OME

28/1/19

Basic Tools

- Flow chart
- Run chart
- Imp - control chart
- causes & effect diagram (fishbone)
- check sheet
- Histogram
- Imp Pareto analysis

80% of the problems may be attributed to 20% of the cause.

Arithmatic Mean ($\bar{X}$)

It is the average of all the values of the varient in the sample $x_1, x_2 \ldots x_n$ are the 'n' values of the varient 'X' in the sample, then arithematic mean is given by

$$\bar{X} = \frac{x_1 + x_2 + x_3 \ldots x_n}{n} = \frac{\Sigma x}{n}$$

If x_1 occurs f_1 times & x_2 occurs f_2 times etc., x_n occurs f_n times will be 'n' observation all together.

$$\frac{f_1 x_1 + f_2 x_2 + f_3 x_3 + \cdots f_n x_n}{f_1 + f_2 + f_3 \cdots + f_n}$$

Median :-

when all the observations are arranged in ascending or descending order, then median is the magnitude of the middle case, it has half the observations above it & below it.

$$\text{Median} = Md - l_m + \left[\frac{N/2 - cf_m}{f_m}\right] x_i$$

where l_m = lower number of the cell with the median.
N = total number of observation
cf_m = cumulative frequency of all cells below l_m
f_m = frequency of median.
i = cell intervals.

~~Mode~~ Mode :-

It is the value that occurs most frequently, in a frequency histogram, it is the observed value corresponding to the high point of the ~~graph~~ graph for example, the recorded observation 2, 3, 2, 4, 2, 2, 5, 7, 2, 4, 2 here 2 occurs most of times hence mode is '2'.

Range :-

It is a simplest measure of dispersion in a sum.

Standard deviation

defined as root mean square the differences b/n observation & median.

$$\sigma = \sqrt{\frac{\Sigma f x^2}{n} - \bar{X}^2}$$

Varience :-

This is the sum of the square of the deviation arithmatic mean divided by the no of observations 'a' in other words,

$$\text{Varience} = \sqrt{(S \cdot D)}^2$$

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4/2/19 Five thermostatic control are tested, to determine the temperature the measured values are 344, 338°c, 342°c, 335°c, 336°c. These values consitutive the first subgroup for certain control chart. compute the arithmatic mean, median, range, SD & varience of this subgroup.

Mean = $\frac{344 + 338 + 342 + 335 + 336}{5}$

= 339°c

Median = 338°c

1st arrange in ascending order.

335, 336, 338, 342, 344

range

Hieght value − lowest value,

344 − 335

= 9°c

Standard Diviation

$$\sqrt{\frac{(335-339)^2 + (336-339)^2 + (338-339)^2 + (342-339)^2 + (344-339)^2}{5}}$$

$$= \sqrt{\frac{16 + 9 + 1 + 9 + 25}{5}} = \sqrt{60/5}$$

= 3.464

Varience :- $(3.46)^2 = 11.97$

Imp

Machine shop produces screw. The width of 100 pills when check after machining & data goes recorded as follows.

width in mm	Frequency f	X	f x	X^2	fX^2
9.50 - 9.51	6	9.505	57.03	90.35	542.1
9.52 - 9.53	2	9.525	19.05	90.73	[illegible]
9.54 - 9.55	20	9.545	190.9	91.11	[illegible]
9.56 - 9.57	32	9.565 (lm)	306.08	91.49	2927.68
9.58 - 9.59	22	9.585	210.87	91.87	2021.14
9.60 - 9.61	8	9.605	76.84	92.2560	738.08
9.62 - 9.63	6	9.625	57.75	92.6406	555.84
9.64 - 9.65	4	9.645	38.58	93.02	372.12
			= ~~785.29~~ = 957.1		= 9160.4

a) where find the arithmatic mean, S.D & varience.

b) what % of the pins manufactured has width of 9.52 - 9.63.

Mean $= \bar{X} = \frac{\Sigma f x}{n} = \frac{957.1}{100} = 9.571$

(σ)

$S.D = \sqrt{\frac{\Sigma f x^2}{n} - \bar{x}^2}$

$= \sqrt{\frac{9160.4}{100} - (9.571)^2} = \cancel{91.750}$

$= \sqrt{\cancel{\frac{9008.796}{100}}}$

$= \sqrt{91.604 - 91.6}$

$= 0.0309$

Varience $= (SD)^2$ $\sqrt{S.D}$

$= 9.5481 \times 10^{-4}$

b) $Z1 = \frac{X1 - \bar{X}}{\sigma}$

$Z2 = \frac{X2 - \bar{X}}{\sigma}$

$Z1 = \frac{9.52 - 9.571}{0.0309} = -1.65$

$= 0.0495$

$Z2 = \frac{9.63 - 9.571}{0.0309} = 1.9$

$= \cancel{0.9973}$

0.9913

$\cancel{Z2} - Z1$

$= 0.0495 - 0.9258$

$= 0.923$

8/2/19 Median :-

$lm + \left[\frac{N/2 - cfn}{fm}\right] x i$

$lm = 9.565 + \left[\frac{100/2 - 40}{32}\right]$

$\boxed{28 - 9.571}$

$9.565 + [10/32] \times 0.01$

$= 9.565 + 0.325 \times 0.01$

$9.562 + 0.003125$

$= 9.568125$

794.75

$= 794.75$ $= 3190.448$

weight (grms)	frequency f	x	fx	x^2	fx^2
3.0 - 3.25	6	3.125	18.75	9.7656 ~~351.5625~~	58.593
3.25 - 3.50	19	3.375	64.125	11.3906	216.421
3.50 - 3.75	35	3.625	126.875	13.1406	459.921
3.75 - 4.00	44	3.875	170.5	15.0156	660.687
4.00 - 4.25	47	4.125	193.875	17.0156	799.734
4.25 - 4.50	29	4.375	126.875	19.1406	555.0724 ~~437.890~~
4.50 - 4.75	15	4.625	69.375	21.3906	320.859
4.75 - 5.00	5	4.875	24.375	23.7656	118.828

Mean, median, mode, S.D, Varience & range.

Mean $\bar{x} = \frac{\Sigma fx}{n}$

$= \frac{794.75}{200} = 3.973$

~~Med~~ SD $\sqrt{\frac{\Sigma fx^2}{n} - \bar{x}^2}$

$= \sqrt{\frac{3190.448}{200} - 15.784}$ ~~794.75~~

$= \sqrt{15.95 - 15.78}$

$= 0.41$

0.17229

range $=$ HV - LV

$= 5 - 3$

$= 2$

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Median $= lm + \left[\frac{N/2 - cfn}{fm}\right] \times i$

$= 3.875 + \left[\frac{200/2 - 60}{44}\right] \times 0.25$

$= 3.875 \left[\frac{100 - 60}{44}\right] \times 0.25$

$= 4.1022$

$96 = 3.897$

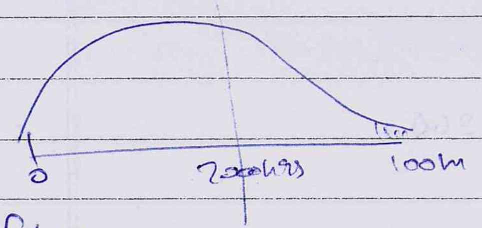
Mode $= l + \left[\frac{f_2}{f_1 + f_2}\right] \times i$

$= \cancel{3.75}\ \cancel{4.4} \cancel{\left[\frac{29}{29+44}\right]}$ $\quad 4 + \left[\frac{29}{29+44}\right] \times 0.25$

lowest of next of middlevalue. + frequency of f_2 below & f_1 above.

$= 4 + 0.093$

$= 4.099$



Problem

a) ~~above~~ more 30000

$\bar{x} = 2000$

$X = 2000$

$\sigma = 400$

$z_1 = \frac{X_1 - \bar{X}}{\sigma}$

$= \frac{3000 - 2000}{400} = 2.5 = 0.9938$

$= 1 - 0.9938$

250 125 :

~~H.H1~~ x 2000

	f	X	fx	fx^2
498 - 498.5	1	498.25	498.25	298253.0825
498.5 - 499	2	498.75	997.5	497503.125
499.5 - 500	4	499.25	1997	997002.25
500.5 - 501	7	499.75	3498.75	1748256.438
501.5 - 502	13	500.25	6503.25	3253750.813
502.5 - 503	17	500.75	8512.75	3259757.313
503.5 - 504	25	501.25	12531.75	6281289.063
	34	501.75	17059.5	8559604.125
	30	502.25	15067.5	7567651.875
	41	502.75	20612.75	10363060.06
	29	503.25	14594.25	7344556.313
	25	503.75	12593.75	6344101.563
	12	504.25	6051	3051216.75
	7	504.75	3533.75	1783407.938
	2	505.25	1010.5	510555.125
505.5 - 506	1	505.75	505.75	255783.0625
	= 250		= 125566.5	= 63068245

$$\text{Mean} = \frac{\Sigma fx}{n}$$

$$= \frac{125566.5}{250} = 502.266$$

$$SD = \sqrt{\frac{\Sigma fx^2}{n} - (\bar{X})^2}$$

$$= \sqrt{\frac{63068245}{250} - 20270399.13}$$

$$= 1.358$$

$$\text{Median} = lm + \left[\frac{N/2 - cfn}{fn}\right] \times i$$

$$= 502.75 + \left[\frac{\frac{250}{2} - 133}{41}\right] \times 0.5$$

$$= 502.75 + \left[\frac{125 - 133}{41}\right] \times 0.5$$

$$= +502.652439 \Rightarrow$$

$$\text{Mode} = l + \left[\frac{f_2}{f_1 + f_2}\right] \times i$$

$$= 502.75 + \left[\frac{29}{30+29}\right] \times i$$

$$= 502.745$$

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UNIT - 3

(write a note on ...)

Problem

The control chart $\bar{X}$ & R are maintained on certain dimension of manufactured path, measured in mm. The subgroup size is 4. The values of $\bar{X}$ & R are compiled for each sub group. After 20 subgroups $\Sigma \bar{X} = 412.83$ $\Sigma R = 3.39$. compute for value of 3 sigma limit for the $\bar{X}$ & R charts and a estimate value of σ'. assumption that the process present statistical control.

Step 1 :-

determine $\bar{\bar{X}}$ which is equal to $\frac{\Sigma \bar{X}}{N}$

$$\left(\Sigma \bar{X} = \bar{X}1 + \bar{X}2 + \cdots + \bar{X}_n \right)$$

Step 2

determine $\bar{R} = \frac{\Sigma R}{N}$

$(\Sigma R = R1 + R2 + \cdots + R_n)$

(N = is subgroup size used to determine $\Sigma \bar{x}$ & ΣR)

Step 3 :-

determine σ'

(S.D for different no of nodes.)

$$\sigma' = \frac{\bar{R}}{d_2}$$ (d_2 = value is from table 'C')

where d_2 is the value obtain for specific subgroup of interest (n).

Step 4 :

determine control chart

To determine $UCL_{\bar{X}} = \bar{\bar{X}} + 3\sigma_{\bar{X}}$

where $3\sigma_{\bar{X}} = \frac{3\sigma'}{\sqrt{n}}$

- lower control limit

$$LCL_{\bar{X}} = \bar{\bar{X}} - 3\sigma_{\bar{X}}$$

Step 5 :-

determine R chart

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

where D_4 canbe obtained from table 'D' for specific subgroup n.

lower control limit R

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

D_3 canbe obtain from 'D' for specific subgroup size

$$\Rightarrow \bar{\bar{X}} = \frac{\Sigma \bar{X}}{N} = \frac{412.83}{20} = 20.6415$$

$$\bar{R} = \frac{\Sigma R}{N} = \frac{3.39}{20} = 0.169$$

$$\sigma' = \frac{\bar{R}}{d_2} = \frac{0.169}{2.059} = 0.0820$$

$UCL_{\bar{x}} = \bar{\bar{X}} + 3\sigma_{\bar{x}}$

$3\sigma_{\bar{x}} = \frac{3\sigma'}{\sqrt{n}}$

$= \frac{3 \times 0.082}{\sqrt{4}} = 0.123$

$20.6415 +$

$= \cancel{20.7038} \quad \underline{20.76}$

$LCL_{\bar{x}} = \bar{\bar{X}} - 3\sigma_{\bar{x}}$

$= 20.6415 - \cancel{0.0615}\ 0.123$

$= \underline{20.518}$

$UCL_R = D_4 \bar{R}$

$= 2.28 \times 0.169$

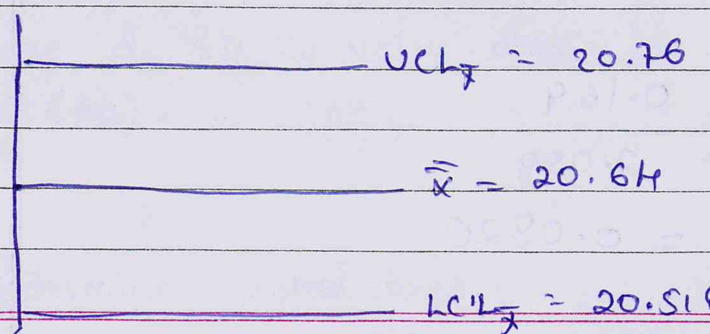
$= \underline{0.3853}$

$LCL_R = D_3 \bar{R}$

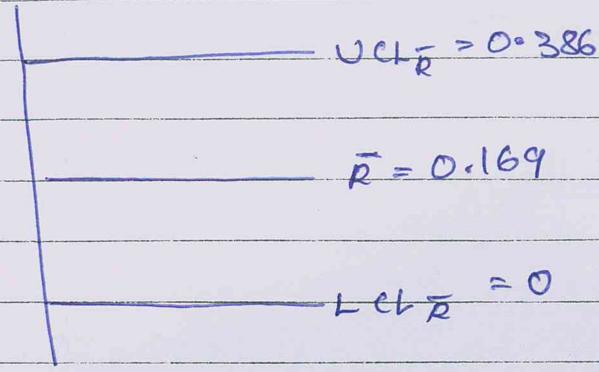
$= 0 \times 0.169$

$\underline{0}$

control chart



Rchart



2) In the capability study of a lathe used to turning in shap to a dice of 23.75 ± 0.1. A sample of 6 consicutive pieces were taken each day for 8 days. Diae of of these shap as is bellow.

1st day	2nd	3rd	4th	5th	6th	7th	8th day
23.77	23.80	23.77	23.79	23.75	23.78	23.76	23.76
23.80	23.78	23.78	23.76	23.78	23.76	23.78	23.79
23.78	23.76	23.77	23.79	23.78	23.73	23.75	23.77
23.78	23.70	23.77	23.74	23.77	23.76	23.76	23.72
23.76	23.81	23.80	23.82	23.76	23.74	23.81	23.78
23.75	23.77	23.74	23.76	23.79	23.78	23.80	23.78
=23.765	=23.77	=23.771	=23.776	23.771	23.758	23.776	=23.766

construct the $\bar{X}$ & R chart & find out process ~~n=6~~ capability for the machine.

$\bar{\bar{X}} = \frac{\Sigma \bar{X}}{N_{(=8)}} = \cancel{3.960}$

$\frac{190.12}{8} = 23.765$

~~$UCL_{\bar{x}} = \bar{\bar{X}} + 3\sigma_{\bar{X}}$~~

~~$= 23.769 +$~~

$$\bar{R} = \frac{\Sigma R}{N}$$

$R_1 = H - L$

$= 23.80 - 23.73$

$= 0.07$

$R_2 = 0.11$

$R_3 = 0.06$

$R_4 = 0.08$

$R_5 = 0.04$

$R_6 = 0.05$

$R_7 = 0.06$

$R_8 = 0.07$

$\bar{R} = 0.0675$

$$\sigma' = \frac{\bar{R}}{d_2} = \frac{0.0675}{2.534}$$

$= 0.0266$

$UCL_{\bar{x}} = \bar{x} + 3\sigma_{\bar{x}}$

$$3\sigma_{\bar{x}} = \frac{3\sigma'}{\sqrt{n}} = \frac{3 \times 0.0266}{\sqrt{6}}$$

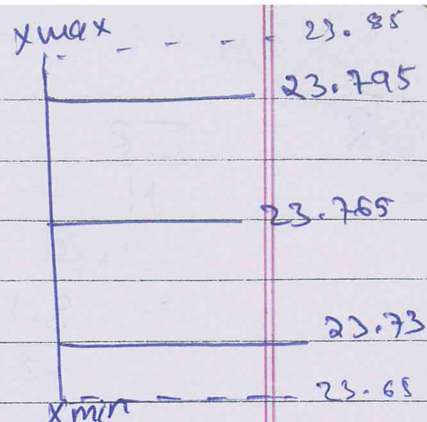
$= 0.0325$

$= \cancel{20.0266}\ 23.765 + 0.0325$

$= \cancel{0.0591}\ 23.795$

$LCL_{\bar{x}} = \cancel{0.0266}\ 23.765 - 0.0325$

$= 23.73$



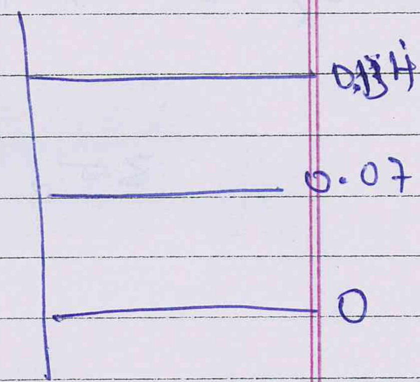
$x_{max} - x_{min} = 0.2$ is greater than $6\sigma'$

$(23.85 - 23.65)$ by default process will be capable.

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

$= 2 \times 0.07$

$= 0.134$



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

$= 0 \times 0.07$

$= 0$

A subgroup of 5 item each are taken from a manufacturing process at a regular interval. A certain policy characteristic is measured & $\bar{X}$ & $\bar{R}$ value are computed. After 25 subgroup it is found that ~~Sum~~ $\Sigma \bar{X} = 357.50$ & $\Sigma R = 8.80$. If the specification limits are 14.40 ± 0.4, & the process is in statistical control, what conclusion can you draw about the ability of the process produced items within specification.

$$\bar{\bar{X}} = \frac{\Sigma \bar{X}}{N} = \frac{357.50}{25} = 14.3$$

$$\bar{R} = \frac{\Sigma R}{N}$$

$$= \frac{8.80}{25} = 0.352$$

$$\sigma' = \frac{\bar{R}}{d_2} = \frac{0.352}{2.326} = 0.151$$

$$UCL_{\bar{x}} = \bar{\bar{x}} + 3\sigma_{\bar{x}}$$

$$3\sigma_{\bar{x}} = \frac{3\sigma'}{\sqrt{n}}$$

$$= \frac{3 \times 0.151}{\sqrt{5}} = 0.202$$

$$= 14.3 + 0.202$$

$$= 14.502$$

$$LCL_{\bar{x}} = 14.3 - 0.202$$

$$= 14.098$$

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

$$= 2.11 \times 0.352$$

$$= 0.742$$

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$$LCL_{\bar{R}} = d_3 \bar{R} = 0 \times 0.352$$

$$= 0$$

$$(X_{max} - X_{min})$$

$$X_{max} = 14.40 + 0.4 = 14.8$$

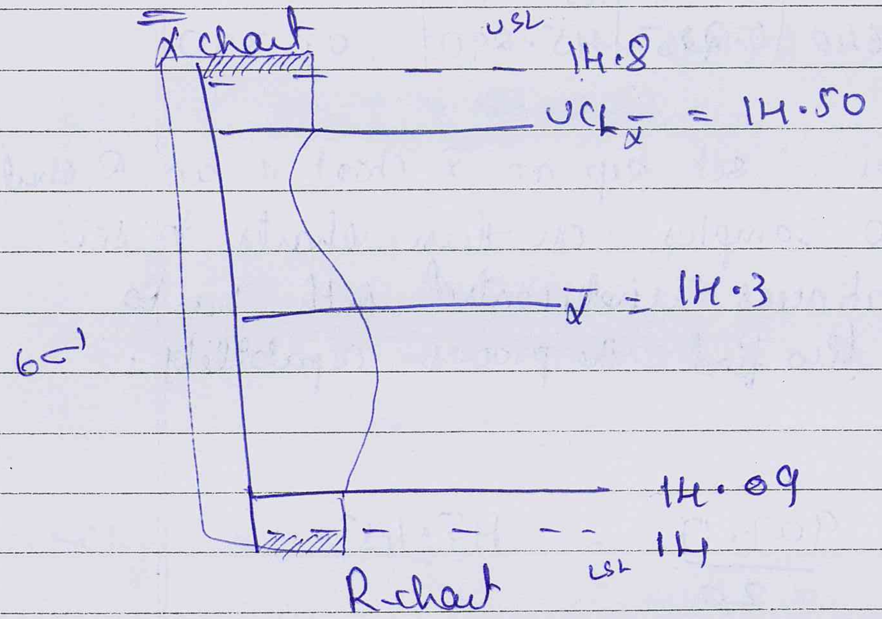
$$X_{min} = 14.40 - 0.4 = 14.$$

$$= 14.8 - 14 = 0.8$$

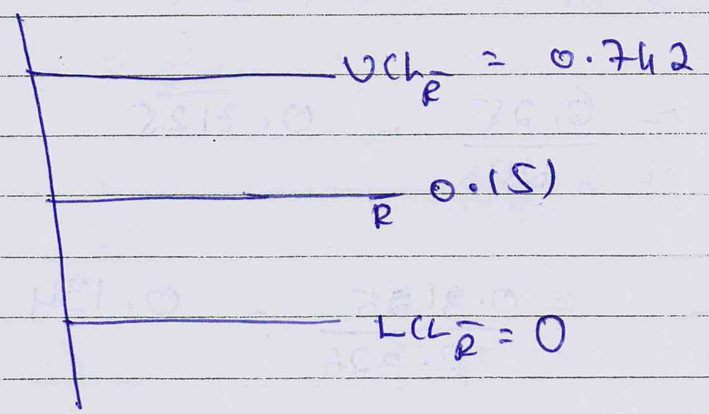
$$6\sigma'$$

$$= 6 \times 0.151$$

$$= 0.906$$



R-chart



The following table shows the averages & ranges of Spindle diameter in milimeters. For 30 subgroups of 5 items each.

$\bar{X}$	$\bar{R}$	$\bar{X}$	$\bar{R}$	$\bar{X}$	$\bar{R}$
45.020	0.375	45.600	0.275	45.260	0.150
44.950	0.450	45.020	0.175	45.650	0.200
45.480	0.450	45.320	0.200	45.620	0.400
45.320	0.150	45.560	0.425	45.480	0.225
45.280	0.200	45.140	0.250	45.380	0.125
45.820	0.250	45.620	0.375	45.680	0.850
45.580	0.275	45.800	0.475	45.260	0.225
45.400	0.475	45.500	0.200	45.640	0.375
45.660	0.475	45.780	0.275	45.390	0.650
45.680	0.275	45.640	0.225	45.290	0.350

For the 1st 20 Samples set up an $\bar{x}$ chart & an R chart plot the next 10 samples on these charts to see with the process continues under control both has to average and range. Also find the process capability.

$$\bar{\bar{x}} = \frac{\Sigma \bar{X}}{N} = \frac{909.17}{20} = 45.45$$

$$\bar{R} = \frac{\Sigma R}{N} = \frac{6.25}{20} = 0.3125$$

$$\sigma' = \frac{\bar{R}}{d_2} = \frac{0.3125}{2.326} = 0.134$$

Process capability

$$6\sigma' = 6 \times 0.134$$

$$= 0.8$$

$$UCL_{\bar{x}} = \bar{\bar{x}} + 3\sigma'_{\bar{x}}$$

$$3\sigma' = \frac{3\sigma'}{\sqrt{n}}$$

$$= \frac{3 \times 0.134}{\sqrt{5}}$$

$$= 0.179$$

$$= 45.45 + 0.179$$

$$= 45.639$$

$$LCL_{\bar{x}} = \bar{\bar{x}} - 3\sigma_{\bar{x}}$$

$$= 45.45 - 0.179$$

$$= 45.271$$

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

$$= 2.11 \times 0.312$$

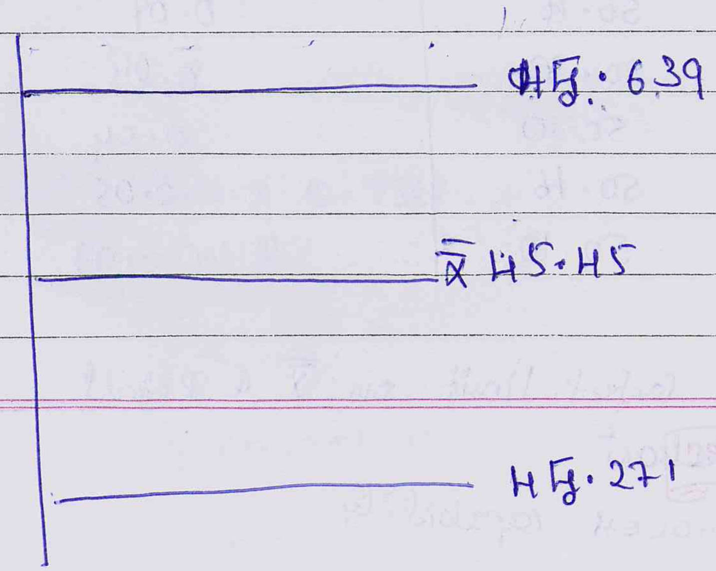
$$= 0.658$$

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

$$= 0 \times 0.312$$

$$= 0$$

$\bar{x}$ chart



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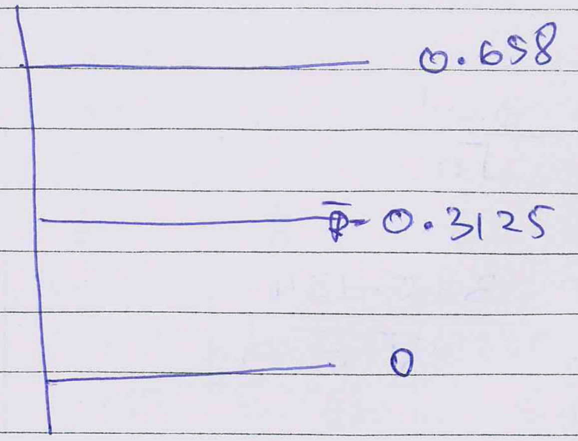


25/2/1x

The $\bar{\bar{x}}$ chart this should be established based on the standard values of $\mu = 600$ & $\sigma = 12$ where $n = 9$

In the manufacter of precission pills in which the diameter of the pins is the quality characteristics should be controlled, 10 samples of 5 pins each where collected after a laps of every 30 min periods. $\bar{\bar{x}}$ & R for each sample where calculated & results were recorded as given below.

Sample no.	$\bar{\bar{x}}$	R
1	50.04	0.07
2	50.24	0.08
3	50.14	0.03
4	50.08	0.05
5	50.28	0.04
6	50.16	0.09
7	50.30	0.04
8	50.10	0.04
9	50.16	0.05
10	50.10	0.07

-) 1st determine the control limit on $\bar{x}$ & R chart
-) plot the $\bar{x}$ & R chart
-) determine process capability

$\bar{\bar{x}} = \frac{\Sigma \bar{x}}{N} = 50.16$

$R = \frac{\Sigma R}{N} = 0.056$

$\sigma' = \frac{\bar{R}}{d_2} = \frac{0.056}{2.326} = 0.024$

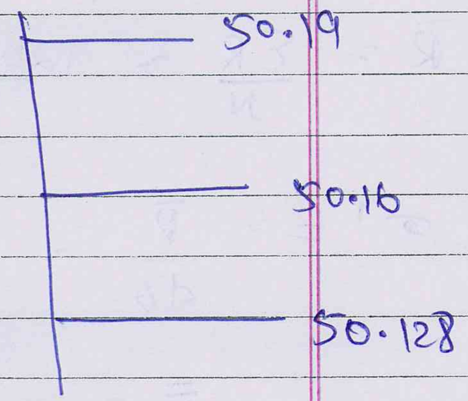
Process probability $= 6\sigma'$
$= 6 \times 0.024$
$= \underline{0.144}$

$UCL_{\bar{x}} = \bar{\bar{x}} + 3\sigma'_{\bar{x}}$

$3\sigma = \frac{3\sigma'}{\sqrt{n}}$

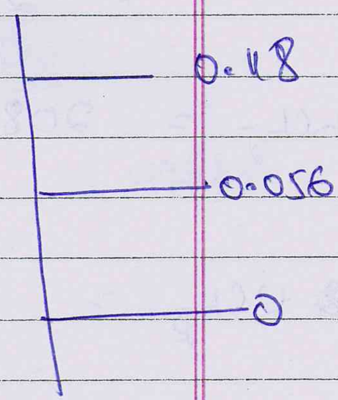
$= \frac{3 \times 0.024}{\sqrt{5}}$

$= 50.16 + 0.032$
$= 50.192$



$LCL_{\bar{x}} = 50.128$

$UCL_{\bar{R}} = D_4 \bar{R}$
$= 2.11 \times 0.056$
$= 0.118$



$LCL_{\bar{R}} = D_3 \bar{R}$
0×0.056
$= \underline{0}$

control chart for $\bar{X}$ & R are maintained on a certain quality chars. of a manufacture product. Subgroup size is 7 & the values of $\bar{X}$ & R are computed for each subgroup. After 35 subgroups, $\Sigma\bar{X} = 7805$ & $\Sigma R = 12,000$. Compute the control limit for the above chart. The specification quality characteristics is 220 ± 35. what is the process capability, what % of the component likely to be rejected if so is there any way the situation can be improved.

$N = 35$
$n = 7$

$$\bar{\bar{X}} = \frac{\Sigma\bar{X}}{N} = \frac{7805}{35} = 223$$

$$\bar{R} = \frac{\Sigma R}{N} = \frac{12000}{35} = 34.28$$

$$\sigma' = \frac{\bar{R}}{d_2} = \frac{34.28}{2.704} = \cancel{126.796}\ 12.679$$

$$UCL = \bar{\bar{X}} + 3\sigma_{\bar{x}}$$

$3\sigma' = 3 \times 126.796$

$$= 223 + 14.377$$
$$= 237.37$$

$$LCL_{\bar{x}} = 208.63$$

$$UCL_{\bar{R}} = D_4\bar{R}$$
$$= 1.92 \times 34.28$$
$$= 65.8176$$

$$LCL_{\bar{R}} = D_3\bar{R} = 0.08 \times 34.28$$
$$= 2.74$$

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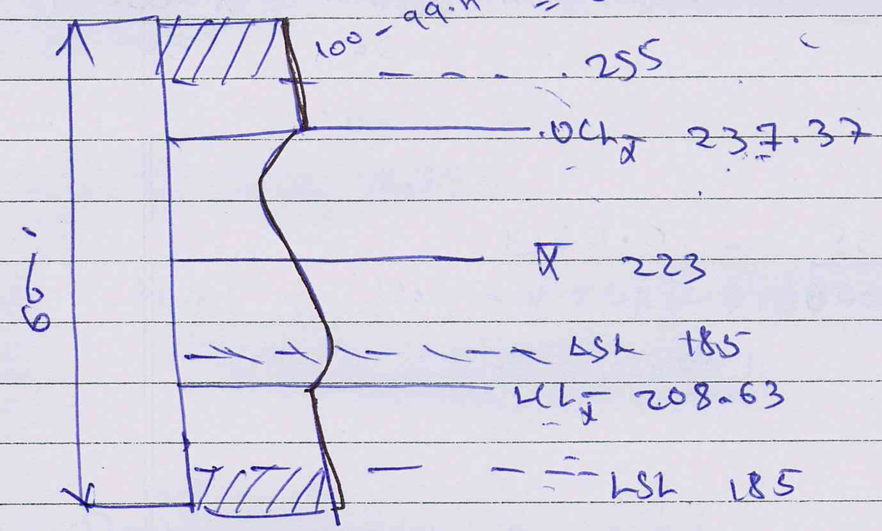
process capability

$x_{max} - x_{min}$

$= 255 - 185$

$= 70$

$6\sigma' = 6 \times 12.679$
$= 76.074$



$$Z_1 = \frac{185 - 223}{12.679} = -2.997$$
$$= 0.0014 = 0.14\%$$

$$Z_2 = \frac{255 - 223}{12.679} = 2.52$$
$$= 0.9941 = 99.41\%$$

~~$= Z_2 - Z_1$~~
~~$= 0.9941 - 0.0014$~~
~~$= 0.9927$~~
~~$= 99.27\%$~~

$0.59 + 0.14$
$= 0.73\%$

Cp & Cpk

A machine is producing product to a specification of 12.58 ± 0.05. A study of 10 subgroups of size 5 each shows following results. $\bar{\bar{X}} = 12.598$ (μ), $\bar{R} = 0.055$ process exhibits statistical control.

a) determine Cp & Cpk & comment on the process
b) compute % non confirmative if any
c) suggest possible ways to improve the process.

$$C_p = \frac{USL - LSL}{6\sigma} \qquad C_{pk} = \min\left(\frac{\bar{\bar{X}} - LSL}{3\sigma}, \frac{\bar{\bar{X}} - USL}{3\sigma}\right)$$

$$\sigma = \frac{\bar{R}}{d_2} = \frac{0.055}{2.326} = 0.023$$

USL = 12.63
LSL = 12.53

$$= \frac{12.63 - 12.53}{6 \times 0.023} = \underline{0.7062}$$

$$= \cancel{0.0}$$

$$= \min\left(\frac{12.598 - 12.53}{3 \times 0.02636}, \frac{12.598 - 12.63}{3 \times 0.02636}\right)$$

$$\min\left(\frac{0.068}{0.0708}, \frac{-0.032}{0.0708}\right)$$

$$(0.967, -0.45).$$

$$Z_1 = \frac{\bar{X}1 - \bar{\bar{X}}}{\sigma}$$

$$= \frac{12.53 - 12.598}{0.023} = -2.88$$

$= 0.0020$
$= 0.2\%$

$$Z_2 = \frac{X2 - \bar{\bar{X}}}{\sigma} = \frac{12.63 - 12.598}{0.0236}$$

$+1.35$

$= \cancel{-10.08} \qquad = 0.9115$
$= 91.15\%$

$100 - 91.15$
$= 8.85\%$

Total rejection $= 8.85\% + 0.2\%$
$= \underline{9.05\%}$

RELIABILITY :-

Imp:

A reliability of a device is a probability of a device performing its purpose adequately for the period intended under the given operating condition.

$$R(t) = e^{-ct}$$

where $R(t)$ is the reliability of the components
t = intended duration
C = failure rate given by $C = 1/MTTF$

MTTF :-

Mean Time To Failure

Mean time to failure is the avg life span of the component. However, MTTF is not equal to actual life span. Therefore MTTF can be less than actual life span or greater than actual life span.

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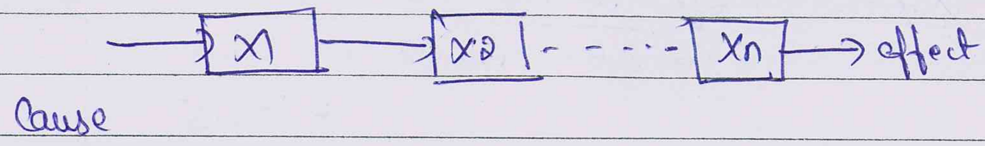
MTBF

Mean Time Between failure

In cases of repairable item, if the items can be repaired & put back to services repeatedly, the avg tym b/n failure is called as MTBF.

Series System :



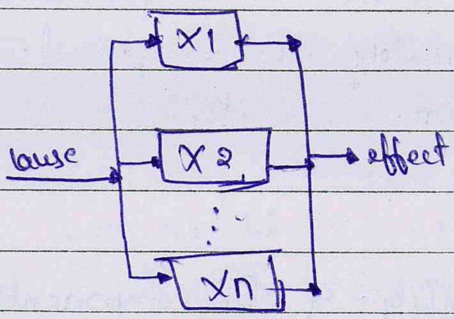
Let X1, X2 -- Xn be the corresponding components assembled in series with their respective failure rates as C1, C2 --- Cn.

$$R(S) = R(X_1) \cdot R(X_2) \cdots R(X_n)$$
$$= e^{-C_1 t} \cdot e^{-C_2 t} \cdots e^{-C_n t}$$

Let $t_1, t_2 \cdots t_n$ be the respective expected working life of respective component.

$$= e^{-C_1 t_1} \cdot e^{-C_2 t_2} \cdots e^{-C_n t_n}.$$

Parallel system :



let X1, X2 --- Xn be the components connected in parallel. Let the probability of each of the units P(X1), P(X2) -- P(Xn) respectively. Also let R(X1), R(X2) --- R(Xn) be the respective reliability & their corresponding failure rates be C1, C2 --- Cn.

$$P(S) = P(X_1) \cdot P(X_2) \cdots P(X_n)$$

Reliability of the system $R(S) = 1 - P(S)$

$$= 1 - [P(X_1) \cdot P(X_2) \cdots P(X_n)]$$
$$= 1 - [(1 - RX_1) \cdot (1 - RX_2) \cdots (1 - RX_n)]$$

$$R(S) = 1 - [(1 - e^{-C_1 t}) \cdot (1 - e^{-C_2 t}) \cdots (1 - e^{-C_n t})]$$

Problem

1) A machine has MTTF of 10,000 hrs. Find the reliability of the system for operating life of

a) 100 hrs

b) 1000 hrs

c) 10000 hrs

Soln :

$$R(100) = e^{-(0.0001 \cdot 100)} \qquad c = 1/10000 = 0.0001$$
$$= \underline{0.99}$$

$$R(1000) = e^{-(0.0001 \cdot 1000)}$$
$$= \underline{0.90}$$

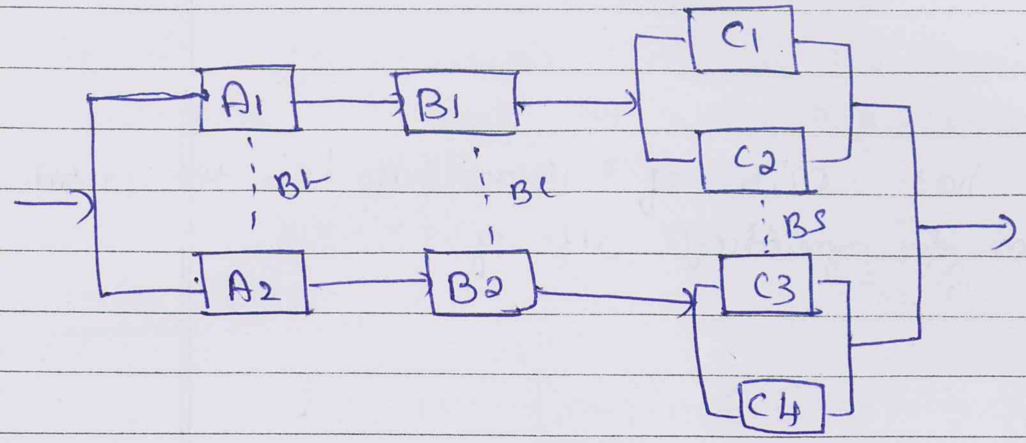
$$R(10000) = e^{-(0.0001 \cdot 10000)}$$
$$= \underline{0.3678}$$

2) There are two sets of bridge in bycle one for front wheel & one for rear. It may be assume that 1 break is sufficient for safe operation. Each break set consits of a hand operated leave, cabel & two ~~set~~ break shoes. 1 break shoe is enough for stoping the bycycle. Hence two breaks are in parallel in the each branch break shoes in parallel & in series the combination with break leave & cabel. If MTBF ~~the~~ components are for break leaves (A) = 500 hrs

break cabel (B) = 100 hrs

break shoes (C) = 20 hrs.

calculate the reliability of overall system for a 2 hrs down hill run.



t = 2hrs

$R(A) = e^{-ct}$ $\quad C = 1/500 = 0.0002$

$= \cancel{e^{-(0.0002 \times 2)}} \; e^{-2/500} = \underline{0.99}$

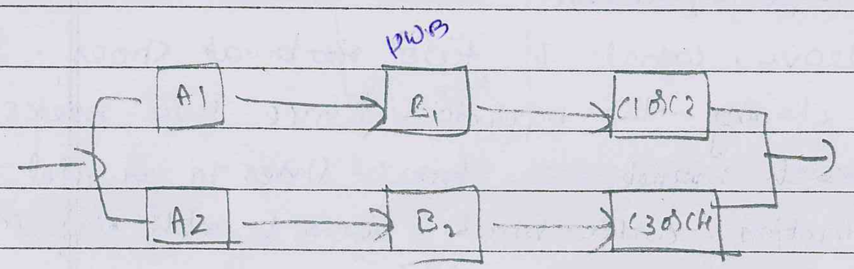
$R(B) = e^{-ct} = e^{-2l} = e^{-2/100}$

$= \underline{0.98}$

$R(C) = e^{-ct} = e^{-2/20} = \underline{0.904}$

$R(C1 \text{ or } C2) = 1 - \left[(1-e^{-c_1 t}) \cdots (1-e^{-c_n t})\right]$

$= 1 - \left[(1-0.904)\cdot(1-0.904)\right] = 0.990$



$R(PWB) = R(A)\cdot R(B)\cdot R(C1 \text{ or } C2) = \underline{0.967}$

$R(S) = 1 - \left[(1-0.967)\cdot(1-0.967)\right]$

$= \left[1-(0.033)\cdot 0.033\right]$

$= 1 - 0.001089$

$= \underline{0.9989}$

Consider the breaking system of an automobile as shown in below. There are two partly dependent system. One is the pedal operated (A) & the other is a mechanical system (B). both actuate same set of break shoes for safe functions. Actuate either both be front wheels breaks (C) or both the rare wheels (D). For safe functions both front & rare will breaks must function otherwise uncontroling. Calculating the reliability of overall system. If individual reliability are given as follows.

$R(A_1) = 0.990$

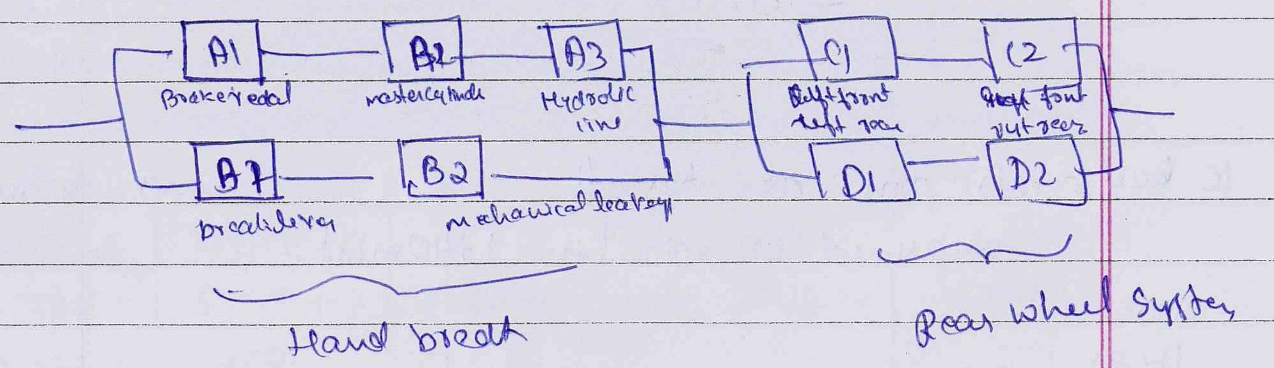
$R(A_2) = 0.970$

$R(A_3) = 0.968$

$R(B_1) = 0.94$

$R(B_2) = 0.975$

$R(C1) = R(C2) = R(D1) = R(D2) = 0.75$



$R(A_1) = e^{-\lambda t}$

$R(A) = R(A1) \cdot R(A_2) \cdot R(A3)$
$= 0.9295 = 92.95\%$

$R(B) = R(B1) \cdot R(B2)$
$= 0.9165 = 91.6\%$

$R(C1 \text{ or } C2) = R(C1) \cdot R(C2)$
$= 0.75 \times 0.75$
$= 0.5625 = 56.25\%$

$R(D_1 \text{ or } D_1) = 0.5625 = 56.25\%$

$R(A,B) = 1 - [(1-R(A)) \cdot (1-R(B))]$
$= 1 - [(1-0.9295)](1-0.9165)$
$= 0.9941$

$R(C,D) = 1 - [(1-R(C1 \text{ or } C2)) \cdot (1-R(D1 \text{ or } D2))]$
$= 1 - [(1-.5625) \cdot (1-0.5625)]$
$= 1 - (0.4375 \cdot 0.4375)$
$= 0.808$

10 ball points pens are tested times to running measured in minutes 1740mint,

2000 mint
1421 mint
1857 mint
1246 mint
1683 mint
1890
1676

compute the mean life & rate of failure. what is the reliability that a brand new refil will last 20hrs of writing.

Soln:

mean time : 1720.5

$= 1/1720.5 = 0.00005812$

UNIT - 4

8/3/19 :- A plastic cabinate supply company is a only home subsidary of an international firm that has major intrest in housing industry. The plat located in boston, seadel, miami. A plants produced 3 fabricated housing components. that are delivered to other company assembly plants in chicago, denwork & nashally. Demand has grown to the point where compny cany justified construction of another plant. Immidical problem is determi-ning the location that will minimize production & transpota-tion cost to the existing assembly plants. In order to be close to raw material & to service to other potential market, the alternative plant location have been narrow down to omaha & phoenex. Cost, demand & production data on the various alternative are as shown in table (a) & (b) below.

Production Data			Assembly Demand	
Plants	units/mnth	cost/unit	Plant	unit/mnth
Boston	2000	\$7	Chicago	6000
Seadel	6000	\$7.08	Denmark	5000
miami	5000	\$ 6.90	Nashwally	6000
Omaha	4000	\$ 6.90		
Phoenex	4000	\$ 6.20		

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Transportation cost/unit ($)

TO	From				
	Boston	Seal	Miami	omaha	Phoenix
Chicago	$5	$7	$ 5	$ 4	$ 6
Den	$ 6	$ 4	$ 7	$ 3	$ 4.5
Nash	$ 5.50	$ 7	$ 3	$ 5	$ 5

Soln :- (Penalty method)

min of 2 cols u row cells

	Boston	Sea	miami	omaha	Demand	Penalty
Chi	2000 [5]	[7]	[5]	4000 [4]	~~6000~~ 2000	1 1 1 2
Den	[6]	5000 [4]	[7]	[3]	~~5000~~	~~1~~
Nash	[5.50]	1000 [7]	5000 [3]	[5]	~~6000~~ 1000	2 2 0.5 2.5
Supply	2000	~~6000~~ 1000	5000	4000	= 17000	
penalty	0.5	3	2	1		

nxt: select high' penalty from row / col

select lowest of them & then Demand - Supply

0.5	0	2	1
0.5	0	0	1
0.5	0	0	0

Total tranportation cost considering omaha

$2000 \times 5 + 4000 \times 4 + 5000 \times 4 + 1000 \times 7 + 5000 \times 3$

$= 10000 + 16000 + 20000 + 7000 + 15000$

$= \$ 68000$

production cost $= 4000 \times 6.90$

$= 27600$

Total production & transportation is $= \$ 68000 + 27600$

$= \underline{95600}$

#|3|4

	Boston	sea	miami	phenex	Demand		
Chi	2000 [5]	~~1000~~ [7]	[5]	[6]	~~6000~~ 0	0	0 1 1
Den	[6]	5000 [4]	[7]	[4.5]	5000	2.5	
Nas	[5.50]	~~1000~~ [7]	5000 [3]	~~4000~~ [5]	6000 1000	2	2 0.5 2
Supply	2000	~~6000~~ 1000	5000.	~~4000~~ 3000	1700		
	0.5	3	2	0.5			
	0.5	0	2	1			
	0.5	0	0	1			
	0	0	0	1			
	~~0~~	0	~~0~~				

$= 76000$

production (Phenex) $= 24800 \Leftarrow 4000 \times 6.20$

$= 76000 + 24800$

$= \underline{1,00,800}$

Imp Error :-

Type 1 :- There no problem with process but we have conclude there is a error in process.

Type 2 : : Process is correct but in reality it is not correct

6 Sigma

Date / /20

13/3/19

Unit - 4

ENTERPreneurship

Key elements

- Innovation
- Risk taking - Operational excellence
- Vision
- Organizing skill

Enterpreneurial Process

Concept of Enterpreneurship

Entrepreneur - Person
Enterprise - Object
Enterproneurship - process of action

Date / /20