NCERT SOLUTIONS

CLASS - 11th



aglasem.com

Class : 11th
Subject : Statistics
Chapter : 6
Chapter Name : Measures of Dispersion

Q1 A measure of dispersion is a good supplement to the central value in understanding a frequency distribution. Comment.

Answer. In order to have a better understanding of the central value and also of the entire frequency distribution table, we need to study the dispersion of data among the various observations. For example, if there is a huge difference between the low income group and the high income group, then we can conclude that there is a large income disparity in the region.

Page : 89 , Block Name : Exercises

Q2 Which measure of dispersion is the best and how?

Answer. The best measure of dispersion is the Standard Deviation. It is because:

1. It can compare multiple quantities easily.
2. It takes into account every aspect and hence provides a comprehensive assessment.
3. It is least affected by the change of samples.
4. It is independent of the origin.
5. It is algebraic in nature as it takes into account the positive and negative deviations.

aglasem.com

Page : 89 , Block Name : Exercises

Q3 Some measures of dispersion depend upon the spread of values whereas some are estimated on the basis of the variation of values from a central value. Do you agree?

Answer. Yes, some measures of dispersion depend upon the spread of values whereas some are estimated on the basis of the variation of values from a central Value. This is the reason the measures are classified into absolute and relative measures. The absolute measures are the range, standard deviation, etc. whereas the relative measures are coefficient of variation, coefficient of standard deviation, etc.

Page : 89 , Block Name : Exercises

Q4 In a town, 25% of the persons earned more than Rs 45,000 whereas 75% earned more than 18,000. Calculate the absolute and relative values of dispersion.

Answer. The absolute value of dispersion will be quartile deviation.

Quartile Deviation $= \frac{(Q_3 - Q_1)}{2}$

$= \frac{(45000 - 18000)}{2}$

= 13500

The relative value of dispersion will be Coefficient of Quartile Deviation.

Coefficient of Quartile Deviation $= \frac{(Q_3 - Q_1)}{(Q_3 + Q_1)}$

$= \frac{(45000 - 18000)}{(45000 + 18000)}$

= 0.478

Page : 89 , Block Name : Exercises

Q5 The yield of wheat and rice per acre for 10 districts of a state is as under :

District	1	2	3	4	5	6	7	8	9	10
Whear	12	10	15	19	21	16	18	9	25	10
Rice	22	29	13	23	18	15	12	34	18	12

Calculate for each crop,

(i) Range

(ii) Q.D.

(iii) Mean deviation about Mean

(iv) Mean deviation about Median

(v) Standard deviation

(vi) Which crop has greater variation?

(vii) Compare the values of different measures for each crop.

Answer.
(i) The range is the difference between the highest and the lowest values.

Wheat Range = 25-9
= 16

Rice Range = 34-12
= 22

(ii) To calculate Q.D., we need to calculate Q_1 and Q_3.

For Wheat:

Q_1 = $\frac{N+1}{4}$ th item
= 2.75th item
= 10

Q_3 = 3 $\frac{N+1}{4}$ th item
= 8.25th item
= 19.50

Quartile Deviation = $\frac{(Q_3 - Q_1)}{2}$
= $\frac{(19.5 - 10)}{2}$

aglasem.com

= 4.75

For Rice :

Q_1 = $\frac{N+1}{4}$ th item

= 2.75th item

= 12

Q_3 = 3 $\frac{N+1}{4}$ th item

= 8.25th item

= 24.50

Quartile Deviation = $\frac{(Q_3 - Q_1)}{2}$

= $\frac{(24.50 - 12)}{2}$

= 6.75

(iii) Mean of Wheat = $\frac{155}{10}$

= 15.5

Tabulation of Values:

Quantity (X)	Deviation $(d = X - X')$
9	6.5
10	5.5
10	5.5
12	3.5
15	0.5
16	0.5
18	2.5
19	3.5

aglasem.com

21	5.5
25	9.5
	Sum = 43

Deviation about Mean = $R \cup S$

= $\frac{43}{10}$

= 4.3

Mean of Rice= $\frac{195}{10}$

= 19.5

Tabulation of Values:

Quantity (X)	Deviation (d=X-X')
12	7.5
12	7.5
12	7.5
15	4.5
18	1.5
18	1.5
22	2.5
23	3.5
29	9.5
34	14.5
	Sum = 60

Deviation about Mean = $\frac{Sum\ of\ deviation}{N}$

aglasem.com

$$= \frac{60}{10}$$

= 6

(iv) Median of Wheat = $\frac{(15+16)}{2}$

= 15.5

Tabulation of Values:

Quantity (X)	Deviation (d=X-X')
9	6.5
10	5.5
10	5.5
12	3.5
15	0.5
16	0.5
18	2.5
19	3.5
21	5.5
25	9.5
	Sum = 43

Deviation about Median = $\frac{Sum\ of\ deviation}{N}$

$$= \frac{43}{10}$$

= 4.3

Median of Rice = $\frac{(18+18)}{10}$

= 18

Tabulation of Values:

Quantity (X)	Deviation (d=X-X')
12	6
12	6
12	6
15	3
18	0
18	0
22	4
23	5
29	11
34	16
	Sum = 57

Deviation about Mean $= \frac{Sum\ of\ deviation}{N}$

$= \frac{57}{10}$

= 5.7

(v) For Wheat, the standard deviation can be calculated as

Wheat (X)	d = X – X' (X' = 15.5)	d^2
9	-6.5	42.25
10	-5.5	30.25
10	-5.5	30.25

aglasem.com

12	-3.5	12.25
15	-0.5	0.25
16	0.5	0.25
18	2.5	6.25
19	3.5	12.25
21	5.5	30.25
25	9.5	90.25
$\sum X = 155$	$\sum d = 0$	$\sum d^2 = 254.5$

Therefore, $\sigma = \sqrt{\frac{\Sigma d^2}{N}}$

$= \sqrt{\frac{254.5}{10}}$

= 5.04

For Rice:

as

Rice (Y)	d = Y – Y' (X' = 15.5)	d^2
12	-7.5	56.25
12	-7.5	56.25
12	-7.5	56.25
15	-4.5	20.25
18	-1.5	2.25
18	-1.5	2.25

aglasem.com

22	2.5	6.25
23	3.5	12.25
29	9.5	90.25
34	14.5	210.25
$\sum Y = 155$	$\sum d = 0$	$\sum d^2 = 512.5$

Therefore, σ = $\sqrt{\frac{\Sigma d^2}{N}}$

$$= \begin{bmatrix} (x^{(1)})^T(\theta^{(1)}) & \dots & (x^{(1)})^T(\theta^{(n_u)}) \\ \vdots & \ddots & \vdots \\ (x^{(n_m)})^T(\theta^{(1)}) & \dots & (x^{(n_m)})^T(\theta^{(n_u)}) \end{bmatrix}$$

= 7.16

(vi) The Coefficient of Variation of Wheat can be calculated as:

CV = $\frac{\sigma \times 100)}{X'}$

CV = $\left(\frac{5.04}{15.5}\right) \times 100$

CV = 32.51

The Coefficient of Variation of Rice can be calculated as:

0

CV = $\frac{\sigma \times 100)}{X'}$

CV = $\left(\frac{7.16}{19.5}\right) \times 100$

CV = 36.71

Therefore, rice has greater variation.

(vii) The comparison can be made using the following table.

aglasem.com

Parameter	Wheat	Rice
Range	16	22
QD	4.75	6.75
MD about Mean	4.3	6
MD about Median	4.3	5.7
SD	5.04	7.16
CV	32.51	36.71

Page : 89 , Block Name : Exercises

Q6 In the previous question, calculate the relative measures of variation and indicate the value which, in your opinion, is more reliable.

Answer. The coefficient of range of wheat can be calculated as:

Coefficient of Range = $\frac{(HL)}{(H+L)}$

= $\frac{(259)}{(25+9)}$

= $\frac{16}{34}$

= 0.47

The coefficient of range of rice can be calculated as:

Coefficient of Range = $\frac{(HL)}{(H+L)}$

$$= \frac{(3412)}{(34+12)}$$

$$= \frac{22}{46}$$

= 0.48

The Coefficient of QD of wheat can be calculated as:

Coefficient of QD = $\frac{(Q_3 Q_1)}{(Q_3 + Q_1)}$

$$= \frac{(19.5010)}{(19.50+10)}$$

= 0.32

The Coefficient of QD of rice can be calculated as:

Coefficient of QD = $\frac{(Q_3 Q_1)}{(Q_3 + Q_1)}$

$$= \frac{(24.5012)}{(24.50+12)}$$

= 0.48

The Coefficient of mean deviation of wheat:

Coefficient of $MD_{X'}$ = $\frac{MD_{X'}}{X'}$

$$= \frac{4.3}{15.5}$$

= 0.28

Coefficient of MD_M = $\frac{MD_M}{M}$

$$= \frac{4.3}{15}$$

= 0.29

The Coefficient of mean deviation of rice:

aglasem.com

Coefficient of $MD_{X'}$ = $\frac{MD_{X'}}{X'}$

= $\frac{6}{19.5}$

= 0.31

Coefficient of MD_M = $\frac{MD_M}{M}$

= $\frac{5.7}{18}$

= 0.32

Page : 89 , Block Name : Exercises

Q7 A batsman is to be selected for a cricket team. The choice is between X and Y on the basis of their scores in five previous tests which are :

X	25	85	40	80	120
Y	50	70	65	45	80

Which batsman should be selected if we want,

(i) a higher run getter, or
(ii) a more reliable batsman in the team?

Answer. The values of dispersion for batsman X are:

X	x = X - X' where, X = 70	X^2
25	-45	2025
85	15	225
40	-30	900
80	10	100
120	50	2500

$\sum X = 350$		$\sum X^2$ = 5750

X' = $\frac{\sum X}{N}$

= $\frac{350}{7}$

= 70

X	X = X - X' where, X' = 70	X^2
25	-45	2025
85	15	225
40	-30	900
80	10	100
120	50	2500
$\sum X$ = 350		$\sum Y^2$ = 5750

$$\bar{X} = \frac{\sum X}{N} = \frac{350}{5} = 70$$

$$\sigma = \sqrt{\frac{\sum X^2}{N}} = \sqrt{\frac{5750}{5}} = 33.91$$

CV = $\frac{\sigma}{\bar{X}} \times 100 = \frac{33.91}{70} \times 100 = 48.44$

The values of dispersion for batsman Y are:

Y	y = Y - Y' where, Y' = 70	$8 - 2\ln(5) \simeq 4,78$
50	-12	144
70	8	64

aglasem.com

65	3	9
45	-17	289
80	18	324
$\sum Y$ = 310		$\sum Y^2$ = 830

$$\bar{Y} = \frac{\sum Y}{N} = \frac{310}{5} = 62$$

$$\sigma = \sqrt{\frac{\sum Y^2}{N}} = \sqrt{\frac{8300}{5}} = 12.88$$

CV = $\frac{\sigma}{\bar{Y}} \times 100 = \frac{12.88}{62} \times 100 = 20.78$

Therefore, to get a higher run getter, we should select batsman X due to high mean.

(ii) As calculated from the values in part (i), we should select batsman Y for reliability due to his lower variation.

Page : 89 , Block Name : Exercises

Q8 To check the quality of two brands of lightbulbs, their life in burning hours was estimated as under for 100 bulbs of each brand.

Life (in hours)	Brand A	Brand B
0-50	15	2
50-100	20	8
100-150	18	60
150-200	25	25
200-250	22	5

	100	100

(i) Which brand gives higher life?
(ii) Which brand is more dependable

Answer. The dispersion parameters can be calculated as:

For Brand A:

Life	No. of Bulbs (f)	Mid value (m)	d = X – A	$d' = \frac{d}{2}$	d'^2	fd'	fd'^2
0-50	15	25	–100	–2	4	–30	60
50-100	20	75	–50	–1	1	–20	20
100-150	18	125 = A	0	0	0	0	0
150-200	25	175	50	1	1	25	25
200-250	22	225	100	2	4	44	88
	$\sum f$ = 100					$\sum fd'$ = 19	$\sum fd'^2$ = 193

$$\bar{X} = A + \frac{\sum fd'}{\sum f} \times c = 125 + \frac{19}{100} \times 50 = 134.5$$

$$\sigma_X = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times c = \sqrt{\frac{193}{100} - \left(\frac{19}{100}\right)^2} \times 50$$

$$\sigma_X = \sqrt{1.93 - 0.0361} \times 50$$

$igned$ = 69

CV = $\frac{\sigma}{\bar{X}} \times 100 = \frac{69}{134.5} \times 100$ =51.3

For Brand B:

aglasem.com

Life	No. of Bulbs (f)	Mid value (m)	d = X – A	d' = $\frac{d}{2}$	d'^2	fd'	fd'^2
0-50	2	25	–100	–2	4	–4	8
50-100	8	75	–50	–1	1	–8	8
100-150	60	125 = A	0	0	0	0	0
150-200	25	175	50	1	1	25	25
200-250	5	225	100	2	4	10	10
	$\sum f$ = 100					$\sum fd'$ = 23	$\sum fd'^2$ = 61

$$\bar{X} = A + \frac{\sum fd'}{\sum f} \times c = 125 + \frac{19}{100} \times 50 = 134.5$$

$$\sigma_x = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times c = \sqrt{\frac{61}{100} - \left(\frac{23}{100}\right)^2} \times 50$$

$\therefore \sigma_x$ = 37.5

CV = $\frac{\sigma}{\bar{X}} \times 100 = \frac{69}{134.5} \times 100$ =27.47

(i) Brand B, due to higher mean.

(ii) Brand A, due to lower variation.

Page : 89 , Block Name : Exercises

Q9 Average daily wage of 50 workers of a factory was Rs 200 with a standard deviation of Rs 40. Each worker is given a raise of Rs 20. What is the new average daily wage and standard deviation? Have the wages become more or less uniform?

Answer. The new average daily wage can be calculated as:

N = 50
X = 50
= 40
X' = $\frac{\sum X}{N}$
200 = $\frac{\sum X}{50}$
$\sum X = 200 \times 50$
= ₹10000

Now, increased wage rate = ₹20
Now, $\sum X = 10000 + 1000\,(50 \times 20)$
= ₹11000

New X' = $\frac{\sum X}{N}$
= $\frac{11000}{50}$
= ₹220

N=50
$\bar{X}$ =200
σ =40
$\bar{X} = \frac{\sum X}{N}$
200 = $\frac{\sum X}{50}$
Thus, $\sum X$ = 200 $\times$ 50 = Rs 10,000
Now, increased wage rate = Rs 20
New $\sum X$ =10,000+1,000 (50×20)=Rs 11,000
$\therefore$ New $\bar{X} = \frac{\sum X}{N} = \frac{11,000}{50}$ =Rs 220

Since standard deviation is independent of origin, it will not change at all.

aglasem.com

Page : 90 , Block Name : Exercises

Q10 If in the previous question, each worker is given a hike of 10% in wages, how are the mean and standard deviation values affected?

Answer. If each worker is given a hike of 10%, the new values will be:

N = 50
X' = 200
σ = 40

Now,

New X' = 200 + 10% of ₹200
New X' = ₹220

Initial SD = ₹40
New SD = ₹40 + ₹4
New SD = ₹44

Page : 90 , Block Name : Exercises

Q11 Calculate the mean deviation using mean and Standard Deviation for the following distribution.

Classes	Frequencies
20-40	3
40-80	6
80-100	20
100-120	12
120-140	9
	50

Answer. The tabulation of values can be done as:

aglasem.com

Classes	(f)	Mid value (m)	d = X – A	d' = $\frac{X-A}{c}$	d'^2	fd'	fd'^2
20-40	3	30	–60	–6	36	–18	108
40-80	6	60	–30	–3	9	–18	54
80-100	20	90 = A	0	0	0	0	0
100-120	12	110	20	2	2	24	48
120-140	9	130	40	4	16	36	144
	$\sum f$ = 50					$diventaline$ = 24	$zodimercato$ = 354

$$\bar{X} = A + \frac{\sum fd'}{\sum f} \times c = 125 + \frac{19}{100} \times 50 = 134.5$$

$$\sigma_x = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times c = \sqrt{\frac{61}{100} - \left(\frac{23}{100}\right)^2} \times 50$$

$\therefore \sigma_x$ = 26.17

$MD_{\bar{x}}$ = $\frac{\sum f|d|}{\sum f} = \frac{960}{50}$ =19.2

Page : 90 , Block Name : Exercises

Q12 The sum of 10 values is 100 and the sum of their squares is 1090. Find out the coefficient of variation.

Answer. The coefficient of variation can be calculated as:

X = 100
N = 10

So, X' = $\frac{\sum X}{N}$

$= \frac{100}{10}$

= 10

$\sum X^2$ = 1090

$\sigma = \sqrt{\left[\left(\frac{1090}{10}\right) - (10)^2\right]}$

= $\sqrt{9}$

= 3

CV = $\frac{(\sigma \times 100)}{X'}$

$\sum X$ =100

N=10

So, $\bar{X} = \frac{\sum X}{N} = \frac{100}{10}$ =10

$\sum X^2$ =1090

$\sigma = \sqrt{\frac{\sum X^2}{N} - \left(\bar{X}\right)^2}$

=$\sqrt{\frac{1090}{10} - (10)^2}$

= $\sqrt{9}$

=3

CV = $\frac{\sigma}{\bar{X}} \times 100$

= $\frac{3}{10} \times 100$

=30

Page : 90 , Block Name : Exercises

aglasem.com

aglasem.com