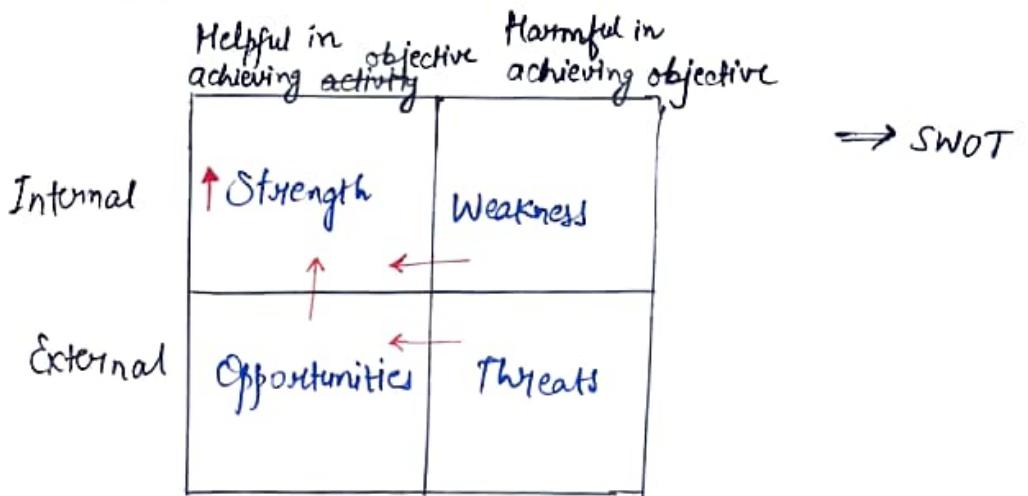
What → What should be done?

Why → Why should it be done?
When

How

Where

Who



Customer: Usually external to the organization.
↳ Also internal in production.

PEST Analysis

↳ Political, Economical, Social, Technological
→ PESTLE
↓
Legal Ethical

Eg. $3x_1 + 2x_2 + x_3 \geq 18$ (Greater than constraint)

$$\Rightarrow 3x_1 + 2x_2 + x_3 - s_1 + A_1 = 18$$

$\begin{matrix} \text{Surplus variable} \\ \downarrow \text{cannot form identity matrix} \end{matrix}$ $\begin{matrix} \text{Artificial variable} \\ \text{(of very large coefficient)} \end{matrix}$

Eg. $x_1 + 2x_2 + x_3 = 10$ (Equal to constraint)

$$\Rightarrow x_1 + 2x_2 + x_3 + A_1 = 10$$

Eg. Minimize $Z = 5x_1 + 6x_2$

such that $2x_1 + 5x_2 \geq 1500$

subject to $3x_1 + x_2 \geq 1200$

$$x_1, x_2 \geq 0$$

Big-M method:

Minimize $Z = 5x_1 + 6x_2 + 0 \cdot s_1 + 0 \cdot s_2 + MA_1 + MA_2$
s.t.

$$2x_1 + 5x_2 - s_1 + A_1 = 1500$$

$$3x_1 + x_2 - s_2 + A_2 = 1200$$

$$x_1, x_2, s_1, s_2, A_1, A_2 \geq 0$$

[Maximization problem: $-M$
 Minimization problem: M
 $(M: \text{very large, so that they never enter the basis vector again})$]

$$\begin{array}{ccccccc} x_1 & x_2 & s_1 & s_2 & A_1 & A_2 \\ \left(\begin{array}{cccccc} 2 & 5 & -1 & 0 & 1 & 0 \\ 3 & 1 & 0 & -1 & 0 & 1 \end{array} \right) \end{array}$$

Leave value
0 Take up

	B	C	x_1	x_2	S_1	S_2	A_1	A_2	RHS	Leave value 0 Take up
I-1	A_1	M	2	(5)	-1	0	1	0	1500	$1500/5 = 300 \rightarrow$
	A_2	M	3	(1)	0	-1	0	1	1200	$1200/3 = 100$
	G_j	5	6	0	0	M	M			
	Z_j	$5M$	$6M$	$-M$	$-M$	M	M			
	Δ_j	$5-M$	$6-6M$	M	M	0	0			
	x_2	6	($2/5$)	1	$-1/5$	0	X	0	300	7500
	A_2	M	($13/5$)	0	$1/5$	-1	0	1	900	$4500/13 \rightarrow$
	G_j	5	6	0	0	.	.	M		
	Z_j	$\frac{12+13M}{5}$	6	$-\frac{6+M}{5}$	-M		M			
	Δ_j	$-\frac{12+13M}{5}$	0	$\frac{6-M}{5}$	M		0			
	x_2	6	0	1	$-\frac{3}{13}$	$\frac{2}{13}$	X	X	$2100/13$	2100/13
	x_1	5	1	0	$\frac{1}{13}$	$-\frac{5}{13}$	X	X	$\frac{4500}{13}$	
I-3	G_j	05	6	0	0	.	.	.		
	Z_j	5	6	-1	-1	.	.	.		
	Δ_j	0	0	+1	+1	.	.	.		

All positive or zero

$$\therefore x_1 = \frac{4500}{13}$$

$$x_2 = \frac{2100}{13}$$

Special cases of Linear Programming

Eg Maximize $Z = 2x_1 + 3x_2$

Subject to $x_1 + 2x_2 \leq 2$
 $4x_1 + 3x_2 \geq 12$
 $x_1, x_2 \geq 0$.

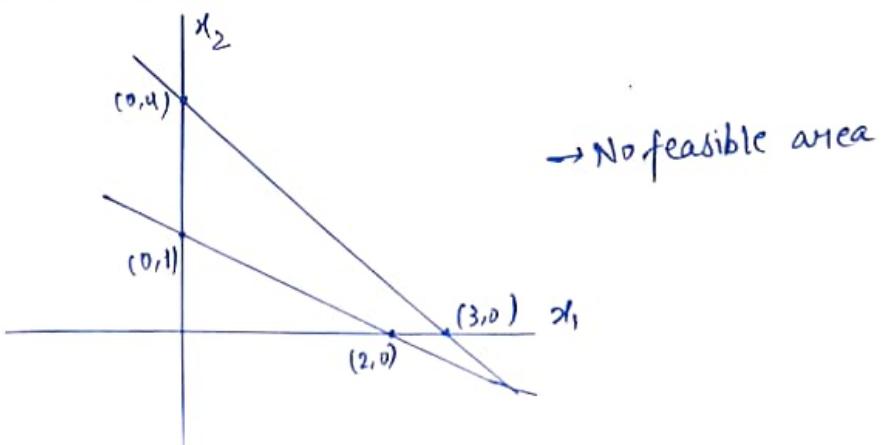
Soln: Maximize $2x_1 + 3x_2 + 0s_1 + 0s_2 - MA_1$

s.t. $x_1 + 2x_2 + s_1 = 2$
 $4x_1 + 3x_2 - s_2 + A_1 = 12$

B	C	x_1	x_2	s_1	s_2	A_1	RHS	Obj.
s_1	0	(2)	2	0	0	0	2	
A_1	-M	(4)	3	0	-1	1	12	3
	c_j	2	3	0	0	-M		
	Z_j	-4M	-3M	0	M	-M		
	Δ_j	2-4M	3-3M	0	-M	0		
I-1	x_1	2	1	2	1	0	2	
	A_1	-M	0	-5	-4	-1	4	
	c_j	2	3	0	0	-M		
	Z_j	2	4+5M	2+4M	M	M		
	Δ_j	0	-1-5M	-2-4M	-M	0		
I-2								

↪ solution is optimal as all are zero but infeasible,
 $Z = 4 - 4M$ [Infeasibility] [Artificial variables are not getting eliminated.]

Graphical method:



Ex Maximize $Z = 2x_1 + x_2$

$$\text{s.t. } x_1 - x_2 \leq 2$$

$$2x_1 - x_2 \leq 3$$

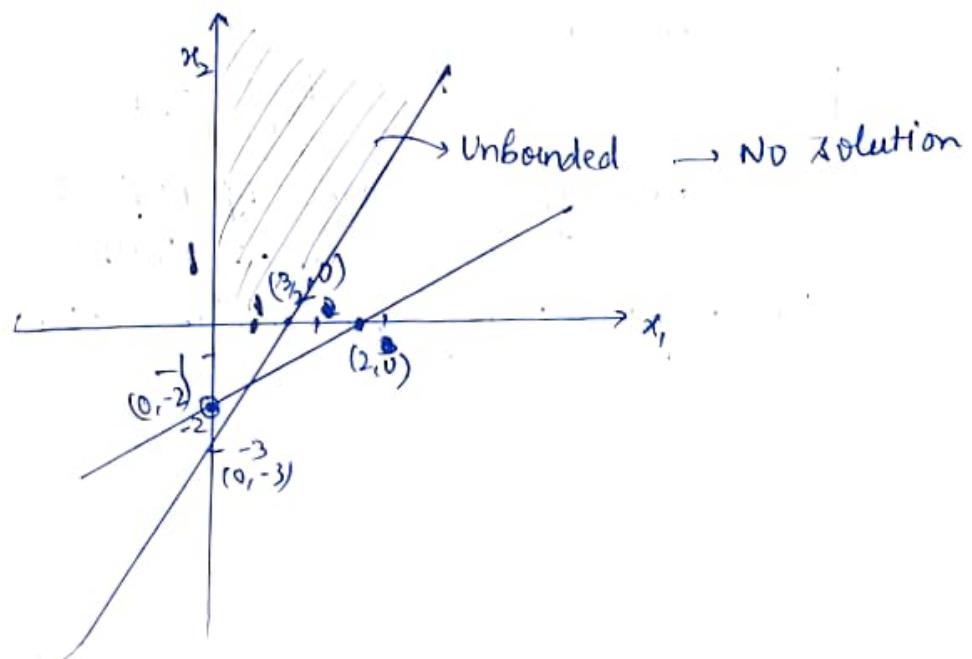
$$x_1, x_2 \geq 0$$

Soln: Maximize $2x_1 + x_2 + 0 \cdot s_1 + 0 \cdot s_2$

$$x_1 - x_2 + s_1 = 2$$

$$2x_1 - x_2 + s_2 = 3$$

B	C	x_1	x_2	s_1	s_2	RHS	θ
s_1	0	(1)	-1	1	0	2	2
s_2	0	(2)	-1	0	1	3	$3/2 \rightarrow$
	Z_j	2	1	0	0		
	Z_j	0	0	0	0		
	Δj	2	1	0	0		
	s_1	0	0	-1/2	1	-1	1/2
	x_1	2	1	-1/2	0	1/2	$3/2$
	Z_j	2	1	0	0		
	Z_j	2	2	0	1		
	Δj	0	-1	0	-1		



Q Maximize $Z = 40x_1 + 100x_2$

$$\text{s.t. } \begin{aligned} 12x_1 + 6x_2 &\leq 3000 \\ 4x_1 + 10x_2 &\leq 2000 \\ 2x_1 + 3x_2 &\leq 9000 \\ x_1, x_2 &\geq 0 \end{aligned}$$

Soln:

$$\text{Maximize } Z = 40x_1 + 100x_2 + 0.S_1 + 0.S_2 + 0.S_3$$

$$12x_1 + 6x_2 + S_1 = 3000$$

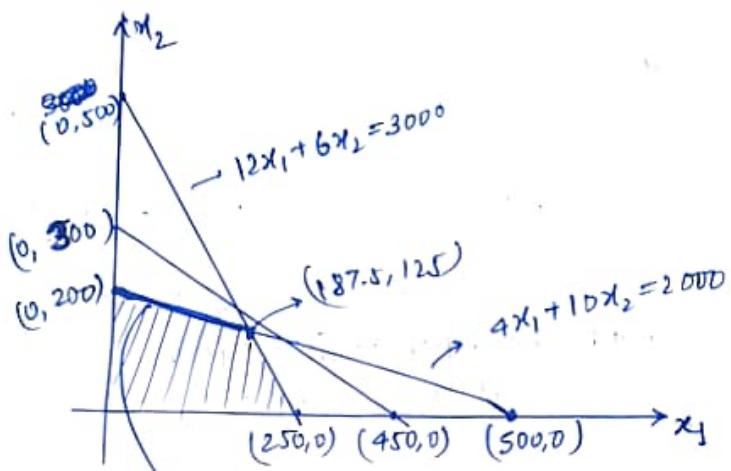
$$4x_1 + 10x_2 + S_2 = 2000$$

$$2x_1 + 3x_2 + S_3 = 9000$$

	B	C	x_1	x_2	S_1	S_2	S_3	RHS	θ
I-1	S_1	0	12	(6)	1	0	0	3000	500
	S_2	0	4	(10)	0	1	0	2000	200
	S_3	0	2	(3)	0	0	1	9000	300
	Z_j	40	100	0	0	0	0		
	Z_j	0	0	0	0	0	0		
	A_j	40	100	0	0	0	0		
I-2	S_1	0	4/5	0	1	-3/5	0	1800	
	x_2	100	2/5	1	0	1/10	0	200	
	S_3	0	4/5	0	0	-3/10	1	300	
	Z_j	40	100	0	0	0	0		
	Z_j	40	100	0	10	0	0		
	A_j	0	0	0	-10	0	0		

Non-Basic variable's A_j (x_i 's) is also becoming zero. \Rightarrow Multiple solution.

[For single soln, only basic variables A_j becomes zero.]



All points on this line gives max. Z-value (20k).
 ↳ Multiple optimal solutions.

$$\begin{aligned}
 & \left. \begin{array}{l} 30x_2 - 6x_2 = 6000 - 3000 \\ \Rightarrow 24x_2 = 3000 \\ \Rightarrow x_2 = \cancel{125} \end{array} \right\} \\
 & \frac{12x_1 + 6x_2 = 3000}{4x_1 + 10x_2 = 2000} \\
 & \frac{24x_2 = 3000}{12x_1 + 6x_2 = 3000} \\
 & x_1 = \frac{2000 - 1250}{4} \\
 & = 187.5
 \end{aligned}$$

Authority and Power

Authority: Consists of rights, position of a person → may get lost.

Power: Ability to influence a person, even if there is no authority.
 ↳ may not be lost when position is lost.

→ French and Raven brought out that authority and power are different:

Bases of Power:

① Legitimate Power: Based on rightful position of a person (same as authority), not on the person.

② Reward Power: Subordinates under a superior because they expect some kind of reward from the superior.

↳ Based on position in the organization.

↳ Financial, non-financial Reward

APAR → Annual Performance Appraisal Report

↳ Recommendation from boss

③ Coercive Power: Negative consequences of not doing a work under the boss.

↳ Negative of reward power.

↳ Not necessarily ^{within} on organization; fear from external factors.

→ Reward and coercive are complementary of each other.

④ Expert Power: Subordinates listen to the boss because of the technical expertise of the boss.

↳ Not necessarily within an organization.

⑤ Referent Power: Ability to influence the behaviour of a person.
↳ Subordinate adopts boss to the extent that he starts emulating boss.
e.g., film stars doing, brand endorsements.

02-04-2025

Quality-Cost-Time Paradigm:

(Q-C-T)

Quality ↑ → cost ↑, Time ↑

→ Things we consider while buying a mobile phone:

<u>Quality</u>	<u>Cost</u>	<u>Time</u>
Display	Price	New model introduction
Processor	EMI	Service time
camera	Resale value	Warranty period
security updates	Spare parts price	Spare parts availability
Ergonomics		
Battery	Repair price	
Memory		
Material		
Water resistance		
colour		
Texture		
QDII		
Brand		
Service		

Big Three in USA
↳ Took 8 yrs. for new products
↳ overtaken by Japanese

Organizing

→ Organization structure should reflect its objectives and strategies chosen.

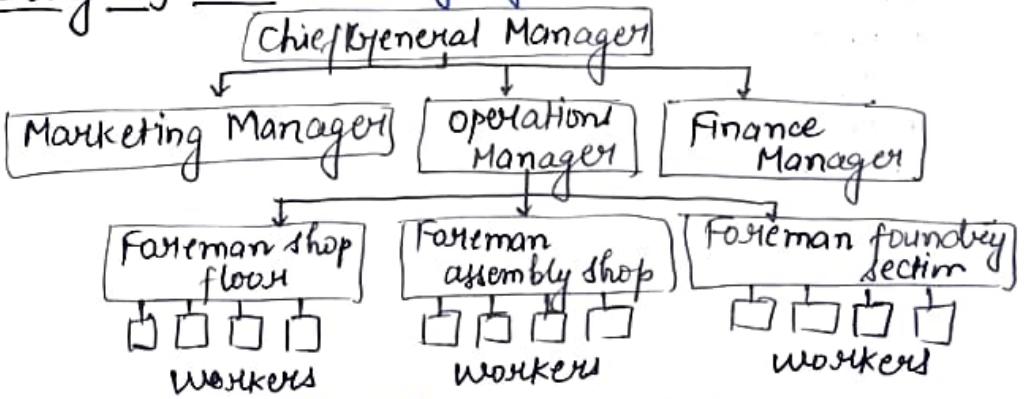
Span of control: No. of subordinates who can be managed effectively by a superior.

Factors affecting span of control:

- capacity of superior
- capacity of subordinates
- nature of work
- degree of decentralization
- degree of planning
- communication techniques
- use of staff assistance
- supervision from others.

Type of organizational structures:

I Line organization: (Military organization)



- ↳ Simplest and oldest type of organization structure.
- ↳ Lines of command flow directly from top to bottom with superiors in charge giving orders to their subordinates.
- ↳ Line of responsibility flows from bottom to top with subordinates directly responsible to their superiors.

Advantages:

- ↳ Simple structure.
- ↳ Unity of command.
- ↳ Line officials independent.
- ↳ The heads are responsible and thus can take decisions in a flexible manner.

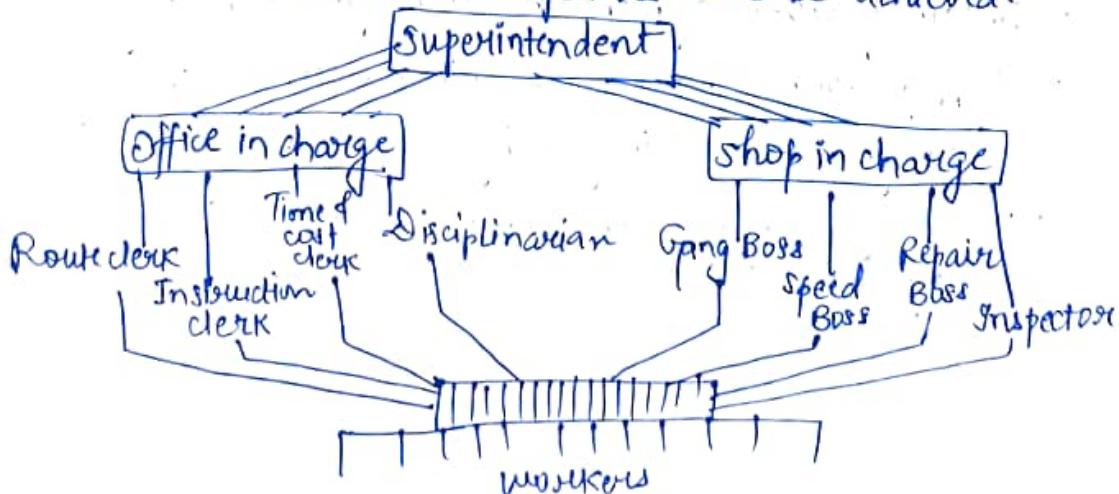
- ↳ Clear channel of communication exists b/w members.
- ↳ Guarantee strong discipline.
- ↳ Quick and prompt decisions can be taken by line officials.
- ↳ Overall development of an all-round executive as a person looks after all activities of department.

Disadvantages:

- ↳ May encourage dictatorial style of functioning in org.
- ↳ Line executives may not be specialized in all fields.
This may lead to wastage of resources.
- ↳ Lower level executives may tend to lose their capacity for independent thinking.
- ↳ Chances of favouritism by them are possible as they can appoint or promote persons of their choice.
- ↳ All departments may work for their self-interest.
Thus, general interest of organization may be overlooked.
- ↳ Unsuitable for large concerns; usually seen in small concerns.

② Functional organization : Proposed by F.W. Taylor

- ↳ Responsibility of shop supervision divided among specialists to take advantage of specialization.
- ↳ Authority from top to bottom is delegated a/c to function.
Each specialist is authorized to give orders to workers in his field of specialization.
- ↳ Top management is responsible for coordinating all functional units such that desired objectives could be achieved.



Advantages:

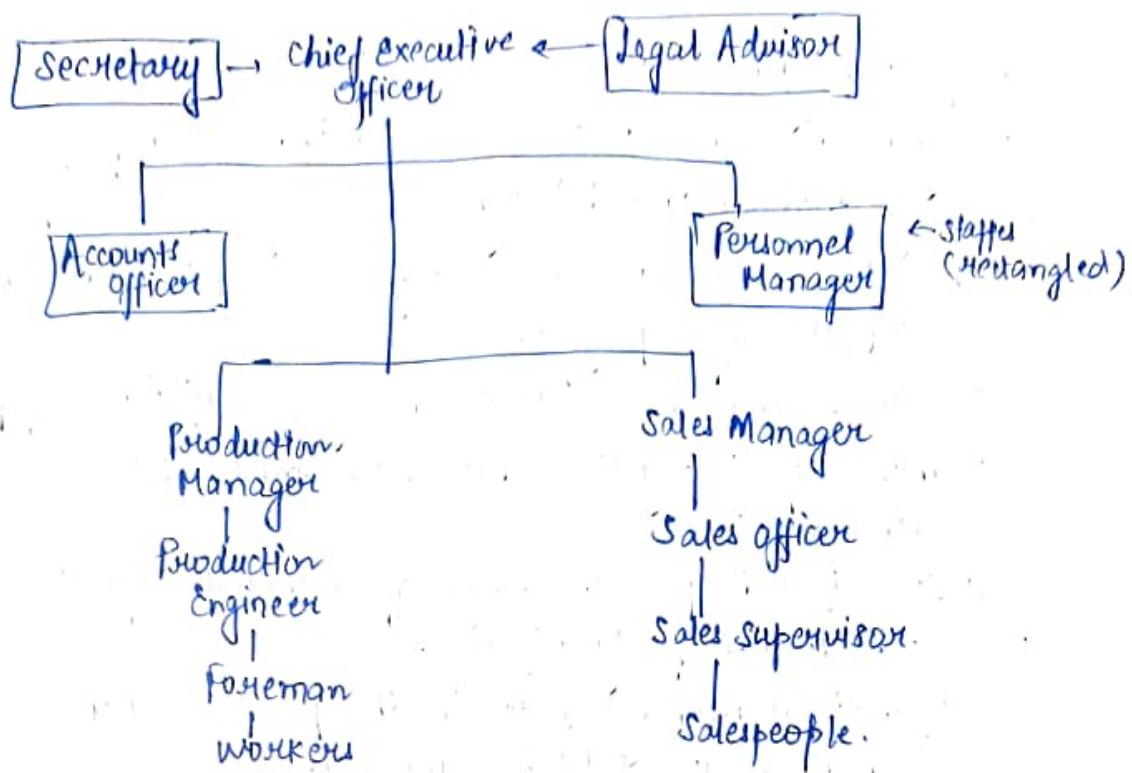
- ↳ Clear separation of planning and doing of work is done.
- ↳ Specialization ensures greater division of labour that leads to an improvement in quality and productivity.
- ↳ Increased efficiency is attained as workers get expert guidance from specialists.
- ↳ Experts can train workers in their field of specialization in a better way with min^m wastage of resources. → improved efficiency.
- ↳ By virtue of standardization and specialization, mass production can be achieved.

Disadvantages:

- ↳ Violated principle of unity of command → result in indiscipline.
- ↳ As many authorities exist, it becomes difficult to fix responsibilities on a particular person in case of poor results.
- ↳ Kills initiative and creative ability of workers as expert guidance from foreman (specialist) is already available.
- ↳ Overlapping of authorities b/w persons of equal rank could lead to strained relationships among them. → decrease in efficiency.
- ↳ Lack of coordination among sub-divided units could ~~lead to~~ make it difficult to take quick decisions.
- ↳ Total job cost increases as experts are high paid ~~high~~ ^{high} salaries.

③ Line and staff organization

- ↳ Alteration of line org. where line heads are assisted by specialist staff.
- ↳ Contain features of both line and functional organizations.
- ↳ Staff personnel have no administrative authority and are only involved in guiding and advising line executives.
- ↳ Power of command and ultimate decision making rests solely with line executives.



Advantages :

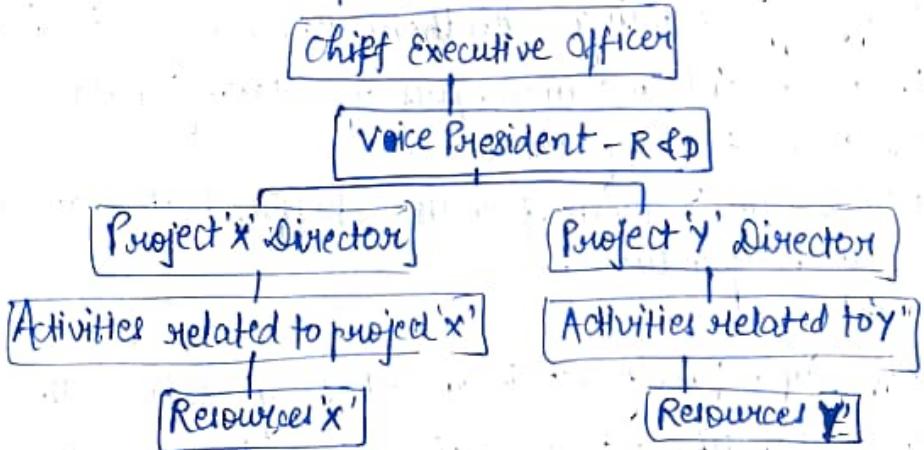
- ↳ Managers get benefits of specialist people at all levels.
 - ↳ Strict discipline can be maintained.
 - ↳ staff officers bring with them knowledge in their field that can aid line managers for taking balanced decisions.
 - ↳ Less wastage of resources.
 - ↳ With advice from specialist staffs, better quality products can be produced.

Disadvantages:

- ↳ Staff people purely act in an advisory role in line staff.
 - ↳ Clear establishment of authority and responsibility b/w line and staff executives is often difficult.
 - ↳ Line officers may even reject good suggestions offered by staff specialists which may de-motivate them.
 - ↳ Differences in opinion on matters b/w line and staff officers can prevent harmonious working among them.
 - ↳ Overhead costs of products ↑ due to salaries paid for staffs.
 - ↳ Loss of initiative by line executives may occur if they depend too much on staff people.

④ Project Organization:

- ↳ Organization undertakes various activities on a project basis by adding required and deleting unnecessary activities as per requirement.
- ↳ Project manager assumes a key role and is responsible for completion of a project.
- ↳ Various divisions are created solely for lifetime of project.
- ↳ When a project gets completed, concerned divisions may get disbanded.
- ↳ Specialized people are drawn from various functional departments of organization.
- ↳ Functional managers decide the person and the way in which work would be completed.
- ↳ Project managers decides the mode for optimum utilization of resources and coordination of various activities associated with project.



Advantages:

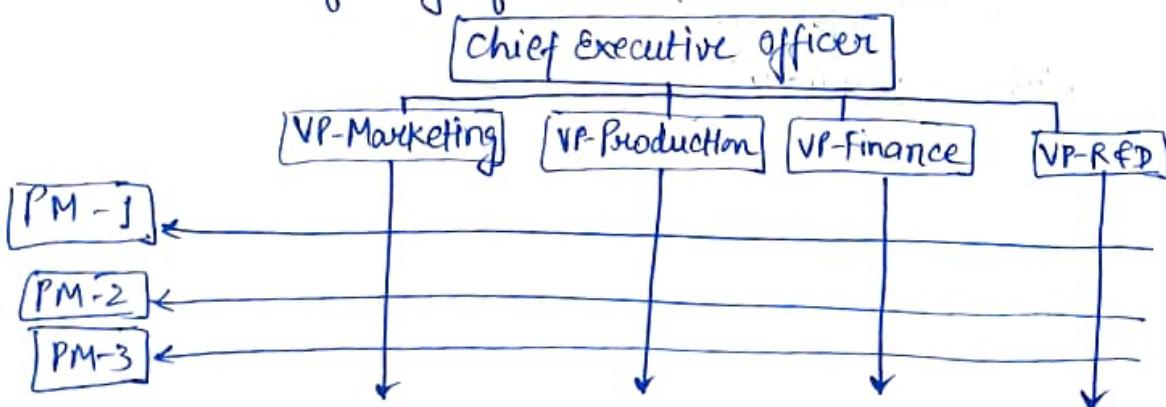
- ↳ Specialized knowledge available utilized to full extent for all projects.
- ↳ Enables organization to adapt itself quickly in a dynamic business environment.
- ↳ Flexibility exists for optimum utilization of resources as they can be allocated to project as and when needed.

Disadvantages:

- ↳ Sense of insecurity and uncertainty exists in people as what would happen to them once project is finished.
- ↳ People encounter difficulties in associating themselves with any particular department, as they do not have permanent tenure in any project. → less loyalty to org.
- ↳ Lack of clarity among members about their role in organization.
- ↳ A project manager may face problems as he has to carry responsibility without authority.

5 Matrix Organization

- ↳ Project and functional type of organizations merged.
- ↳ Preferred when an organization has a large no. of smaller projects so that when one project is completed, its resources are directed to other projects.
- ↳ Project manager coordinates activities of project by drawing personnel from respective functional departments.
- ↳ Each functional staff has two bosses, his own administrative head and his project manager.
- ↳ Principle of unity of command is violated.



Advantages:

- ↳ Enables better planning and control of projects as it focuses upon resources in a single project.
- ↳ Flexible and particularly suited to dynamic business environments.
- ↳ By emphasizing on professional competence rather than by authority and position, personnel are able to contribute their maximum to org.

Disadvantages:

- ↳ Dual command; people always try to maximize their benefits, thus power struggle always exists among people.
- ↳ Anarchy could be developed if matrix structure is not ~~not~~ properly managed.
- ↳ May not work well in situations where there is economic crunch.
- ↳ Delay in decisions if matrix organization is not followed properly.
- ↳ In initial stages, matrix structure can be a costly affair b/c of heavy management.

6 Team-based organization

Team: Small group of people with complementary skills who are committed to a common purpose, performance goals and approach for which they hold themselves ~~not~~ mutually accountable.

- ↳ Small no. of people
- ↳ Members need to have complementary skills
 - Technical or functional skills
 - Problem solving and decision-making skills
 - Interpolation skills
- ↳ Common purpose and common goals.
- ↳ Common approach.
- ↳ Mutual accountability.

Staffing

- ↳ Process of acquiring, developing, appraising, remunerating, and retaining people so that right people are available at right positions and at right time in the organization.
- ↳ Managerial function of staffing : filling positions in org. structure through identifying workforce requirements, inventoing people available, recruitment, selection, placement, promotion, appraisal, compensation, and training of needed people.

Manpower Planning

- ↳ Taking appropriate decisions about skills, talents, education, responsibility and training of people necessary for successful running of organizations.
- ↳ Done on periodic basis to utilize human resources in an org.
- ↳ Factors affecting manpower planning:
 - working hours per day by employees
 - no. of shifts in a factory
 - type of products manufactured
 - nature of product mix
 - better utilization of time resources, etc.

Recruitment and selection of manpower:

- ① Internal sources → company's policy is already known to personnel.
 - ↳ Level of morale ↑
 - ↳ Less time consuming
 - ↳ Reliable info. about working style of person
 - ↳ Labour turnover ↓, creates sense of security.
 - ↳ Deprive of fresh outlook and new ideas.
- ② External sources →
 - ↳ Advertisement
 - ↳ Employment exchanges
 - ↳ Professional and academic institutions
 - ↳ References from employees
 - ↳ Application at gates
 - ↳ Labour unions

Method of scientific selection of employees

- ↳ Decision making process where norms and principles are decided by management for differentiating b/w qualified and unqualified candidates for the job.
- ↳ Aims for finding 'the right' person for the right job!

Steps: ① Receipt of applications

② Screening of applications

- ③ Selection tests
- ↳ Intelligent tests
 - ↳ Psychological tests
 - ↳ Aptitude tests
 - ↳ Interest tests
 - ↳ Dexterity tests
 - ↳ Personality tests

④ In-depth interview

⑤ Reference check

↳ Asked to supply personal or work references to test skills.

⑥ Medical examinations.

⑦ Final selection and offer of appointment.

Training of Manpower

- ↳ Aims to develop some specific knowledge and skill needed for current job.
- ↳ Caters an individual's present job and thus considered as an active process.

Development of manpower

- ↳ To develop a person for future jobs.

↳ Better preparation for future needs can be considered as a proactive process.

Training Methods of workers:

- ① Demonstration
- ② On-the-job training
- ③ Vestibule school training
- ④ Apprenticeship.

Methods of training of supervisors:

- ① Induction and orientation programs
- ② Lecture (classroom) method.
- ③ Conference
- ④ Written instructional method.
- ⑤ Training within industry (T.W.I.)

Executive (managerial) training methods:

On-the-job training methods:

- ① Understudies
- ② Membership of committee
- ③ Job rotation
- ④ Job enlargement
- ⑤ Job enrichment
- ⑥ Management by Objectives (MBO)

Off the job training methods:

- ① Lectures
- ② Case study method
- ③ Business games
- ④ Role playing
- ⑤ Conference.

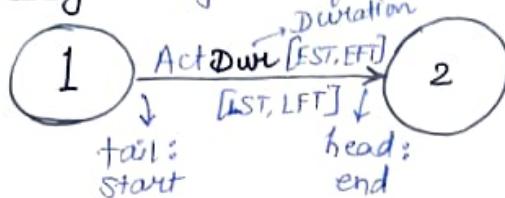
Project Management

- # PMBOK → Project Management Body of Knowledge
- # PMI → Project Management Institute.

Project → A No. of activities (inter-related).

Program → A No. of projects

Activity: Any identifiable things that consume resources.



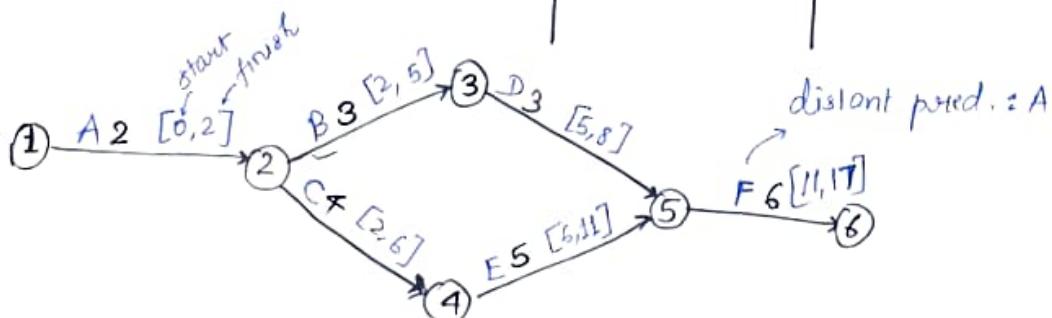
EST: Early start time of Activity
LFT: Late finish time of activity.

1, 2 nodes: Events → Do not consume resources

EST, EFT: Should not exceed the duration of activity.

Eg. An electrical circuit has 2 subsystems. Test them individually and then final testing.

Activity	Description	Pre	Immediate Predecessor	Duration (hr)
A	Full system design	-	-	2
B	Subsystem 1 implementation	A	A	3
C	Subsystem 2 implementation	A	A	4
D	SubSystem 1 testing	B	B	3
E	Subsystem 2 testing	C	C	5
F	Full system testing	D, E	-	6



$$\therefore \text{Total time} = 17 \text{ hrs.}$$

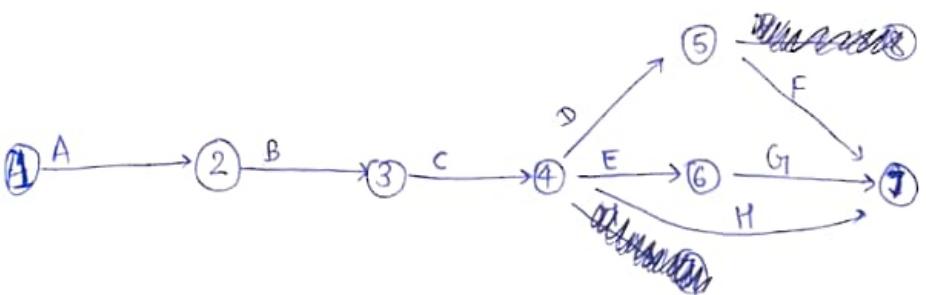
(: finish)

Rules of Network Diagrams

- ① Each activity is represented by only one arrow in the project network.
- ② Before starting an activity assume that all its predecessor activities are completed.
- ③ Arrow^{tail} indicates the logical predecessor. [Length of the arrow has no significance] ④ only one initial node and one final terminal node exist.
- ⑤ Fulkerson's rule in PM: Network should always progress towards higher nodes.
- ⑥ Two activities (to avoid looping) cannot have common starting and common ending nodes.

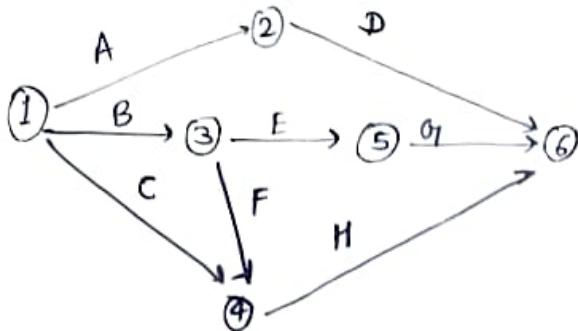
Eg. Act. Pred.

A	-
B	A
C	B
D	C
E	D, C
F	D
G	E
H	C



Eg. Act. Pred.

A	-
B	-
C	-
D	A
E	B
F	B
G	E
H	C, F

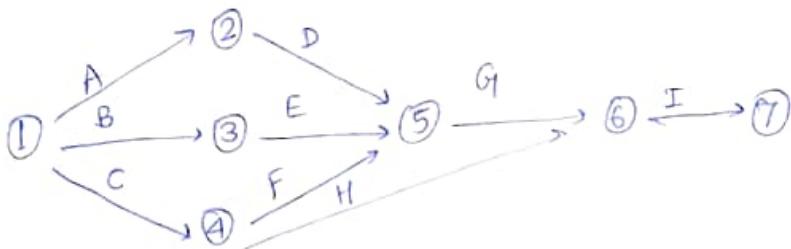


[09-04-2025]

Eg.	<u>Activity</u>	<u>Predecessor</u>
	A	-
	B	-
	C	-
	D	A
	E	B
	F	C
	G	D, E, F
	H	C
	I	G, H

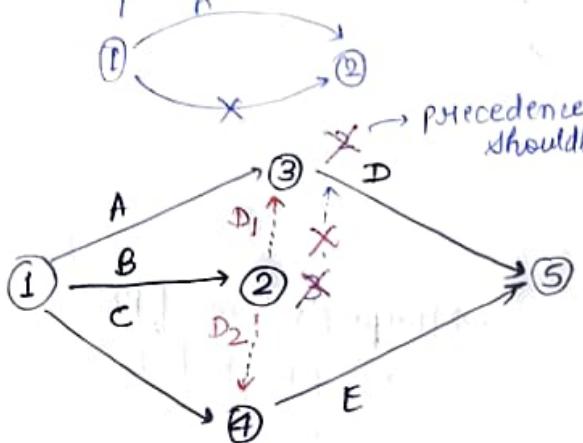
→ Murphy's Law of PMs:

- ↳ Anything that can go wrong, will go wrong,
- ↳ and at worst possible time.
(colloquial addendum)
- ↳ It is project manager's duty to tackle Murphy's law.



Eg.	<u>Act.</u>	<u>Preed.</u>
	A	-
	B	-
	C	-
	D	A, B
	E	B, C

Rule: Two activities cannot have common start- and common end-points.



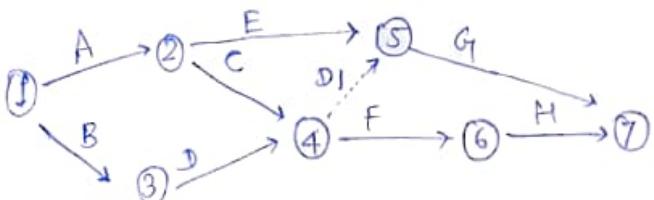
precedence rule
should be followed.

D₁, D₂: dummy activities

↓
Use only when absolutely necessary.

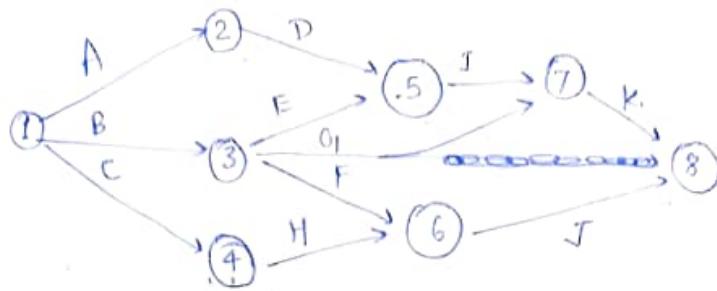
Eg. Act. Pred.

A	-
B	-
C	A
D	B
E	A
F	C, D
G	C, D, E
H	F



Eg. Act. Pred.

A	-	H	C
B	-	I	D, E
C	-	J	H, F
D	A	K	G, I
E	B		
F	B		
G	B		



e.g. Activity Predecessor

15-04-2025

A —

B —

C —

D A

E A, C

F B, D, E

G B, D

H E, F, G

X → Immediate predecessor

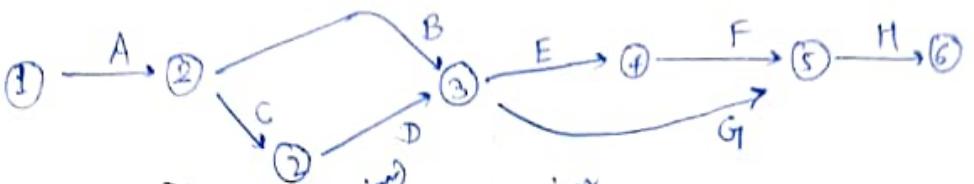
O → Distant predecessor

⊗ → Redundant

} Take only immediate predecessor

PMBOK

	A	B	C	D	E	F	G	H
A								
B	X							
C	X							
D	⊗		X					
E	O	X	O	X				
F	O	⊗	O	⊗	X			
G	O	X	O	X				
H	O	O	O	O	⊗	X	X	



Eg. Team Activity

	M ₁	M ₂	→ Man hours
- J ₁ -	5	4	
- J ₂ -	2	3	
- J ₃ -	13	14	
- J ₄ -	10	1	
- J ₅ -	8	9	
- J ₆ -	12	11	

Johnson's rule
↳ for sequencing / scheduling

$$J_1 \rightarrow J_2 \rightarrow J_3 \rightarrow J_4 \rightarrow J_5 \rightarrow J_6$$

	M ₁		M ₂	
	start	end	start	end
J ₁	0	5	5	9
J ₂	5	7	9	12
J ₃	7	20	20	34
J ₄	20	30	34	35
J ₅	30	38	38	47
J ₆	38	50	50	61

$$\text{Design idle time} = 61 - 50 = 11 \text{ hrs.}$$

$$\begin{aligned} \text{Idle production time} &= 5 + 8 + 3 + 3 \\ &= 19 \text{ hrs.} \end{aligned}$$

$$\text{Total time} = 61 \text{ hrs.}$$

To produce total time as well as idle time: $6!$ possibilities.

Iteration-1:



Iteration-2:



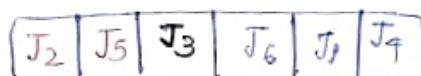
Iteration-3:



Iteration-4:



Iteration-5:

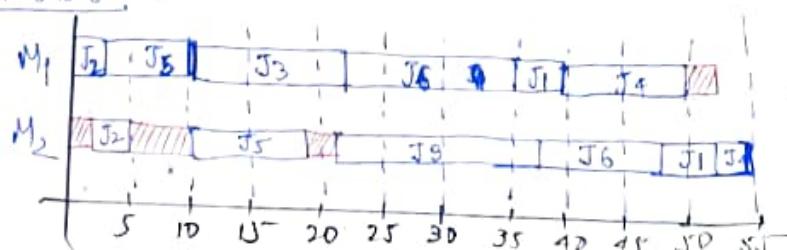


	M_1		M_2	
	start	end	start	end
J_2	0	2	2	5
J_5	2	10	10	19
J_3	10	23	23	37
J_6	23	35	37	48
J_1	35	40	48	52
J_4	40	50	52	53

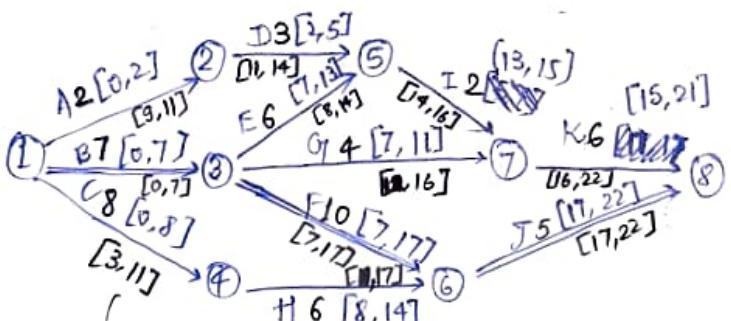
Idle design = 3 hours

Production idle = $2 + 5 + 4 = 11$ hrs.

Gantt chart:



<u>Activity</u>	<u>Predecessor</u>	<u>Days</u>
A	-	2
B	-	7
C	-	8
D	A	3
E	B	6
F	B	10
G	B	4
H	C	6
I	D, E	2
J	H, F	5
K	G, I	6



① A Dur[EST, EFT]
[LST, LFT]

flexibilities
∴ 22 days to finish the project.

Critical Path Method (CPM):

No.	path	Duration
1	1 → 2 → 5 → 7 → 8	13 days (2+3+2+6)
2	1 → 3 → 5 → 7 → 8	21 days
3	1 → 3 → 7 → 8	17 days
4	1 → 3 → 6 → 8	22 days → longest path
5	1 → 4 → 6 → 8	19 days

flow to be given utmost attention by manager

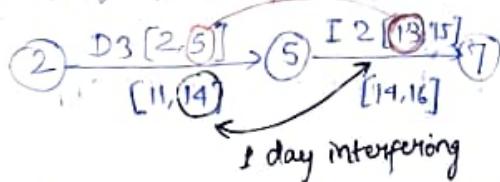
critical path
↳ [EST = LST]
↳ [EFT = LFT]
↳ any delay in this will delay the project

Float: Flexibility with non-critical activity.

Activity	Total float	Interfering float	Free float	Independent float
A	9	0		
B	0	0	0	0
C	"	"	"	"
D	9	1	8	(-1) \rightarrow 0
E				
F	0	0	0	0
G	5	1	4	4
H				
I				
J	0	0	0	0
K				

Total float: Max. flexibility

Interfering float: free days = 8



Free float: No. of days free, b/w. EFT of successive activities.

Independent float = EST of following activity - LFT of predecessor - Duration of current activity

$$(13 - 11 - 3 = -1) \text{ for D}$$

Douglas McGregor → Theory X → pessimistic
Theory Y → optimistic

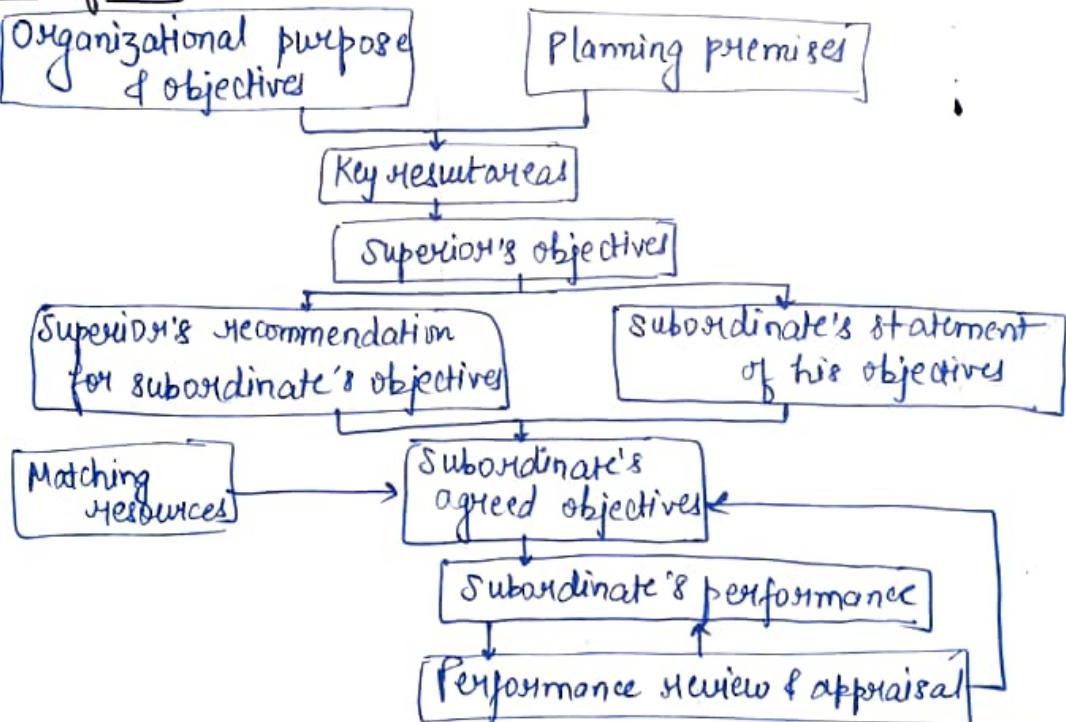
Coercive Power: Must be exercised by manager over employees.

Management by Objectives (MBO) → Human approach

Objectives:

- Specific
 - Measurable
 - Attainable
 - Realistic
 - Timely
- } "SMART"

Process of MBO:



Roles of Managers:

22-04-2025

- | ① Interpersonal roles | ② Informational roles | ③ Decisional roles |
|---------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------|
| i) Figurehead
ii) Leader
iii) Liaison | iv) Monitor
v) Disseminator
vi) Spokesperson | vii) Entrepreneur
viii) Disturbance handler
ix) Resource allocator
x) Negotiator |

~~QUESTION~~

Q. An airline that operates seven days a week has a time-table shown below. Crews must have a minimum layover over 6 hours b/w flights. Obtain the pairing of flights that minimizes the layover time away from the home. For any given pairing, the crew will be based at the city that results in the smaller layover.

Flight no.	Delhi-Kolkata		Flight no.	Kolkata-Delhi	
	Depart	Arrive		Depart	Arrive
6E 389	7 am	9 am	6E 2472	9 am	11 am
6E 6517	9 am	11 am	6E 2198	10 am	12 Noon
6E 219	1:30 pm	3:30 pm	6E 2415	3:30 pm	5:30 pm
6E 513	7:30 pm	9:30 pm	6E 5198	8 pm	10 pm

Sol: Layover for flights based in Delhi:

	6E 2472	6E 2198	6E 2415	6E 5198
6E 389	24	25	6.5	11
6E 6517	22	23	28.5	9
6E 219	17.5	18.5	24	28.5
6E 513	11.5	12.5	18	22.5

Layover for flights based in Kolkata:

	6E 389	6E 6517	6E 219	6E 513
6E 2472	20	19	13.5	9
6E 2198	22	21	15.5	11
6E 2415	26.5	25.5	20	15.5
6E 5198	8.5	7.5	26	21.5

V. Hungarian assignment problem method:

	6E 2472	6E 2198	6E 2415	6E 5198
6E 389	20	19	6.5	9
6E 6517	22	21	11	9
6E 219	17.5	18.5	15.5	15.5
6E 513	8.5	7.5	18	21.5

6E 389 - 6E 2415
6E 6517 - 6E 5198
6E 219 - 6E 2472
6E 513 - 6E 2198

PERT (Program Evaluation and Review Technique)

Conventional Project

Technology: Existing / Familiar

Market: Known / Existing

Innovation: Minimal

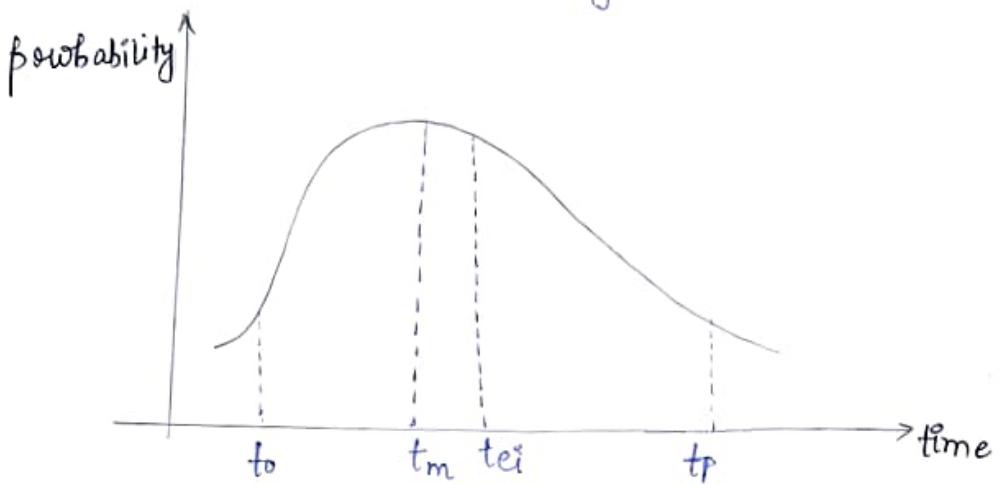
R&D Project

New / Unfamiliar

Unknown / New

Radical change
(eg. invention)

Beta distribution: Followed by PERT activities.



t_o : optimistic time → if everything goes as per plan

t_p : worst time for the completion of activity. (Pessimistic time)

t_m : modal time / most-likely time

(Pessimistic time)

Mean of beta distribution:

$$t_{ei} = \frac{t_o + 4t_m + t_p}{6}$$

Variance,

$$\sigma^2 = \left(\frac{t_p - t_o}{6} \right)^2$$

Normal distribution (μ, σ)

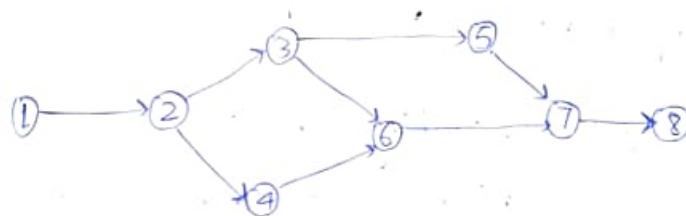
μ : critical path of the project network

σ : sum of variances along the critical path

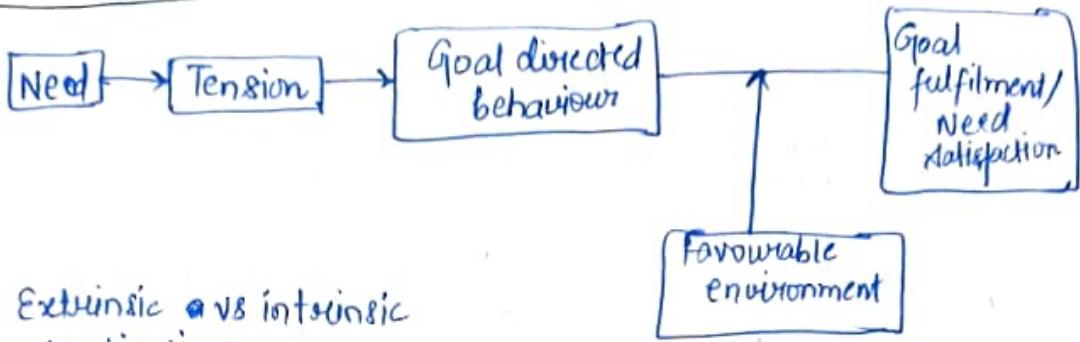
By central Limit Theorem (CLT), the means of any distribution follows the normal distribution.

Eg. Activity	Immediate predecessor	Time			Passimistic
		optimistic	Modal	Pessimistic	
A	-	4	6	8	
B	A	5	7	15	
C	A	4	8	12	
D	B	15	20	25	
E	B	10	18	26	
F	C	8	9	16	
G	E	4	8	12	
H	D, F	1	2	3	
I	G, H	6	7	8	

Soln: Network diagram:

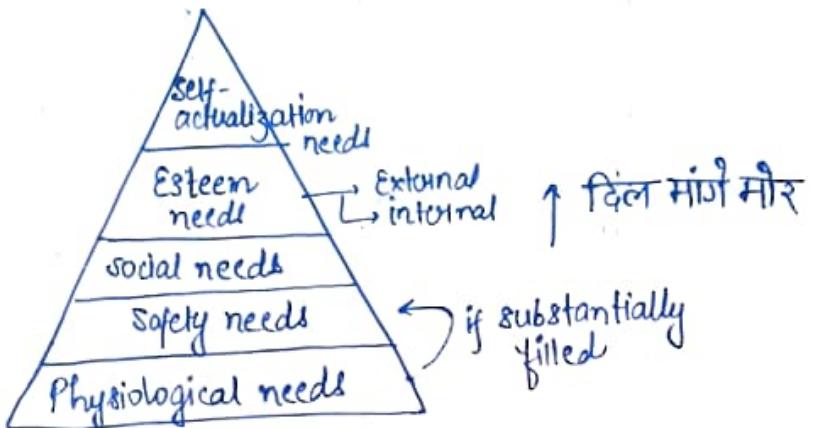


Goal Directed Behaviour : A continuous Process



Extrinsic vs intrinsic motivations

Abraham Maslow Hierarchy of Needs:



Primary needs : Food, clothing, shelter.

- Physiological, biological or unlearned needs.
- Essential for survival.
- Intensity may differ from person-to-person.

(28-04-2025)

Two-factor theory/Motivation-Hygiene Theory