SIMPLE LINIER CORRELATION AND REGRESSION ANALYSIS USING MICROSOFT EXCEL AND ITS APPLICATION IN MARKETING MANAGEMENT

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Abstract

The research entitled "Correlation Analysis and Simple Linear Regression Using Microsoft Excel and Its Application to Marketing Management" aims to calculate the correlation coefficient and simple linear regression equation using MS-excel and its application in the field of marketing management. This research was conducted using a personal computer with an existing MS Office application, especially the MS-excel application. Applications in MS-Excel are used to perform statistical calculations as a substitute for manual calculations, especially for calculating correlation coefficients and regression constants. The results showed that the calculation of the correlation coefficient and simple linear regression equation can be done with the MS-excel application easily, quickly, and efficiently. The calculations use the facilities and commands in MS-Excel andthe functions in it. Applied to marketing management shows that there is a positive correlation between promotion and sales with a very strong relationship. Each additional promotion results in an additional sales value.

Keyword
correlation coefficient, simple linear regression, promotion, sales

Introduction

Data processing in statistics, sometimes difficult and tedious. This is because there are several formulas in complex statistics. The results of the calculations are sometimes less accurate, especially when it comes to rounding. One part of the statistics that is widely used is correlation and regression analysis. This analysis is used to determine whether there is a relationship between variables and the strength of the relationship. For example, between promotions and sales, between the price and the number of goods demanded by consumers, between IQ and someone's success, and others. In the business field, the results of the analysis can be used to make decisions that benefit the company. Regression analysis is used in many aspects of life, not only in business but also in other fields such as organizations, service companies, foundations, cooperatives, socio-politics, and others. Microsoft Excel (MS-excel) is a business application program that can be used to facilitate numerical calculations. The facilities in MS- Excel in the form of functions are numerous and can be used to facilitate calculations in statistics. Basic functions such as arithmetic operations are often used. There are many functions in MS- Excel that may be less well known or rarely used, including count, sum, sqrt, ^, round, count, date,time, and others. But these functions are very useful in more detailed statistical analysis. Correlation and regression analysis can be done using MS-excel software easily, quickly, and practically. In the field of management, especially marketing management, it is necessary to knowthe relationship between one variable and other variables, for example, promotion and sales. Therelationship between promotion and sales needs to be analyzed to determine how much influence the promotion has on sales. Qualitative analysis can only be used to determine whether there is a relationship, but it cannot be known to what extent the relationship is affected. From the importance of correlation and regression analysis and the ease of calculating the value of correlation and regression coefficients with MS-excel, the authors would like to make a guide for calculating correlation and regression coefficients using MS-excel.

METHOD

This research is an experiment in the laboratory or with a personal computer with any version of the MS-Excel application. In the experiment, formulations and examples were made to calculate correlation coefficients and simple linear regression constants.

The formulas used are:

1. Correlation coefficient.

   Least squares method.

$$r = \frac{n\sum XY - \sum X.\sum Y}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

2. Simple linear regression.

   The relationship between the 2 variables is expressed in the form: Y = f (X).

   Y: dependent variable (variable that is affected). X: independent variable (variable that affects).

   The general equation for simple linear regression is: Y = a + bX.

   a: the intercept, which is the point of intersection with the Y axis. b: the coefficient of direction (slope).

   The formula for calculating the values of a and b is:

$$a = \frac{(\sum Y)(\sum X^2) - (\sum X)(\sum XY)}{(n)(\sum X^2) - (\sum X)^2}$$

$$b = \frac{(n)\sum XY) - (\sum X)(\sum Y)}{(n)(\sum X^2) - (\sum X)^2}$$

LITERATURE REVIEW

Correlation is an analysis used to measure the strength of the relationship between variables. The relationship between these variables is the presence or absence and strength of the relationship. If there is a relationship between variables, the changes that occur in one variable will result in changes to the other variables. The relationship between these variables is expressed by the correlation coefficient (r).

The measurement of the degree of closeness between the X and Y variables depends on the simultaneous variation and interrelation pattern between the two. The variation is a co-variation and the measurement is a correlation problem [1].

There are several types of simple linear correlation coefficients, namely:

1. Pearson correlation coefficient.

   The Pearson correlation coefficient can be found using 2 methods, namely:

   a. The least-squares method, with the formula:

$$r = \frac{n\sum XY - \sum X . \sum Y}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

   b. Product moment method, with the formula:

$$r = \frac{\sum xy}{\sqrt{\sum x^2 - \sum y^2}}$$

2. Rank Spearman correlation coefficient.

The Spearman rank correlation coefficient is an index or number used to measure the closenessof the relationship between 2 variables whose data is ordinal and rank data.

3. Kendall Rank correlation coefficient.

The Kendall Rank correlation coefficient is an extension of the Spearman correlation coefficient. This coefficient is used for pairs of variables X and Y that do not correspond to rank [2].

The correlation coefficient can be used to:

1. Determine the direction and strength of the relationship between variables.

There are 2 kinds of relationships, namely:

   a. Positive relationship (proportional or directly proportional), that is, if the X value increases,the Y value also increases.

   b. Negative relationship (inversely proportional), that is, if the X value increases, the Y value decreases.

2. Determine covariance, namely how 2 random variables (X and Y) are mixed.

The strength of the relationship in correlation can be divided into 7, namely:

   a. no connection,

   b. very weak relationship,

   c. low relationship,

   d. relationship is quite meaningful,

   e. strong relationship, relationship

   f. very strong and

g. perfect relationship.

The correlation coefficient (KK) is an index or number used to measure the strength and weakness of the relationship between variables [3].

KK scores, between -1 and 1 ($-1 \leq KK \leq 1$).

1. If the KK is positive, the variables are positively correlated.
2. If the KK is negative, the variables are negatively correlated.

The closeness of the relationship between variables based on the KK value is as follows:

1. KK = 0 means there is no correlation.
2. $0 < KK \leq 0,2$, meaning that the correlation is very weak.
3. $0.20 < KK \leq 0.40$, meaning that the correlation is low, weak but certain.
4. $0.40 < KK \leq 0.70$, which means a significant correlation.
5. $0.70 < KK \leq 0.90$, meaning that the correlation is high, strong.
6. $0.90 < KK < 1.00$, meaning that the correlation is very strong.
7. KK = 1, meaning perfect correlation.

Correlation represents the degree of relationship between variables, namely how well a linear equation or any equation describes the relationship between these variables. Quantitatively, how well a line or curve can explain the relationship between variables through direct observation on the scatter diagram [4].

Regression is an analytical tool to measure whether there is a relationship between variables. The term regression means forecast or estimate. One of the regression models is simple linear regression. It is called simple because it is only for the analysis of 2 variables. It is called linear regression because it uses a straight line approach.

Regression analysis is more accurate in conducting correlation analysis because in this analysis the difficulty in showing the degree of change of a variable to other variables can be demonstrated [5].

The problem of the relationship between 2 variables (X and Y) generally revolves around 2 things, namely:

1. Determining the form of the appropriate equation in order to predict the mean Y through the mean of X. Such a problem is called regression.

2. Measuring the degree of closeness of the relationship between X and Y variables. This closeness depends on the simultaneous variation or interrelation pattern. Such variation is a co-variation and the measurement is a correlation problem [6].

To find a mathematical equation that connects a number of variables, the first step is to collect data showing the values that correspond to the variables in question. The next step is to create a scatter diagram. From the scatter diagram, a fine line is drawn which is an approximation of the data. Such a curve is called an approximation curve [7]. There are several types of approximate curves, namely:

1. A straight line.
2. Parabola or quadratic curve.
3. Cubic curve.
4. Curves of degree n.
5. Logarithmic curve.

The relationship between 2 variables can be expressed in the notation:Y

= f (X), where

X is the independent variable.

Y is the dependent variable.

In a causal relationship, the independent variable is the variable that affects and the dependent variable is the variable that is affected.

The simplest type of approximate curve is a straight line whose general equation is Y = a0 + a1X where a0 is the intercept (the intersection of the Y axis) and a1 is the slope. One of the ways to form straight line equations is by using the least squares method.

Correlation and regression studies can be applied in many scientific fields, one of which is in the field of management, especially marketing management. In marketing management, in theory there is a relationship between promotion and sales. The greater the promotion, the greater the sales of the company's products. The results of the analysis can be used to determine whether there is a relationship between promotion and sales and the extent of the influence of promotion on sales.

Microsoft Excel (MS-excel) is software for data processing, including basic calculations, use of functions, graph creation and data management. This software is very helpful for solving administrative problems ranging from simple to complex.

MS-Excel is a program for automatic processing of data, both simple and complex, such as finance, statistics, databases and others.

MS-Excel is the main application for recording and calculation for various fields such as accounting, finance, sales, statistics and others.

The facilities in MS-Excel in the form of functions are numerous and can be used to facilitate calculations in statistics. Basic functions such as arithmetic operations are often used. There are many functions in MS-Excel that may be less well known or rarely used, including: count, sum, sqrt, ^, round, int, mod, count, date, time and others. These functions are very useful in more detailed statistical analysis.

In everyday life we will find all simple calculation models such as buying and selling to complex calculations such as banking and statistics. For this purpose, MS-Excel is here to provide fast and accurate solutions in presenting quantitative data information in the form of numbers, tables and graphics [8].

Table 1. The commands in MS-excel that are widely used include:

No	Command	Function	Information
1	=(formula)	For calculation orders.	Sel/range.
2	=sum	To sum up some numbers.	Range.
3	=average	To calculate the average value.	Range.
4	=sqrt	To find the square root.	Sel.
5	=count	To count the number of cells.	Range.
6	copy	To copy cell contents or formulas.	Sel/range.

Marketing is an individual and organizational activity that facilitates and accelerates satisfying exchange relationships in a dynamic environment through the creation, distribution, promotion and pricing of goods, services and ideas. This view shows the extent of the problems that marketing managers have to solve and to the extent of the information needed to solve these problems [9].

Sales promotion is a core ingredient in a marketing campaign, consisting of a collection of incentive tools, mostly short-term, designed to stimulate faster or larger purchases of a particular product or service by consumers or commerce [10].

Sales promotion is an activity or material (or both) that acts as an invitation, provides added value, or an incentive to buy a product, to retailers, sellers or consumers.

The purpose of sales promotion is very broad where the seller can use consumer promotion, the goal is to attract consumers to want to try new products, to lure consumers to leave competitive products, or to make consumers leave mature products, or to hold back and reward loyal consumers. The purpose of a trade promotion includes getting retailers to trade on new products and making more room for inventory, getting them to buy in advance. From the above statement, it can be concluded that the objectives of the sales promotion are manifold, namely trade promotions are carried out to make retailers trade products, provide more space for inventory, and make advance purchases. Meanwhile, consumer promotion is one of them is to attract consumers to try new products and lure consumers to leave competing products, this is becauseit is not only creating short-term sales volume but helps strengthen products and build long-term relationships with consumers [11].

The number of consumers who are interested in buying and using the products issued by the company will result in sales of these products so that the promotional activities carried out havea direct impact on increasing sales. Sales promotion consists of a diverse set of incentive tools, most of them short-term, designed to encourage the faster and/or greater purchase of a particular product/service by consumers or merchants. Based on this statement, it can be said that sales promotions encourage sales of products or services, this proves that there is a relationship between sales promotions and sales.

DISCUSSION

This study emphasizes the use of MS-excel for correlation analysis and simple linear regression. The data analyzed is secondary data taken from the article "Analysis of the Influence of Promotion and Sales Achievement (Case Study at PT. Cahya Yamaha Kediri)" [12].

Sales and promotion data at PT. Cahya Yamaha Kediri for 4 years from 2009-2012 are as follows [13] :

Table 2. Promotion and Sales Data for 2009-2012.

Year	Quarter	Promotion	Sales	Sales
		(Rp)	(Rp)	(unit)
2009	1	23.600.000	14.042.970.000	972
	2	84.900.000	20.717.715.000	1.434
	3	32.000.000	18.420.955.000	1.275
2010	1	90.750.000	21.421.400.000	1.400
	2	97.550.000	23.578.841.000	1.541
	3	87.550.000	17.704.874.000	1.157
2011	1	87.550.000	10.972.046.000	674
	2	87.550.000	9.474.378.000	582
	3	87.550.000	15.741.961.000	967
2012	1	87.550.000	14.091.852.500	935
	2	87.550.000	12.117.486.000	804
	3	87.550.000	13.188.016.500	875
Average		51.962.500	15.956.041.250	1.051

Source: Article by Ayunda Wulansari.

From the data above, it can be calculated the value of the correlation coefficient using MS-excel. The calculation of the r correlation coefficient value is presented in Table 3.2.

Table 3. Calculation of the correlation coefficient (r) with MS-Excel.

X	Y	X_2	XY	Y_2
23,600.00	14,042,970.00	556,960,000.00	331,414,092,000.00	197,205,006,420,900.00
84,900.00	20,717,715.00	7,208,010,000.00	1,758,934,003,500.00	429,223,714,821,225.00
32,000.00	18,420,955.00	1,024,000,000.00	589,470,560,000.00	339,331,583,112,025.00

90,750.00	21,421,400.00	8,235,562,500.00	1,943,992,050,000.00	458,876,377,960,000.00
97,550.00	23,579,841.00	9,516,002,500.00	2,300,213,489,550.00	556,008,901,585,281.00
49,400.00	17,704,874.00	2,440,360,000.00	874,620,775,600.00	313,462,563,355,876.00
29,400.00	10,972,046.00	864,360,000.00	322,578,152,400.00	120,385,793,426,116.00
40,600.00	9,474,378.00	1,648,360,000.00	384,659,746,800.00	89,763,838,486,884.00
43,550.00	15,741,961.00	1,896,602,500.00	685,562,401,550.00	247,809,336,125,521.00
44,250.00	14,091,852.00	1,958,062,500.00	623,564,451,000.00	198,580,292,789,904.00
46,600.00	12,117,486.00	2,171,560,000.00	564,674,847,600.00	146,833,466,960,196.00
40,950.00	13,188,016.50	1,676,902,500.00	540,049,275,675.00	173,923,779,204,272.00
623,550.00	191,473,494.50	39,196,742,500.00	10,919,733,845,675.00	3,271,404,654,248,200.00

The formula used is :

$$r = \frac{n\sum XY - \sum X . \sum Y}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

Calculation :

Number of data pairs	=	12
Counter value	=	11,643,508,652,625.00
The value of The dominator	=	14,546,230,859,772.00
Value of r	=	0.800448499

Table 4. The commands in MS-excel on calculating the correlation above are:

No	Notation	Command	Information
1	=(formula)	For a calculation formula	Cell/range
2	*	Multiplication	Cell / Cells
3	+	Summation	Cell
4	-	Subtraction	Cell
5	/	Division	Cell
6	=SQRT	Square root	Cell
7	=SUM	Addition of several cells	Range
8	=COUNT	To count the number of cells	Range
9	COPY	To copy cell contents or formulas	Cell /range

Table 5. The commands in MS-excel on calculating the correlation above are:

No	Cell address	Column / column headings	Com mand
1	D6	X^2	=B6^2
2	E6	XY	=B6*C6

3	F6	Y2	=C6^2
4	B19	Sum of column X data values	=SUM(B6:B17)
5	C19	Sum of column Y data values	=SUM(C6:C17)
6	D19	Sum of column X2 data values	=SUM(D6:D17)
7	E19	Sum of column XY data values	=SUM(E6:E17)
8	F19	Sum of column Y2 data values	=SUM(F6:F17)

Table 6. The commands in MS-excel on calculating the correlation above are:

No	Cell address	Row title	Command
1	E26	Number of data pairs	=COUNT(B6:B17)
2	E27	Counter value	=((E26*E19)-(B19*C19))
3	E28	The value of the denominator	=SQRT((E26*D19-(B19)^2)*(E26*F19-(C19)^2))
4	E29	Level r	=E27/E28

From the data above, a simple linear regression constant can be calculated using MS-excel. The calculation of the constant value of simple linear regression is presented in Table 3.

Table 7. Calculation of simple linear regression constant

X	Y	X^2	XY
23,600.00	14,042,970.00	556,960,000.00	331,414,092,000.00
84,900.00	20,717,715.00	7,208,010,000.00	1,758,934,003,500.00
32,000.00	18,420,955.00	1,024,000,000.00	589,470,560,000.00
90,750.00	21,421,400.00	8,235,562,500.00	1,943,992,050,000.00
97,550.00	23,579,841.00	9,516,002,500.00	2,300,213,489,550.00
49,400.00	17,704,874.00	2,440,360,000.00	874,620,775,600.00
29,400.00	10,972,046.00	864,360,000.00	322,578,152,400.00
40,600.00	9,474,378.00	1,648,360,000.00	384,659,746,800.00
43,550.00	15,741,961.00	1,896,602,500.00	685,562,401,550.00
44,250.00	14,091,852.00	1,958,062,500.00	623,564,451,000.00
46,600.00	12,117,486.00	2,171,560,000.00	564,674,847,600.00
40,950.00	13,188,016.50	1,676,902,500.00	540,049,275,675.00
623,550.00	191,473,494.50	39,196,742,500.00	10,919,733,845,675.00

The formula used is:

$$a = \frac{(\sum Y)(\sum X^2) - (\sum X)(\sum XY)}{(n)(\sum X^2) - (\sum X)^2}$$

$$b = \frac{(n)\sum XY) - (\sum X)(\sum Y)}{(n)(\sum X^2) - (\sum X)^2}$$

Number of data pairs	=	12
Calculation of the value of a (intercept):		
Counter Value	=	696,137,220,021,020,000.0
The value of the dominator	=	81,546,307,500.0
Value a	=	8,536,710.51
Calculation of the value of b (*slope*) :	=	
Counter Value	=	11,643,508,652,625.00
The value of the dominator	=	81,546,307,500.00
Value b	=	142.78

Regression equation Y= 8,536,710.51 + 142,78 X

Table 8. The commands on MS-excel in the regression calculation above are:

No	Cell address	Column / column headings	Command
1	D6	X^2	=B6^2
2	E6	XY	=B6*C6
3	B19	Sum of column X data values	=SUM(B6:B17)
4	C19	Sum of column Y data values	=SUM(C6:C17)
5	D19	Sum of column X^2 data values	=SUM(D6:D17)
6	E19	Sum of column XY data values	=SUM(E6:E17)

Table 9. The commands on MS-excel in the regression calculation above are:

No	Cell address	Column / column headings	Command
1	E26	Number of data pairs	=COUNT(B6:B17)
	Intercept value (a)		
2	E30	Counter value	=((C19*D19)-(B19*E19))
3	E31	The value of the denominator	=((E28*D19-(B19)^2))
4	E32	Value a	=E30/E31
	Slope (b) value		
5	E35	Counter value	=((E28*E19)-(B19*C19))
6	E36	The value of the denominator	=((E28*D19-(B19)^2)
7	E37	Value b	=E35/E36

From the results of data analysis, it is found that the correlation coefficient r is 0.8 and the simple linear regression equation is Y = 8,536,710.51 + 142.78 X.

1. The correlation coefficient r = 0.8.

Calculation using the facilities in MS-Excel is to add 3 columns, namely columns X2, XY, Y2 and add up the values in each column with the command = SUM (range) for calculations on the correlation coefficient formula.

The calculation for X2 is by squaring the X value in cell D6 with the command = B6 ^ 2. These commands are given on the first line and the second line and are then searched for by copying the formula.

The XY calculation is to multiply column X by column Y, namely in cell E6 with the command = B6 * C6. These commands are given on the first line and the second line and are then searched for by copying the formula.

The calculation of Y2 is by squaring the Y value, namely cell F6 with the command = C6 ^ 2. These commands are given on the first and second lines and are then searched for by copying the formula.

The number of data pairs in cell E26 is calculated by the command = count (B6: B17).

Calculation of the correlation coefficient r, by first calculating the numerator and denominator values. This is intended to simplify calculations. The numerator value in cell E27 is calculated with the command = ((E26 * E19) - (B19 * C19)). The reference value in cell E28 is calculated by the command = SQRT ((E26 * E19) ^ 2) * (E26 * F19) - (C19 ^ 2)). After the numerator and denominator values are obtained, the value of r is calculated by dividing the numerator value into the denominator, which is in cell E29 with the command = E27 / E28.

From the r-value of 0.8, it can be seen that there is a strong relationship between promotion and sales. The relationship is positive, meaning that promotion and sales are proportional, that is, the greater the promotion, the greater the sales.

2. The simple linear regression equation is Y = 8,536,710.51 + 142.78 X.

Calculation using the facilities in MS-Excel is to add 2 columns, namely columns X2 and XY, and add up the values in each column for the calculation of the values a and b from a simple linear regression equation.

The calculation for X2 is by squaring the X value in cell D6 with the command = B6 ^ 2. These commands are given on the first and second lines and are then searched for by copying the formula.

The XY calculation is to multiply column X by column Y, namely in cell E6 with the command = B6 * C6. These commands are given on the first and second lines and are then searched for by copying the formula.

The number of data pairs in cell E26 is calculated by the command = count (B6: B17).

Calculation of the value of a, by first calculating the numerator and denominator values. This is intended to simplify calculations. The numerator value in cell E30 is calculated with the command = ((C19 * D19) - (B19 * E19)). The denominator in cell E31 is calculated by the command = ((E28 * D19- (B19 ^ 2)). After the numerator and denominator values are obtained, the value of a is calculated by dividing the numerator value into the denominator, which is in cell E29 with the command = E27 / E28.

Calculation of the value of b, by first calculating the numerator and denominator values. This is intended to simplify calculations. The numerator value in cell E35 is calculated by the command = ((E28 * E19) - (B19 * C19)). The denominator in cell E36 is calculated by the command = ((E28 * D19- (B19 ^ 2)). After the numerator and denominator values are obtained, the value of b is calculated by dividing the numerator value into the denominator, which is in cell E37 with the command = E35 / E36.From the a and b values, a simple linear regression equation is obtained Y = 8,536,710.51 + 142.78 X.

From the regression equation, it can be seen that the value of a is 8,536,710.51, meaning that if there is no promotion, the amount of sales is Rp. 8,536,710,51, - (in thousands). The value of b of 142.78 means every additional Rp. 1, - promotion will cause additional sales of Rp. 142,78, - (in thousands). A positive b value means that the relationship between promotion and sales is comparable.

CONCLUSION

From the results of the analysis it can be concluded that:

1. The use of MS-Excel can facilitate easy, practical and efficient calculation of the correlation coefficient.

2. The use of MS-Excel can facilitate the calculation of simple linear regression equations in an easy, practical and efficient manner.

3. In the field of marketing, there is a positive relationship between promotion and sales and that relationship is very strong.

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