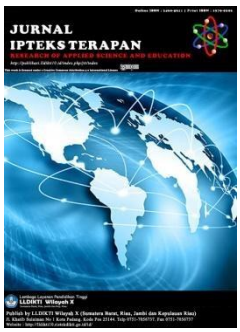

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IMPLEMENTATION OF THE LEAST SQUARE METHOD TO FORECAST CEMENT SALES

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Abstract

Background: Frequent shortage of cement stock causes consumer demand to not be fulfilled. Over time, the uncertain demand for each product can cause difficulties in determining the supply of cement brands in the future. Forecasting techniques are very influential on the decision of the owner of UD Timbul Rezeki to determine the amount of inventory that must be provided. **Method:** Using the Least Square Method which is one method in the form of time series data, which requires past sales data to forecast future sales. Quantitative method is a research method used to examine a particular population or sample, the sampling technique is generally done randomly. **Result:** The results of the application of the Least Square Method for forecasting cement sales for the September 2022 period at UD Timbul Rezeki got the results of forecasting Garuda cement totaling 439.85 sacks, red and white cement totaling 321.06 sacks, Holcim cement totaling 273.18 sacks, three-wheeling cement totaling 669 ,70 sacks and cement jakarta amounted to 270.23 sacks. **Conclusion:** This results in a system design that can predict the amount of cement inventory using the Least Square Method at UD Timbul Rezeki, so that the cement management process takes place more effectively and efficiently, because the forecasting process is fast and can help the cement sales forecasting process easily.
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Keywords: Cement Sales, Forecasting, Least Square Method

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INTRODUCTION

UD Timbul Rezeki Asahan is located on Jalan Sei Alim Hasak which is a business engaged in the sale of building materials. This trading business is quite well known by the public, especially for those who want to build or renovate houses. All processes for lifting goods carried out at UD are still carried out manually by workers, with workers arranging goods in warehouses, loading and unloading goods on vehicles, then shipping and serving buyers during transactions at the store. The problem that is often faced at UD Timbul Rezeki is that there is often a shortage of stock of goods, especially cement stock. This can lead to unmet consumer demand. Over time, the uncertain demand for each product can cause and experience difficulties in determining the supply of cement brands in the future so that forecasting techniques are needed to help UD overcome these problems.

With the forecasting technique, it is very influential on the decision of the owner of UD Timbul Rezeki to determine the amount of goods that must be provided, especially the supply of cement brand products in the following month based on data that has been recorded from existing data. Production pays attention to market demand, to find out market demand, a trading business conducts sales forecasting, which can be searched using trends to estimate how many sales may occur in the coming period. Forecasting is an art in the form of science to predict future events or the future. This can involve past data and place it into the future in the form of a mathematical model [1]. In this study the method used is the Least Square Method. The Least Square method is a method in the form of time series data, which requires past sales data to forecast future sales. The Least Square method can be applied to create a straight trend line using the statistical method [2]. So the Least Square method is very helpful in predicting future market needs.

Several previous studies that have applied the Least Square Method include research with the title "Blood Stock Inventory Prediction System Using the Least Square Method in the Blood Transfusion Unit, Case Study of PMI Cirebon City". The result of this study is an information system for predicting the need for blood stock for the next period, making it easier for officers to manage data and report data on blood demand and blood stock per period. [3]. Then, the research entitled "Forecasting Turnover Using the Least Square Method". The results of the January 2019 income prediction, get forecasting results of Rp. 1,649,531 from the original data of Rp. 1,440,000, the percentage of results is 87.29% and the error value is 12.71% so that these results can help predict the turnover obtained in the following month [4]. The research is entitled "Medicine Needs Prediction System in Public Health Centers Using the Least Square Method". The system test results obtained an average prediction error rate of 12.70%. With this system, it is hoped that it can help the planning process for future drug needs at the puskesmas [5]. Then the research entitled "Forecasting Rice Production Using the Least Square Method in Leranwetan Village, Palang District, Tuban Regency". From the forecasting model, it was found that rice production forecasts in 2017 were 2,475,779412 tons, in 2018 as many as 2,547,911765 tons, in

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2019 as many as 2,620,04416 tons, in 2020 as many as 2,692,176496 tons, in 2021 as many as 2,764,308822 tons, in 2020. 2022 as many as 2,836,4411752 tons [6].

The system that will be created uses the PHP programming language and MySQL database by applying the Least Square Method. So with this system, it will help UD. Fortune arises in managing sales data and can predict cement sales in the future so that cement supplies can be met.

RESEARCH METHODS

The research method used in this research is quantitative research. Quantitative method is a research method used to examine a particular population or sample, the sampling technique is generally done randomly. Included in the quantitative methods are experimental research methods and survey research methods. The survey method is used to obtain data from certain natural places (facts/not engineering) using data collection through questionnaires, tests, interviews and so on. [7]. By using this research, it will be obtained the significance of the relationship between the variables studied [8].

In quantitative research, the researcher presents the formulation of the problem and the research hypothesis, sometimes the research objectives are also formulated simultaneously. Problem formulation is generally used in social science research and more specifically in survey research. While the research objectives identify the long-term goals to be achieved [9].

Forecasting is the art and science of predicting future events. Forecasting will involve taking historical data (such as last year's sales) and projecting them into the future using mathematical models [2]. In essence, forecasting is only an estimate (guess) using certain techniques, so forecasting becomes more than just an estimate [3]. Forecasting itself is used to estimate economic development, the activities of a business and changes in activities around a certain environment [4]. Forecasting methods are used to estimate future events. Forecasting is not only done to determine the number of production goods to be made or the capacity of services to be provided, but is also needed in various fields (such as procurement, sales, personnel, including for forecasting technology, economics). [10].

The Least Square method is one of the methods in the form of time series or time series data, which requires past demand data to forecast future demand so that the results can be determined. The Least Square method is included in the approach method group based on the measured error distribution through the overall approach interval [3]. The characteristic of this method is that the X parameter must be worth 0, if it has been obtained, it will be substituted later to calculate the forecasting results, this method is used to calculate periodic data because the calculation is more accurate by drawing the most appropriate line from all data points in the past which is called linear regression. namely connecting the dependent variable (Y) with the independent variable (X) to predict future data, where the variable (Y) is dependent or its value is influenced by the independent variable (X) whose value is not influenced by other variables [4].

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RESULTS AND DISCUSSION

The prediction process using the least square method can be explained as follows [5]:

1. Initialize input data
2. Specifies the data period/time variable
3. Counting the amount of usage (Y)
4. Calculating the t-score.
5. Find the value of the coefficient a using:

$$a = \frac{\sum Y}{n} \quad (1)$$

6. Calculate the value of the coefficient of b against x (time) using:

$$b = \frac{\sum t.Y}{t^2} \quad (2)$$

7. Determine the trend value variable equation by:

$$Y' = a + bx \quad (3)$$

Information:
Y' = The variable you are looking for the trend
T = Variable time (day, month, or year)
N = Amount of data
a = Trend value in base year
b = Average growth rate

The forecast error is the difference between the actual value and the estimated value. Accurate projection results are forecasts that can minimize forecast errors. The magnitude of the forecast error is calculated by subtracting the real data from the magnitude of the forecast.

$$error\ (e) = Y_t - F_t \quad (4)$$

Where:
Yt : Actual data period t
Ft : t period forecast

CALCULATION OF THE LEAST SQUARE METHOD

The data in this study are the data taken from the last 12 months of cement sales as follows:

Month	Cement Name				
	Garuda	Merah Putih	Holcim	Tiga Roda	Jakarta
09/21	250	200	100	300	100
10/21	180	280	200	350	200
…	…	…	…	…	…
07/22	380	350	300	600	255
08/22	450	320	250	650	240

Table 1. Cement Sales Data

1. Garuda Cement

The following data will be the sample calculation, namely Garuda cement sales data and get the following calculation results:

No	Month	Sales (Y)	X	X.Y	X^2
1	Sep-21	250	-11	-2750	121
2	Okt-21	180	-9	-1620	81
3	Nov-21	250	-7	-1750	49
4	Des-21	300	-5	-1500	25
5	Jan-22	290	-3	-870	9
6	Feb-22	330	-1	-330	1
7	Mar-22	320	1	320	1
8	Apr-22	350	3	1050	9
9	Mei-22	360	5	1800	25
10	Jun-22	370	7	2590	49
11	Jul-22	380	9	3420	81
12	Agu-22	450	11	4950	121
Total		3830	0	5310	572

Table 2. Calculation of Garuda Cement

Least square method formula: $Y' = a + bx$. Looking for a and following:

$$a = \frac{\sum Y = Total\ sales\ (Y)}{n = Amount\ of\ Data} = \frac{3830}{12} = 319{,}17$$

$$b = \frac{\sum X.Y = \text{Total } X * Y}{X^2 = Total\ X^2} = \frac{5310}{572} = 9{,}28$$

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September 2022 = 319,17 + 9,28 (13)
= 439,85

2. Merah Putih Cement

The following data will be the sample calculation, namely the sales of Merah Putih cement and get the calculation results as follows:

No	Month	Sales (Y)	X	X.Y	X^2
1	Sep-21	200	-11	-2200	121
2	Okt-21	280	-9	-2520	81
3	Nov-21	300	-7	-2100	49
4	Des-21	280	-5	-1400	25
5	Jan-22	350	-3	-1050	9
6	Feb-22	300	-1	-300	1
7	Mar-22	290	1	290	1
8	Apr-22	350	3	1050	9
9	Mei-22	200	5	1000	25
10	Jun-22	270	7	1890	49
11	Jul-22	350	9	3150	81
12	Agu-22	320	11	3520	121
Total		3490	0	1330	572

Table 3. Calculation of Merah Putih Cement

Least square method formula: $Y' = a + bx$. Looking for a and following:

$$a = \frac{\sum Y = Total\ sales(Y)}{n = Amount\ of\ Data} = \frac{3490}{12} = 290{,}83$$

$$b = \frac{\sum X.Y = Total\ X * Y}{X^2 = Total\ X^2} = \frac{1330}{572} = 2{,}33$$

September 2022 = 290,83 + 2,33 (13)
= 321,06

3. Holcim Cement

The following data will be the sample calculation is the sales data of holcim cement and get the calculation results as follows:

No	Month	Sales(Y)	X	X.Y	X^2
1	Sep-21	100	-11	-1100	121
2	Okt-21	200	-9	-1800	81
3	Nov-21	230	-7	-1610	49
4	Des-21	260	-5	-1300	25
5	Jan-22	280	-3	-840	9
6	Feb-22	200	-1	-200	1
7	Mar-22	210	1	210	1
8	Apr-22	240	3	720	9
9	Mei-22	210	5	1050	25
10	Jun-22	220	7	1540	49
11	Jul-22	300	9	2700	81
12	Agu-22	250	11	2750	121
Total		2700	0	2120	572

Table 4. Calculation of Holcim Cement

Least square method formula: $Y' = a + bx$. Looking for a and following:

$$a = \frac{\sum Y = Total\ sales(Y)}{n = Amount\ of\ Data} = \frac{2700}{12} = 225$$

$$b = \frac{\sum X.Y = Total\ X * Y}{X^2 = Total\ X^2} = \frac{2120}{572} = 3{,}71$$

September 2022 = 225 + 3,71 (13)
= 273,18

4. Tiga Roda Cement

The following data will be the sample calculation, namely data on Tiga Rodacement sales and get the following calculation results.

No	Month	Sales(Y)	X	X.Y	X^2
1	Sep-21	300	-11	-3300	121
2	Okt-21	350	-9	-3150	81
3	Nov-21	380	-7	-2660	49
4	Des-21	350	-5	-1750	25
5	Jan-22	400	-3	-1200	9
6	Feb-22	450	-1	-450	1
7	Mar-22	500	1	500	1
8	Apr-22	520	3	1560	9
9	Mei-22	540	5	2700	25
10	Jun-22	580	7	4060	49
11	Jul-22	600	9	5400	81
12	Agu-22	650	11	7150	121
Total		5620	0	8860	572

Table 5. Calculation of Tiga Roda Cement

Least square method formula: $Y' = a + bx$. Looking for a and following:

$$a = \frac{\sum Y = Total\ sales(Y)}{n = Amount\ of\ Data} = \frac{5620}{12} = 468{,}33$$

$$b = \frac{\sum X.Y = Total\ X * Y}{X^2 = Total\ X^2} = \frac{8860}{572} = 15{,}49$$

September 2022 = 468,33+15,49 (13)
= 669,70

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5. Jakarta Cement

The following data will be a sample calculation, namely Jakarta cement sales data and get the following calculation results.

No	Month	Sales(Y)	X	X.Y	X^2
1	Sep-21	100	-11	-1100	121
2	Okt-21	200	-9	-1800	81
3	Nov-21	220	-7	-1540	49
4	Des-21	210	-5	-1050	25
5	Jan-22	250	-3	-750	9
6	Feb-22	230	-1	-230	1
7	Mar-22	200	1	200	1
8	Apr-22	250	3	750	9
9	Mei-22	220	5	1100	25
10	Jun-22	250	7	1750	49
11	Jul-22	255	9	2295	81
12	Agu-22	240	11	2640	121
Total		2625	0	2265	572

Table 6. Calculation of Jakarta Cement

Rumus metode *least square*: $Y' = a + bx$. Looking for a and following:

$$a = \frac{\sum Y = Total\ sales(Y)}{n = Amount\ of\ Data} = \frac{2625}{12} = 218{,}75$$

$$b = \frac{\sum X.Y = \text{Total } X * Y}{X^2 = Total\ X^2} = \frac{2265}{572} = 3{,}95$$

September 2022 = 218,75+ 3,95 (13)

= 270,23

System testing is a stage in assessing the program that has been built starting from finding program errors or deficiencies in the program. In testing this software, using the blackbox testing method which is a software testing method that tests the functionality of the application as opposed to the internal structure or work. The testing of the system that has been built is as follows.

CONCLUSION

Based on the results of the study, it is known that the management of cement at UD Timbul Rezeki currently used is the lack of availability of the amount of stock for each product which results in unfulfillment of consumer demand. Production pays attention to market demand, to find out market demand, a trading business conducts sales forecasting, namely to estimate how many sales may occur in the coming period. Based on the results of the application of the Least Square Method for forecasting cement sales at UD Timbul Rezeki, the results of forecasting Garuda cement in September 2022 totaled **439.85** sacks of sales, Merah Putih cement in September 2022 sales totaled **321.06** sacks, Holcim cement sales in September 2022 totaled **273, 18** sacks, Tiga Roda cement in September 2022 sales totaled **669.70** bags and Jakarta cement sales in September 2022 totaled **270.23** sacks. Based on the results of designing a system to predict the amount of cement inventory using the Least Square Method at UD Timbul Rezeki, it results in an effective and efficient cement management process, a fast forecasting process and can help the cement sales forecasting process easily.

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