

Engineering Management

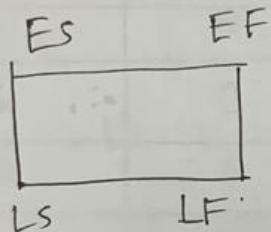
Final Term

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Network diagram

AON → Activity of Node.

AOA → Activity of Arrows.



ES → Earliest start

EF → Earliest finish

LS → Latest start

LF → Latest finish

slack:

$$\text{slack} = \begin{cases} LF - EF \\ LS - ES \end{cases}$$

বেশি সময় নাই করা যাবে এটা।

Activity	Immediate Predecessor	Duration weeks
A		4
B		10
C		7
D	A	5
E	B	3
F	B	6
G	C	2
H	F	8
I	F, G	11
J	D, E	8

(a) Draw AON, Find critical path, completion time, slack and also find all possible paths.

(b) If \$1000 can be saved for each delayed day of activity H, then how much dollar can be saved keeping the project completion time unchanged?

(a)

(c) Activity G needs a delayed time of 2 weeks and extra time of 5 weeks, is it possible by keeping the project completion time unchanged? Explain.

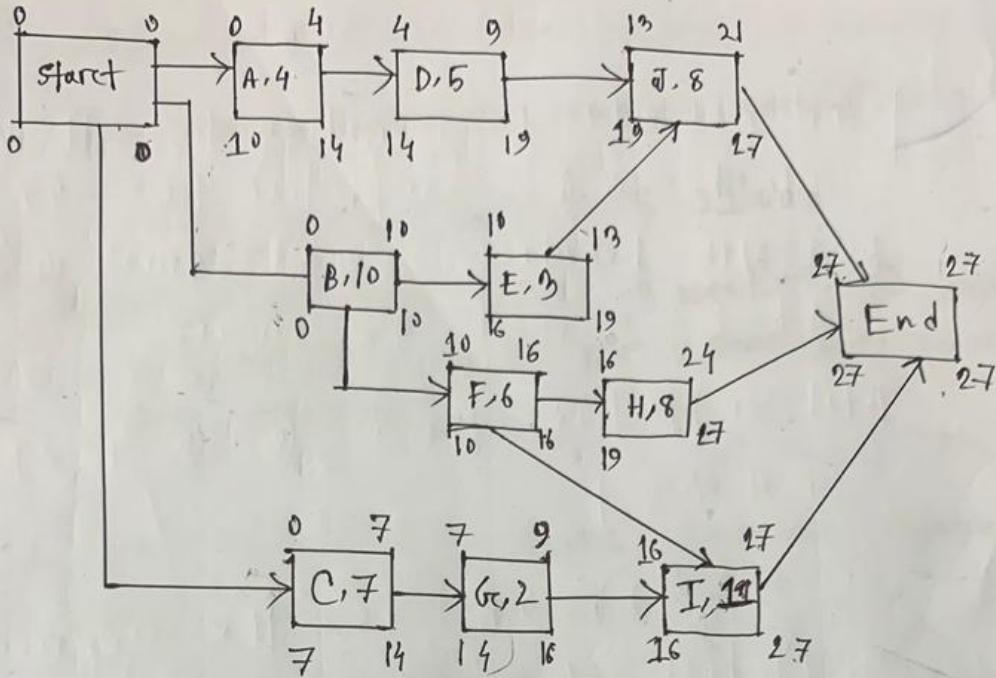
(d) The PM wants to shorten the duration of the activity I from 11 weeks to 9 weeks. What will be the impact of these changes on project completion time?

(e) prepare Gantt chart

unit activities along with their start and end dates
Activity - Start Date End Date Duration
A 01/01/2023 01/02/2023 1 week
B 01/02/2023 01/03/2023 1 week
C 01/03/2023 01/04/2023 1 week
D 01/04/2023 01/05/2023 1 week
E 01/05/2023 01/06/2023 1 week
F 01/06/2023 01/07/2023 1 week
G 01/07/2023 01/08/2023 1 week
H 01/08/2023 01/09/2023 1 week
I 01/09/2023 01/10/2023 1 week
J 01/10/2023 01/11/2023 1 week
K 01/11/2023 01/12/2023 1 week
L 01/12/2023 01/13/2023 1 week
M 01/13/2023 01/14/2023 1 week
N 01/14/2023 01/15/2023 1 week
O 01/15/2023 01/16/2023 1 week
P 01/16/2023 01/17/2023 1 week
Q 01/17/2023 01/18/2023 1 week
R 01/18/2023 01/19/2023 1 week
S 01/19/2023 01/20/2023 1 week
T 01/20/2023 01/21/2023 1 week
U 01/21/2023 01/22/2023 1 week
V 01/22/2023 01/23/2023 1 week
W 01/23/2023 01/24/2023 1 week
X 01/24/2023 01/25/2023 1 week
Y 01/25/2023 01/26/2023 1 week
Z 01/26/2023 01/27/2023 1 week

to add break after each week so that we can have a break
between each week and also we can have a break between each activity
so that we can have a break between each activity and also we can have a break between each activity

(a)



slack:

$$A = 10$$

$$B = 0$$

$$C = 7$$

$$D = 10$$

$$E = 6$$

$$F = 0$$

$$G = 7$$

$$H = 3$$

$$I = 0$$

$$J = 6$$

~~প্রক্রিয়ার~~ slack no-value 0 present নিচে-
সবুর path ক উচ্চ
critical path.

Now, critical path = B → F → I

All possible path:

- B → F → I
- A → D → J
- B → E → J
- B → F → H
- C → G → I

critical path এর length
মাধ্যিক ও বাই 25-।
এখনে present path এর
length ক নাই-।
[critical path is also a
possible path]

(b) Activity "H" can be delayed 3 weeks.

For every ~~week~~ day can be saved \$1000.

$$\text{So, } 3 \times 7 \times 1000 = \$21000$$

[Activity H has slack value 3 weeks, ~~so~~ saving
\$1000 per ~~day~~ | \$1000 per week saving price fixed
Ans \$21000]

(c) At Activity "G" there can be delayed 7 weeks driven from ADN.

So, It is possible to delay 2 weeks and it can be take extra 5 weeks.

[$G_0 + \text{slack} = 7$ weeks, so 2 week delay
extra $7 - 2 = 5$ weeks]

(d) IS, $11 - 9 = 2$ weeks is shorten on Activity "I"

I is a part of critical path, so the completion time will be shorten by 2 weeks

$$\text{So, } 27 - 2 = 25 \text{ weeks.}$$

2. Draw a bar chart and "H" activity (d)

[In Activity I, Duration fine 11 week
slack = 0], completion time 27 week

[Duration duration 2 week min - max]

$$11 - 2 = 9 \text{ week end min}$$

Total completion time (b) 2 weeks

ANS 20

3. Draw a bar chart and "S" activity + A (e)

[$27 - 2 = 25$ is the current
completion time]

[slack is the delay path of activity A
critical path is the longest path of
activity]

[Draw R → S → F diagram using

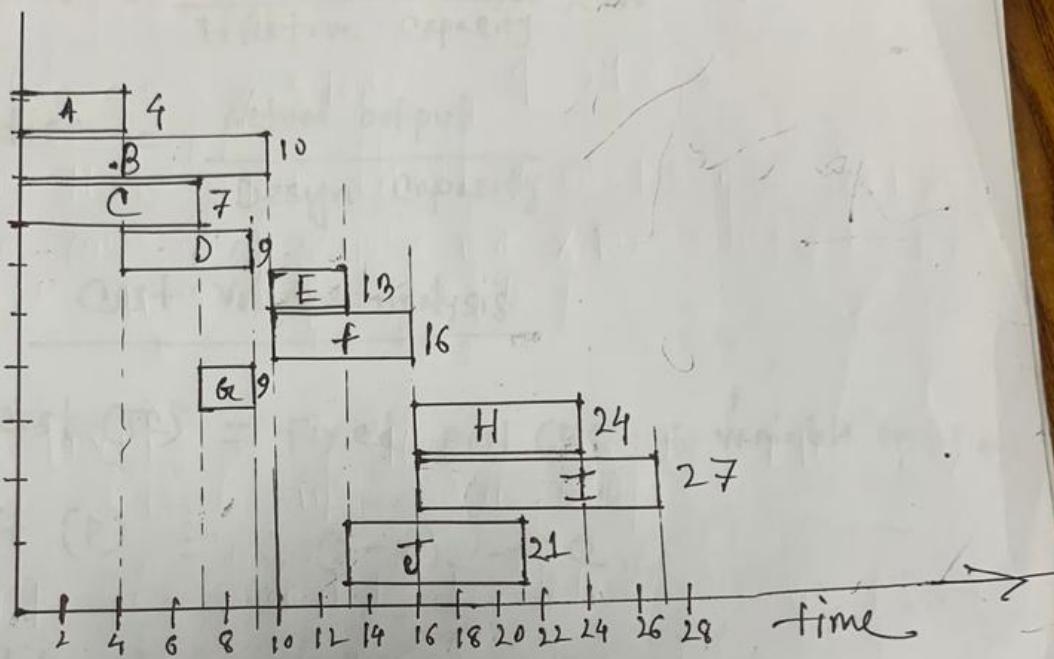
activities (i) (ii) (iii) S = 9 - 11, 25 (b)

"L" activity

+ 02 days waiting for long o 21 L
days waiting for new unit arrival on 09

(e)

Gantt chart :-



capacity planning

$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}} \times 100$$

$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}}$$

Cost Volume Analysis

1. Total cost (TC) = Fixed cost (FC) + variable cost (v)

2. Profit (P) = Q (R-v) - FC

3. Quantity to generate specific profit,

$$Q = \frac{P_f FC}{R-v}$$

4. Quantity at Break even point,

$$Q_{BEP} = \frac{FC}{R-v}$$

Profit = Total Revenue - Total Cost

Example: The owners of old fashion berry pies -

Mrs. Dipto, is planning a new line of pies which will require leasing new equipments for a monthly payment of \$ 6000, variable cost would be \$ 2.00 per pie, and pies retails for \$ 7.00 each.

(a) How many pies must be sold in order to break even point?

$$Q = \frac{FC}{R-V} = \frac{6000}{7-2} = 1200 \text{ pies}$$

$\left| \begin{array}{l} \text{Fixed cost (FC)} = \$6000 \\ VC = \$2 \text{ per pie} \\ R = \$7 \text{ per pie} \end{array} \right.$

(b) What would be profit or loss if 1000 pies sold in a month?

$$\begin{aligned} P &= Q(R-V) - FC \\ &= 1000(7-2) - 6000 \\ &= -\$1000 \text{ (loss)} \end{aligned}$$

(c) How many pies must be sold to realize a profit of \$4000? $\left. \begin{array}{l} \\ P = \$4000 \end{array} \right\}$

$$Q = \frac{P - FC}{R - V} = \frac{4000 + 6000}{7 - 2} \\ = 2000 \text{ pies}$$

(d) If 2000 can be sold, and profit target is \$5000, what price should be charged per pie?

$$\text{profit } (P) = Q(R - V) - FC \\ \Rightarrow 5000 = 2000(R - 2) - 6000 \\ \Rightarrow R = \$7.50$$

Location Planning

Fixed and variable cost for four potential plant location are shown below

Location	Fixed cost per year	variable cost per unit
A	\$ 250,000	\$ 11
B	\$ 100,000	\$ 30
C	\$ 150,000	\$ 20
D	\$ 200,000	\$ 35

(a) Plot the total cost lines for these location in a single graph.

$$\text{Fixed cost} + \text{variable cost} = \text{Total cost}$$

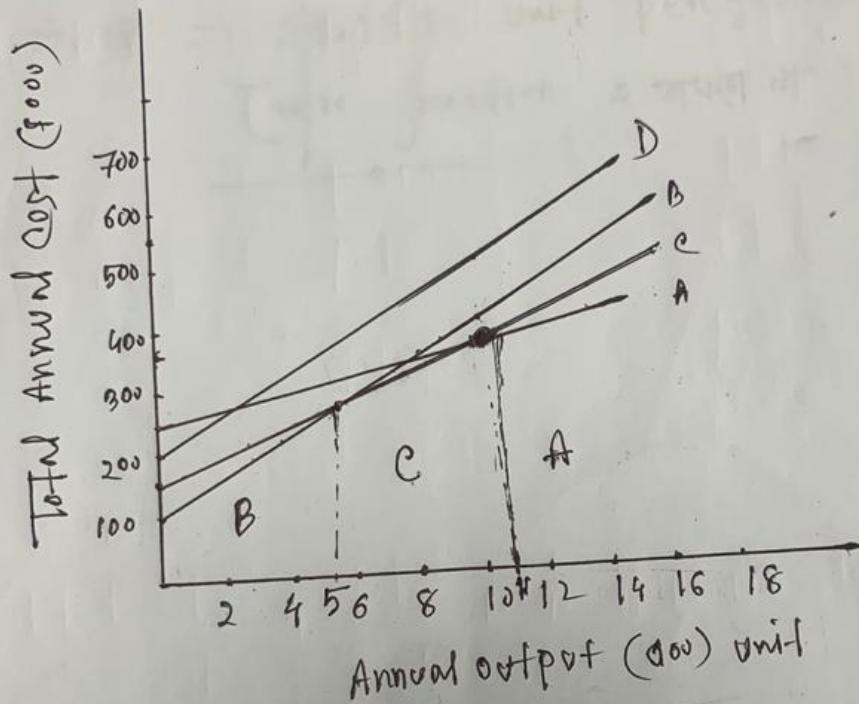
$$A. \$ 250,000 + \$ 11(10000) = \$ 360,000$$

$$B. \$ 100,000 + 30(10000) = 400,000$$

$$C. \$ 150,000 + 20(10000) = 350,000$$

$$D. \$ 200,000 + 35(10000) = 550,000$$

greater variable cost per unit \Rightarrow higher per unit
 unit cost \Rightarrow \$10,000 per unit \Rightarrow fixed cost less
 Total cost line \Rightarrow steeper \Rightarrow 1



(b) In break even output level,

(B)

$$\$10,000 + 30Q = \$150,000 + 20Q$$

$$\Rightarrow 10Q = 50,000$$

$$\Rightarrow Q = 5,000 \text{ units per year}$$

Total Cost
 $(TC) = FC + VQ$

For C And A

$$\$ 150,000 + 20Q = \$ 250,000 + \$ 11Q$$

$$\Rightarrow 9Q = 100000$$

$$\Rightarrow Q = 11111 \text{ units per year}$$

[valve fraction & profit]

Quality control

SAMPLE Control chart

	1	2	3	4	5
1	12.12	12.15	12.09	12.12	12.09
2	12.10	12.12	12.09	12.10	12.14
3	12.11	12.10	12.12	12.08	12.13
4	12.08	12.11	12.15	12.10	12.12
\bar{x}	12.10	12.12	12.11	12.10	12.12

$$\bar{x} = \frac{12.10 + 12.12 + 12.11 + 12.10 + 12.12}{5}$$

$$= 12.11$$

$$UCL = \bar{x} + Z \sigma \bar{x} \quad | \quad \sigma \bar{x} = \frac{\sigma}{\sqrt{n}}$$

$$LCL = \bar{x} - Z \sigma \bar{x}$$

$$Z = 3, n = 4 \quad \sigma = .02$$

$Z \sigma \bar{x} = 3 \times .02 \approx 0.06$ value given in table

UCL = upper control limit

LCL = lower control limit

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Value of \bar{x} is 12.11 and value of S is 0.02

$$UCL = 12.11 + 3 \left(\frac{0.02}{\sqrt{4}} \right) = 12.14$$

$$LCL = 12.11 - 3 \left(\frac{0.02}{\sqrt{4}} \right) = 12.08$$

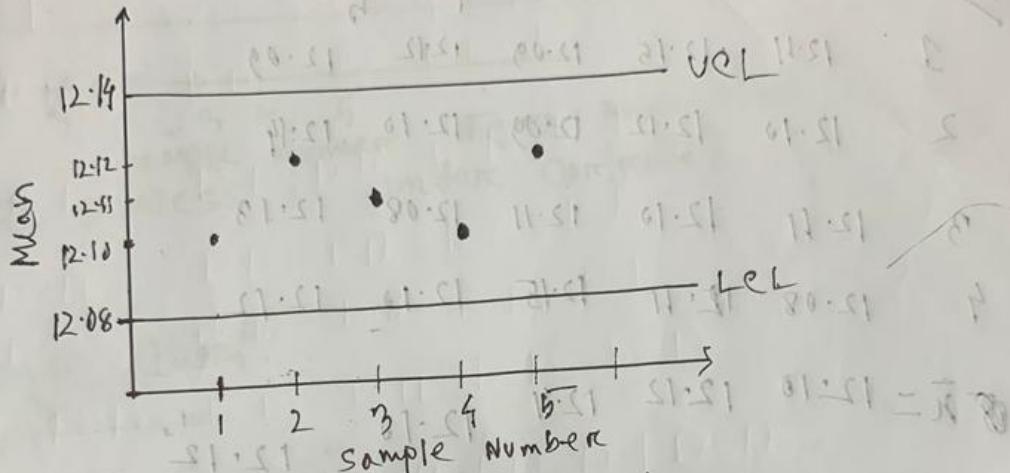


Figure : Mean chart

This process is under controlled.

[reject sample 1, 2, 3, 4, 5 as they are mean value less than LCL and more than UCL process is under control]

Under control

$$80.51 =$$

এবাব

২০ value ক্ষেত্রে না পরিসর ১০.৫² $A_2 = \frac{2}{3}$ ২০ value
 ২০ পরিসর মানের ক্ষেত্রে অন্তর্ভুক্ত হলে। Mean chart works process
 Under control কিন্তু যদি কোন ঘৰ্য্যতে।

SAMPLE:

	1	2	3	4	5
--	---	---	---	---	---

1	12.11	12.15	12.09	12.12	12.09
---	-------	-------	-------	-------	-------

2	12.10	12.12	12.09	12.10	12.14
---	-------	-------	-------	-------	-------

3	12.11	12.10	12.11	12.08	12.13
---	-------	-------	-------	-------	-------

4	12.08	12.11	12.15	12.10	12.12
---	-------	-------	-------	-------	-------

$$\bar{x} = 12.10 \quad 12.12 \quad 12.11 \quad 12.10 \quad 12.12$$

$$\bar{x} = 12.11$$

$$R = 0.03 \quad 0.05 \quad 0.06 \quad 0.04 \quad 0.05$$

$$\bar{R} = 0.046 \quad / \quad \bar{R} = \frac{0.03 + 0.05 + 0.06 + 0.04 + 0.05}{5} = 0.046$$

$$UCL = \bar{x} + A_2 R$$

$$= 12.11 + 0.73 \times 0.046$$

$$= 12.14$$

$$LCL = \bar{x} - A_2 R$$

$$= 12.11 - 0.73 \times 0.046$$

$$= 12.08$$

Range
 R = sample ২০ -
 Highest value -
 Lowest value

$A_2 = 2.0$ value এখন
 ২ ক্ষেত্রে কাম।

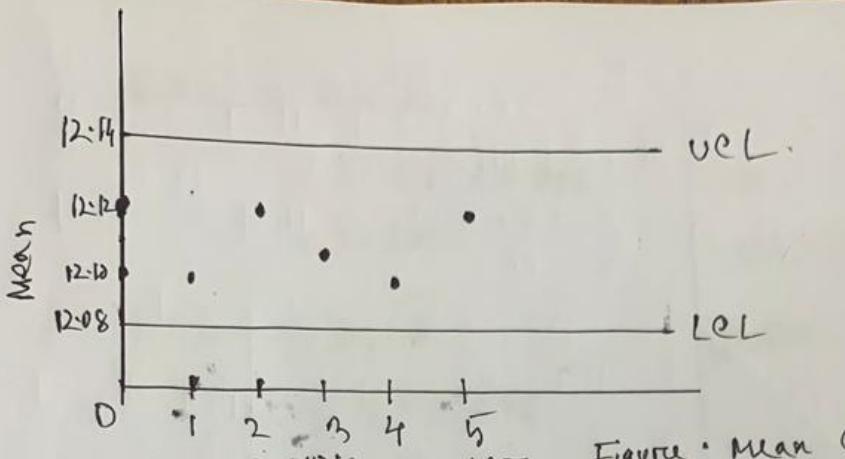


Figure: Mean chart
The process is under controlled

Range Chart:

$$UCL = D_4 \bar{R}$$

$$LCL = D_3 \bar{R}$$

Sample:

	1	2	3	4	5
1	12.11	12.15	12.09	12.12	12.09
2	12.10	12.12	12.03	12.10	12.19
3	12.11	12.10	12.11	12.08	12.13
4	12.08	12.11	12.15	12.10	12.12
\bar{R}	0.03	0.05	0.06	0.04	0.05

$$\bar{R} = 0.046$$

$$UCL = D_4 \bar{R}$$

$$= 2.28 \times 0.046$$

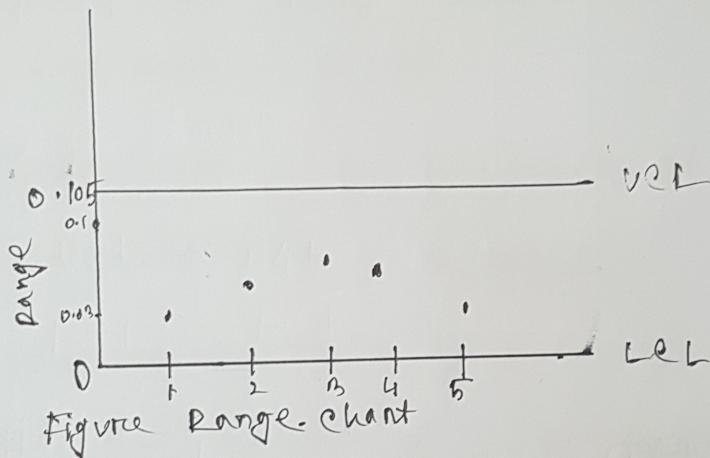
$$= 0.105$$

$$LCL = D_3 \bar{R}$$

$$= 0 \times 0.046$$

$$= 0$$

$D_3 \approx 0$ $D_4 \approx 2.28$
 value question a
 (0.105 approx)
 Answer,
 $D_4 = 2.28$
 $D_3 = 0$



To construct a Frequency distribution from this data we proceed as follows.

1. Determine the largest and smallest number in the raw data
2. Find the range (difference between largest and smallest number)
3. Determine the number of classes
4. Calculate class interval
5. Determine class frequencies.
6. At the bottom of the frequency column record the total frequency.

Data table!

3.67	10.94	5.47	8.69	2.84
3.183	4.80	5.42	1.97	2.09
6.72	4.95	4.65	3.32	2.78
3.34	6.45	5.11	7.20	3.53
5.10	9.15	3.89	3.65	4.10
2.75	1.93	4.15	4.85	3.21

Step-1:

$$\text{largest value} = 10.94$$

$$\text{smallest value} = 1.83$$

Step-2: Range = $10.94 - 1.83$
 $= 9.11$

Step-3: In order to determine number of classes we will use

$$\cancel{e^k \geq n}$$

[k is smallest positive Number]

$e^k > 1$ [k is the smallest positive number]

$$e^k > 1 \text{ } 3 \text{ } 0$$

when,

$$k=1:$$

$$\begin{aligned} 2^{\cancel{k}} &= 2 \\ \text{when } k &= 2 \\ 2^2 &= 4 \end{aligned}$$

when $k=3$

$$2^3 = 8$$

when $k=4$

$$2^4 = 16$$

when $k=5$

$$2^5 = 32$$

∴ For this example number of class,

$$k=5$$

Step - 4:

Step 4:

Class Interval
1.5 - 3.5
3.5 - 5.5
5.5 - 7.5
7.5 - 9.5
9.5 - 11.5

$$\text{size of the class interval} = \frac{\text{largest value} - \text{smallest value}}{\text{Number of classes}}$$

$$= \frac{9.5 - 1.5}{5}$$

$$= 1.82 \approx 2$$



Step - 5:

Class Interval	Tally	Frequency
1.5 - 3.5		10
3.5 - 5.5		14
5.5 - 7.5		3
7.5 - 9.5		2
9.5 - 11.5		1

* Histogram drawn
below -> frequency = number

20000 a.m.d.t.

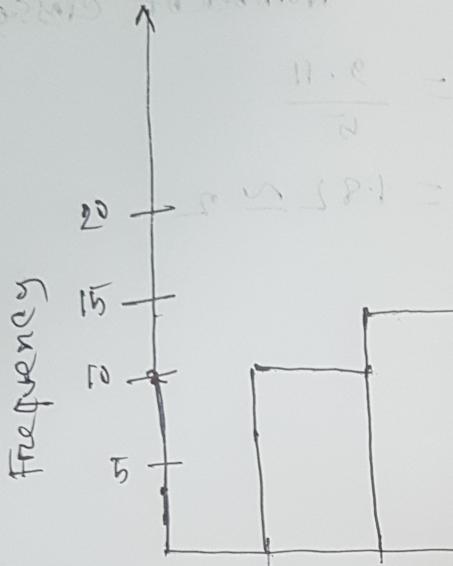


Figure: Histogram