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ANNEXURE 01-Preliminary Interview Guide Line

ANNEXURE 02-Questionnaire Type I

ANNEXURE 03- Questionnaire Type II

ANNEXURE 04- Calculations for RII Index

ANNEXURE 05-Calculations for Indirect Relationship

ANNEXURE 06-Details of Input Percentages of Road Projects

ANNEXURE 07-Calculations for Correlation and Regression (Bitumen)

ANNEXURE 08-Calculations for Correlation (Equipment)

ANNEXURE 09-Calculations for Correlation and Regression(A.B.C.)

ANNEXURE 10-Calculations for Correlation (Fuel)

ANNEXURE 11-Calculations for Correlation and Regression(Metal)

ANNEXURE 12-Calculations for Correlation and Regression(Earth)

ANNEXURE 13- Correlation & Regression Analysis

Regression and Correlation

This is a statistical method that is used to deal with paired data of two variables, which may relate in some way (Hooda, 2003). According to the Lindley (1987), knowing that relationship exists between any two variables is vital information that invites keen interest and concern. For, often this may be crucial for decision making in any given situation. For example it is very important for a contractor to know how the unit rate asphalt concrete is related with the fuel prices.

In the same stream, a former is well advised if he knows the relationship between crop yield and the quantum of fertilizer used. Likewise, a physical instructor would do better if he knows that a relationship exists between the weight and height of students at different levels in his school (Hooda, 2003).

As states by Hooda(2003),in all such cases as, one is interested in:

3. Knowing the nature of relationship between any two characteristics of one's interest

4. Getting a definite idea about the degree of that relationship

Fox (1997) states that systematized knowledge on these two related aspects can be obtained by using appropriate statistical methods. Most specifically, the methods needed here relate to the following issues:

4. Bringing out the nature and the degree of relationship between any two variables, say X and Y.

5. Measuring the rate of change in one (the dependent) variable associated with a given change in the other (the dependent) variable.

6. Evaluating the predictive strength of the relationship that obtain, and assessing the reliability of an estimate derived from that relationship

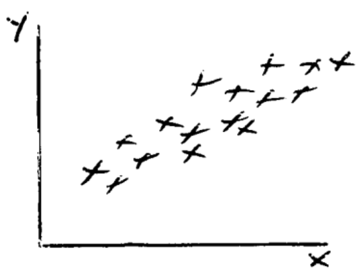
Since these three issues are inter related by Fox (1997), regression and correlation, as two sides of single basic process, consist of methods of examining the relationship between two variables. Regression is mainly concerned with bringing out the nature of the relationship and using it to know the best approximate value of one variable corresponding to a known value of the other variable. Correlation, on the other hand, is concerned with quantifying the closeness of such relationship (Fox, 1997).

Typed of Relationships

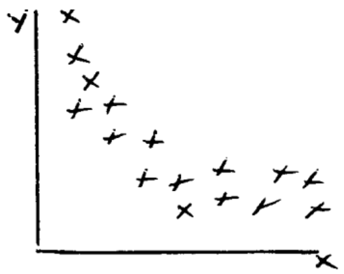
The relationship between any two variables may be linear or non-linear. It may be described by means of straight line or a curve. If the relationship is best explained by a straight line, it is said to be linear. On the contrary if it is described more appropriately by a curve, the relationship is said to be non-linear (Hooda, 2003).

According to Hardle (1990), the linear relationship implies a constant absolute change in the dependent variable in response to unit changes in the independent variable. It is extensively used for its better predictive strength and greater reliability of an estimate base thereon. A non-linear implies varying absolute change in dependent variable with respect to changes in the independent variable. Its predictive value is limited and, consequently, the reliability of estimate more doubtful.

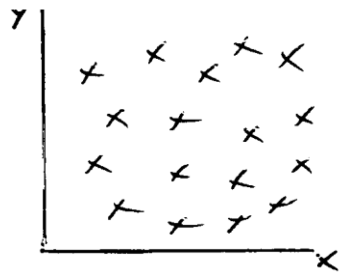
Following images create a better picture on the relationship between two variables (Linear Regression, 2007).



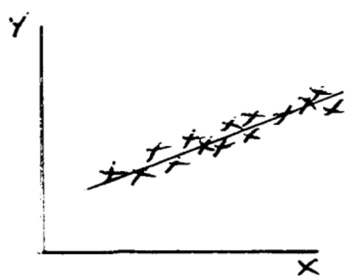
Positive Linear, straight line relationship



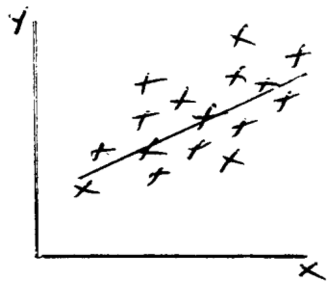
Negative Non Linear



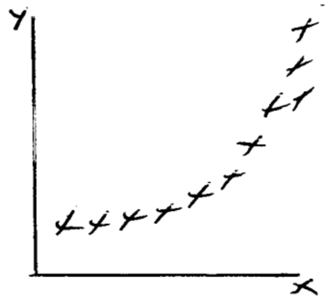
No relationship



Strong and positive linear relationship



Weak and positive linear relationship



Strong and non linear relationship

The Coefficient Correlation

The strength of a relationship can be measured by a correlation coefficient. One of the most widely used is Pearson's Product Moment Correlation Coefficient, denoted r, which provides a measure of the strength of linear association (Hooda, 2003).

This measure is independent of scale and always lies in the range –1 to +1;

- –1if there is a perfect negative linear relationship
- +1if there is a perfect positive linear relationship.

Some illustrations showing scatter diagrams together with values of r are (Linear Regression, 2007).

Calculation of r

Hooda (2003) stated three methods to calculate r either:

- Use the computational formula for hand calculations - see the example in section
- Use a package such as Minitab or a spreadsheet such as Excel
- Use the correlation button (usually labeled r) available on some calculators

Interpretation of r

Hardle (1990) has given a sound interpretation for r:

1. r measures the LINEAR relationship between 2 variables. If a relationship is non- linear, r can be very misleading.

2. A high value of r (close to +1 or –1) does not imply any casual link between the variables. It just means that if one variable is relatively high in value then the other tends to be relatively high as well (or low if r is negative). There may be a third variable which is causing the changes in both X and Y. Examples of these so-called spurious correlations are given below (Hardle, 1990).

    X: milk consumption per capita

    Y: incidence of cancer

    Common factor: Degree of development

Regression Analysis

The Dependent Variable and the Explanatory Variable

Lindley (1987) has concerned with the form of the relationship between the variables. This can be summarized by an equation that enables us to predict or estimate the values of one variable (Y - the dependent variable) given values of the other variable (X - the independent or explanatory variable). The first thing to do then is to decide which variable is which. To summarize:

"Regression analysis is concerned with how the values of Y depend on the corresponding values of X. The variable that is eventually to be predicted or estimated should be labeled Y (Lindley, 1987)."

Finding the Best-Fitting Line

Lindley (1987) stated that in practice, most relationships are not exact - there will be a certain amount of scatter about a line. We require the equation of the line that fits the data best. This could be done by fitting a line by eye but a better approach is to use the Method of Least Squares. This is a mathematical technique that gives the slope and the intercept of the best-fitting line in the sense that it minimizes the errors involved in using the line to predict values of Y.

In order to find the slope, b, and the intercept, a, of this least-square regression line which is general is denoted:

$$Y = \mathbf{a} + \mathbf{b}\ X$$

- Use the computational formulae for hand calculations
- Use a package such as Minitab or spreadsheet such as Excel
- Use the regression buttons (usually labeled a and b) available on some calculator

Interpretation of a and b

Slope (b)

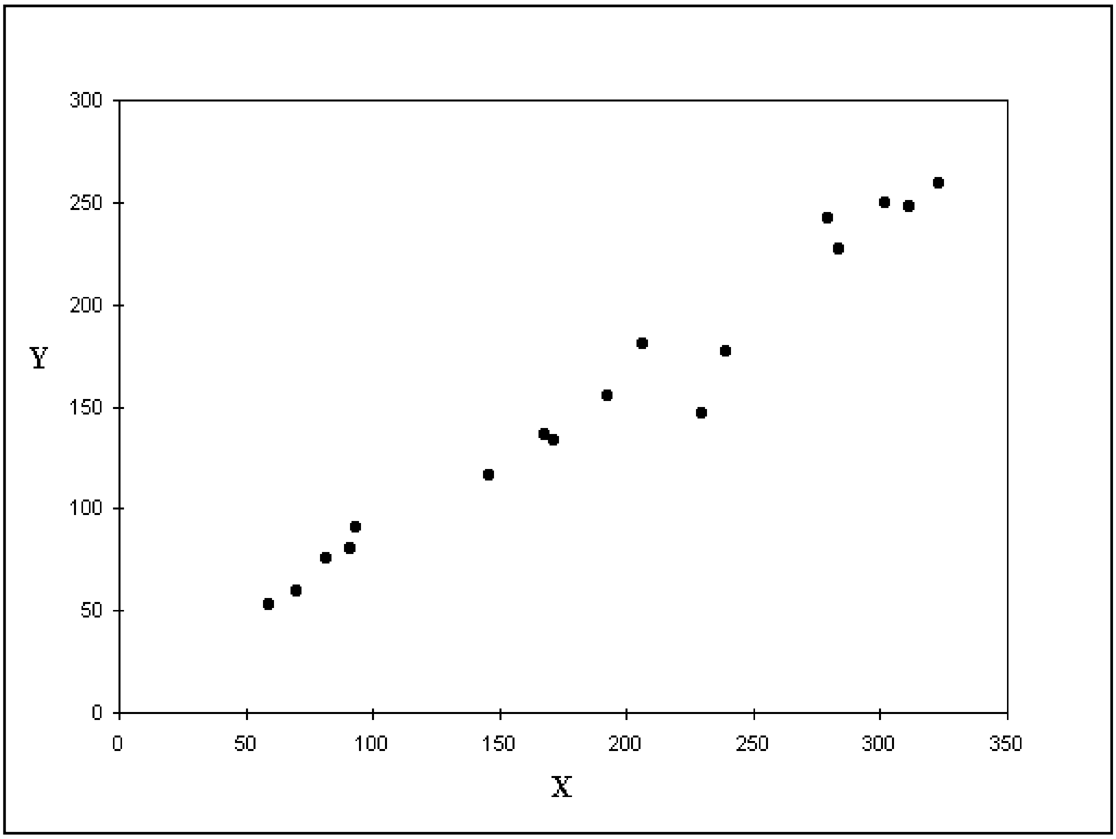
In general this tells us how we expect Y to change, on average, if X is increased by 1 unit (If the slope were positive, we would expect Y to increase as X increases.)

Intercept (a)

This is the value of Y predicted for X = 0.

Correlation and Regression versus Minitab

Correlation coefficients can suggest where causes may lie but to show that changing one variable causes changes in the other variable requires a controlled experiment



(useminitab, 2011).

Figure A: 0-1 Scatter plot for X and Y

By looking at this scatter plot, it can be seen that variables X and Y have a close relationship that may be reasonably represented by a straight line. This would be represented mathematically as:

$$\mathbf{Y = a + b\,X + e} \qquad \text{(useminitab, 2011)}$$

It further describes that the line crosses the y-axis, b describes the slope of the line, and e is an error term that describes the variation of the real data above and below the line. Simple linear regression attempts to find a straight line that best 'fits' the data, where the variation of the real data above and below the line is minimized.

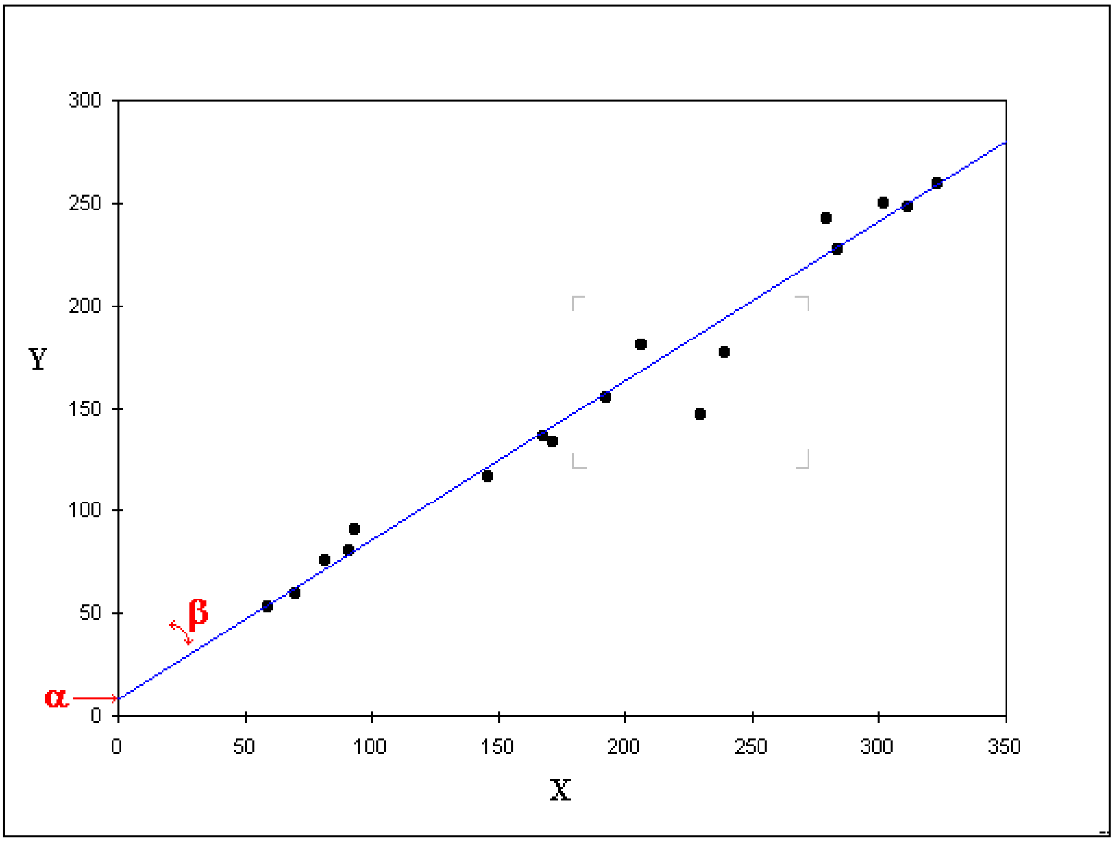


Figure A:0-2 Regression Line for X and Y

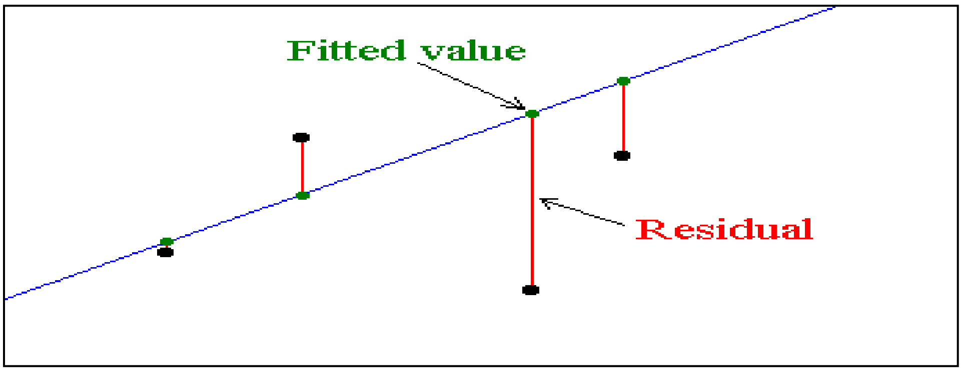


Figure A:0-3 Fitted line and Residuals

Assuming that variation in Y is explained by variation of X, we can begin our regression. In Minitab it would look like this.

The command, regr 'Y' 1 'X', instructs Minitab to regress Y onto just 1 explanatory variable, X.Useminitab (2011) describes that this output tells us several things: the output tells us the equation of the fitted line and gives us important formal information regarding the association of the variables and how well the fitted line describes the data.

```
MTB > regr 'Y' 1 'X'

The regression equation is
Y = 7.76 + 0.769 X                                   1

Predictor        Coef       Stdev    t-ratio        p
Constant        7.764       7.633       1.02    0.325   2
X             0.76941     0.03631      21.19    0.000

s = 13.14       R-sq = 96.8%     R-sq(adj) = 96.6%   3

Analysis of Variance

SOURCE        DF          SS          MS         F        p
Regression     1       77550       77550    449.04    0.000   5
Error         15        2591   4     173
Total         16       80141

Unusual Observations
Obs.       X         Y        Fit  Stdev.Fit  Residual    St.Resid
  6      230    146.30     184.65       3.49    -38.35      -3.03R
                                                                     6
R denotes an obs. with a large st. resid.
```

Figure A:0-4 Output of Regression Analysis

Following table describes the output of the regression analysis. It is explaining the information about regression equations derived by the Minitab software. Most important information is highlighted by a box and a reference number is given to the each box. Table describes the information related to the reference number.

Table A: 0-1 Explanation of Regression Output

Number	Explanation
1	The fitted line has a=7.76 and b=0.769 and now that we know the equation, we can plot the line onto the data (e is not needed to plot the line); see Fig 2.1 below. This is the mathematical model describing the functional response of Y to X.
2	The p (probability) values for the constant (a) and X, actually the slope of the line (b). These values measure the probability that the values for and b are not derived by chance. These p values are not a measure of 'goodness of fit' per se, rather they state the confidence that one can have in the estimated values being correct, given the constraints of the regression analysis (ie., linear with all data points having equal influence on the fitted line). The p(X) value of 0.000 is a little misleading as Minitab only calculates p values to 3 decimal places, so this should be written as: $P(X) < 0.001$
3	The R-squared and adjusted R-squared values are estimates of the 'goodness of fit' of the line. They represent the % variation of the data explained by the fitted line; the closer the points to the line, the better the fit. Adjusted R-squared is not sensitive to the number of points within the data. R-squared is derived from R-squared = 100 * SS (regression) / SS (total) For linear regression with one explanatory variable like this analysis, R-squared is the same as the square of r, the correlation coefficient.

Number	Explanation
4	The sum of squares (SS) represents variation from several sources. SS (regression) describes the variation within the fitted values of Y, and is the sum of the squared difference between each fitted value of Y and the mean of Y. The squares are taken to 'remove' the sign (+ or -) from the residual values to make the calculation easier. SS (error) describes the variation of observed Y from estimated (fitted) Y. It is derived from the cumulative addition of the square of each residual, where a residual is the distance of a data point above or below the fitted line (sees Fig 2.2). SS (total) describes the variation within the values of Y, and is the sum of the squared difference between each value of Y and the mean of Y.
5	This is the same as the p(X) value in highlight 2
6	Data points that are unusually far from the fitted line (compared to the other points) are pointed out to the user in Minitab and Genstat. Such data points are worthy of special attention, as they may be spurious, due to recording error, for example, and could cause a dodgy regression line to be fitted. There is some justification for removing such points from the data before attempting regression analysis, but there must be very strong evidence that the data is unreliable.