

9) Solution MANUFACTURING FIRM
 To find the slope (b) and the intercept (a), we will use the Least Squares Method to find the line of best fit:
 $Y = a + bx$ where $a = \bar{Y} - b\bar{X}$ and $b = \frac{n\sum XY - \sum X \sum Y}{n\sum X^2 - (\sum X)^2}$

Quarter	X	Y	X ²	XY	Y ²
1	5	42	25	210	1764
2	7	48	49	336	2304
3	6	45	36	270	2025
4	9	55	81	495	3025
5	10	58	100	580	3364
6	12	63	144	756	3969
7	11	60	121	660	3600
8	14	70	196	980	4900
Sum ($\sum$)	74	441	752	4287	24951

$$\text{Calculating slope (b)} = \frac{n\sum XY - \sum X \sum Y}{n\sum X^2 - (\sum X)^2} = \frac{8(4287) - (74)(441)}{8(752) - (74)^2}$$

$$= \frac{34296 - 32634}{6016 - 5476} = \frac{1662}{540}$$

$$b = 3.078$$

$$\text{Calculating intercept (a)} = \bar{Y} - b\bar{X}$$

$$\bar{X} = \text{mean of } X = 74/8 = 9.25$$

$$\bar{Y} = \text{mean of } Y = 441/8 = 55.125$$

$$a = \bar{Y} - b\bar{X}$$

$$= 55.125 - (3.078 \times 9.25)$$

$$a = 55.125 - 28.4715$$

$$a = 26.654$$

$$\text{Line of best fit} = Y = 26.654 + 3.078x \quad \leftarrow \text{also called Regression Equation}$$

b) Interpretation of the Slope Coefficient

from the calculation in (a) above, the slope ($b = 3.078$) indicates that for every \$1 million increase in training expenditure, labour productivity is expected to increase by approximately 3.08 units per worker. For management, this suggests a positive return on investment in training.

c) 1 billion training expenditure = \$13 million i.e. when $X = 13$

$$\text{Using regression equation or line of best fit} = Y = 26.654 + 3.078x$$

$$Y = 26.654 + 3.078(13)$$

$$Y = 26.654 + 40.014$$

$$Y = 66.67 \text{ units per worker}$$

$$\text{d) Coefficient of Determination (R}^2\text{)} = \frac{[n\sum XY - \sum X \sum Y]^2}{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]} = \frac{(1662)^2}{(540)[8(24951) - (441)^2]}$$

$$= \frac{2762244}{540 \times [199608 - 194481]} = \frac{2762244}{540 \times 5127}$$

$$R^2 = \frac{2762244}{2768580} = 0.9977$$

Meaning: Approximately 99.8% of the variation in labour productivity is explained by training expenditure. This shows an extremely strong relationship.

e) One Limitation of Using Simple Regression Analysis for managerial decisions

* Extrapolation Risk: The model is based on training costs between \$1 million & \$14 million. If management decides to jump to \$50 million, the regression equation might give a wildly inaccurate prediction because we do not have any data.