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Forecasting **Of Optimal Raw Material Supplies For Paving Block Making In UD. Karya Jaya** Diana Khairani Sofyan University of Malikussaleh Department of Industrial Engineering, faculty of Engineering Nanggroe Aceh Darussalam, Indonesia hatikue@yahoo.com Chalirafi University of Malikussaleh Department of Management, Faculty of Economics and Business Nanggroe Aceh Darussalam, Indonesia chalirafi_84@yahoo.co.id Sayuti, M University of Malikussaleh Department of Industrial Engineering, faculty of Engineering Nanggroe Aceh Darussalam, Indonesia Tgk_sayuti@yahoo.co.uk Abstract — **UD. Karya Jaya is one of the manufacturing companies engaged in the production of paving blocks, located in Keude Bungkah Village, Muara Batu, North Aceh.**

In **the implementation of the production system, the company has been using machines and equipment that has been adapted to technological developments.** In the sense, the machine used is a machine designed by the company, which has the level and effectiveness of production 99% has a perfect success for its products. In producing paving blocks, **the raw materials used** are cement, sand, gravel and paint additives.

Such raw materials shall always be available for the smoothness of production. Available means according to production needs. Based on the above, it is necessary to calculate the inventory forecasting to avoid the accumulation of raw materials. **The results showed that the** forecasting method **used to predict the** demand of raw materials in the month of August 2017-July 2018 is Cement raw material is linear method, Sand raw materials is a quadratic method, raw materials of gravel and paints are linear methods.

With the result of the forecast that is the amount of raw material demand for the period of August 2017-July 2018 average per month is the cement is 1098 sacks, Sand is 20

trucks, the gravel is 8 trucks and the paint is 105 sacks. Keywords — Production; Forecasting; Raw Materials. I. INTRODUCTION UD. Karya Jaya is one of the manufacturing industry engaged in the production of materials for building needs such as brick and paving block located in Keude Bungkah, Muara Batu, North Aceh. In the implementation of the production system the raw materials used are cement, sand, gravel and paint.

such raw materials shall always be available for the smoothness of production. In fulfillment of its requirement, the company does not have the planned amount of order, in the sense that the company makes inventory only based on past experience only, and its nature is fixed every month. Inventories that are too large or too small can cause problems in the company.

Lack of inventory will result in the production process is hampered. So that consumer demand can not be fulfilled at the right time. This research is conducted to plan the planning and control of raw materials more efficient. Planning method that will be used is forecast raw material inventory, so that the raw material needs can be controlled as needed. II. LITERATURE REVIEW 2.1

Forecasting A good production capacity plan should be in line with demand. Future conditions are not predictable so that business people are unwilling to work with an uncertain future condition orientation. Attempts to minimize uncertainty are commonly accomplished by certain methods or forecasting techniques.

Forecasting is the art and science of predicting future events by retrieving historical data and projecting it into the future using several forms of mathematical models. Forecasting is the application of a model that has been developed in the future [1]. The main purpose of forecasting is to predict future demand. Forecasting will never be perfect, but even so the results of forecasting will provide direction for a plan [2].

When viewed from the time horizon, the purpose of forecasting can be classified into 3 (three) groups, are [3]: a. Long term forecasting, generally 5 to 20 years, this planning is used for production planning and resource planning, in this case the role of top management is needed in planning the purpose of forecasting. b.

Medium term forecasting, generally monthly or quarterly, is used to determine cash flow calculations and budget determination on production planning and control, in this case the middle management role required in planning forecasting purposes. c. Short term forecasting, generally daily or weekly, is used to make decisions in relation to the scheduling of labor, machine, raw materials and other.

Short term production resources, the role of Low Management is needed in setting forecasting objectives. 2.2 Forecasting Method In forecasting systems, the use of forecasting methods greatly affects the results of forecasting obtained. of the nature of its users, then forecast **can be divided into two** types, namely [4]: a. Forecasting is subjective, forecasting based on intuition or user feeling.

the nature and characteristics of the user forecasting, greatly affect whether or not the forecasting results obtained. b. Forecasting is objective, forecasting based on past data. The use of this method is done by using certain calculation techniques followed by analysis of forecasting results.

Based on the nature of the prediction then generally forecasting method is classified into 2 (two) parts, that is the method of qualitative forecasting and the method of quantitative forecasting. The classification of forecasting methods based on the predicted nature of the prediction **can be seen in Figure** 1 [5]. Figure 1 Classification of Forecasting In doing the calculation of the method of quantitative forecasting, required forecasting steps, namely: 1.

Define the purpose of forecasting. 2. Preparation of scatter diagrams (scatter diagram). 3. Selection of at least two forecasting methods deemed appropriate. 4. Calculation of the parameters of the forecasting function. 5. Calculation of errors of each forecasting method. 6. Selection of the best method by looking at the results of the calculation method with the smallest error. 7. Verify forecasting. III.

RESEARCH METHODS The research method used is the method of forecasting calculation that begins with the determination of forecasting purposes, depiction scatter diagram, determination and selection of forecasting method used, calculation of forecasting error, verification of forecasting results and ending by calculation of forecasting results for the next year. IV. RESULTS 4.1 Data of Raw Material The following is data of demand for raw material of paving block on UD.

Karya Jaya Period August 2016-July 2017, which **can be seen in Table** 1. Table 1 Data of Raw Material Demand on Paving Block Making No Month Total of Cement (Sacks) Amount of Sand (Truck) Number of Gravel (Truck) Number of Paint (Sacks) 1 August 1030 21 8 106 2 September 1030 21 7 103 3 October 1000 20 9 107 4 November 1050 22 8 105 5 December 1000 20 7 103 6 January 1050 22 9 105 7 February 1080 23 8 108 8 March 1100 24 9 110 9 April 1050 22 7 100 10 Mey 1070 23 8 105 11 June 1050 22 8 103 12 July 1050 22 8 105 Total 12555 258 94 1251 4.2

Forecasting Calculation of Raw Material Requirement for Paving Block Making

Forecasting is the beginning of the calculation that will be done by using the Time series method. Here are the steps of forecasting done, including are as follows: 1. Determining the purpose of forecasting. The purpose of this forecast is to determine the amount of demand for raw materials paving block UD. Karya Jaya period August 2017-July 2018.

The raw materials are: Cement, Sand, Gravel, Paint. 2. Create a scatter diagram. Here is a scatter diagram of each raw material can be seen in Figure 2-Figure 5. Survey Technique Poll Engineering Delphi Technique Method of Management Decision Group Methods Are Structured Market Research Historical Analogy Cycle Life Cutve Time Series - Smoothing - Regression - Seasonal - Decomposition Causal - Trend Linier - Trend Exp.

- Trend Logarithm - Trend Geomaetric - Trend Hyperbola FORECASTING Quantitative Methods Qualitative Methods Figure 2 Scatter Diagram of Total Demand Cement Raw Materials at UD. Karya Jaya Figure 3 Scatter Diagram of Total Demand Sand Raw Materials at UD. Karya Jaya Figure 4 Scatter Diagram of Total Demand Gravel Raw Materials at UD.

Karya Jaya Figure 5 Scatter Diagram of Total Demand piant Raw Materials paint at UD.

Karya Jaya 3. Choosing a forecasting methods. The forecasting methods chosen to forecast data include constant, linear, quadratic, exponential, and cyclical methods. 4. Forecasting parameters. a. Constant Method Forecasting Function is (1) The following is the result of the calculation of forecasting parameters for the constant method as shown in Table 2-Table 5.

Table 2 Calculation of Forecasting Parameters Constant Method of Cement Raw Materials Month (2017-2018) t Y August 1 1030 September 2 1030 October 3 1000 November 4 1050 December 5 1000 January 6 1050 February 7 1080 March 8 1100 April 9 1050 Mey 10 1070 June 11 1050 July 12 1050 Total 78 12560 = = 1.046,67 The forecasting function is: $Y' = 1,046.67$ The same calculation is done for the raw material of sand with a total of 262 the forecasting function is: $Y' = 21,833$, Total Gravel Raw Materials with 96 the forecasting function is: $Y' = 8$ and Paint Raw Material with Total 1260 the forecasting function is: $Y' = 105$. b.

Linear Method Forecasting Function is $Y' + x$ (2) (3) a = (4) The result of calculation forecasting parameters for linear methods as shown in Table 3. Table 3 Calculation of Forecasting Parameters for Linear Method of Cement Raw Materials $b = b = b = 4,266$ a = = = 1018,94 The equation is: $Y' = a + bt$ 11,+ 46t The same calculation is done for sand raw material with forecasting function $Y' = 20,605 + 0,189t$, Gravel Raw Material with forecasting function $Y' = 7,955 + 0,007t$ and Paint Raw Material with forecasting function

$$Y' = 105,591 - 0,091t. \text{ c.}$$

Quadratic Method Forecasting function: $Y' = a + bt + ct^2$ The result of calculation forecasting parameters for quadratic method as shown in Table 4. Table 4 Calculation of Forecasting Parameters for Quadratic Methods of Cement Raw Materials

Month (2017-2018)	T	Y	tY	t ²	t ³	t ⁴	Y tY	t ² Y
August	1	1030	1030	1	1	1	1030	1030
September	2	1030	2060	4	8	16	2060	4120
October	3	1000	3000	9	27	81	3000	9000
November	4	1050	4200	16	64	256	4200	16800
December	5	1000	5000	25	125	625	5000	25000
January	6	1050	6300	36	216	1.296	6300	37800
February	7	1080	7560	49	343	2.401	7560	52920
March	8	1100	8800	64	512	4.096	8800	70400
April	9	1050	9450	81	729	6.561	9450	85050
Mey	10	1070	10700	100	1.000	10.000	10700	107000
June	11	1050	11550	121	1.331	14.641	11550	127050
July	12	1050	12600	144	1.728	20.736	12600	151200
Total	78	12.560	82250	650	6.084	60.710	12560	82250

$\sum t^2 Y = 949,666$ The equation is: $Y' = 4,6 + ,67 ,25 2$
 The same calculation is done for sand material with forecasting function $Y' = 19,728 + 0,565t - 0,029t^2$, Gravel Raw Material with forecasting function $Y' = 9,301 + 0,143t - 0,041t^2$ and Paint Raw Material with forecasting function $Y' = 1513,96 - 0,05t^2$ d.
 Exponential Method Forecasting function: $dt' = aebt$. The result of the calculation of exponential parameter forecasting method as shown in Table 5.

Table 5 Calculation of Forecasting Parameters for Exponential Method of Cement Raw Materials

Month (2017-2018)	T	Y	t ²	lnY	t lnY
August	1	1030	1	6,937	6,937
September	2	1030	4	6,937	13,875
October	3	1000	9	6,908	20,723
November	4	1050	16	6,957	27,826
December	5	1000	25	6,908	34,539
January	6	1050	36	6,957	41,739
February	7	1080	49	6,985	48,893
March	8	1100	64	7,003	56,025
April	9	1050	81	6,957	62,609
Mey	10	1070	100	6,975	69,754
June	11	1050	121	6,957	76,522
July	12	1050	144	6,957	83,479
Total	78	12560	650	83,436	542,921

$b = (13) = = 0,0041$ $\ln a = (14) = = 6,926$ $a = 1018,412$, The equation is: $Y' = 1018,412 e^{0,0041t}$ The same calculation is done for sand material with forecasting function $Y' = 20,594 e^{0,009t}$, Gravel Raw Material with forecasting function $Y' = 7,909 e^{0,0012t}$ and Raw Material with forecasting function $Y' = 105,531 e^{0,0009t}$ e.

Cyclical Method Forecasting function: $Y' = a \sin t + c \cos t$ The result of calculation of cyclic method forecasting parameters as shown in Table 6. Table 6 Calculation of Forecasting Parameters for Cyclic Method of Cement Raw Materials

t	Y	Sin	Cos	YSin	YCos	Sin ²	Cos ²
1	1030	-0,988	0,154	-1017,64	158,62	0,976	0,024
2	1030	-0,305	-0,952	-314,15	-979,65	0,093	0,907

-314,15 -980,56 0,093 0,907 0,290 3 1000 0,894 - 0,448 894 -448 0,799 0,201 -0,401 4
 1050 0,581 0,814 610,05 854,7 0,337 0,663 0,473 5 1000 -0,715 0,699 -715 699 0,511
 0,489 -0,500 6 1050 -0,801 - 0,598 -841,05 -627,9 0,642 0,358 0,479 7 1080 0,468 - 0,884
 505,44 -954,72 0,219 0,781 -0,413 8 1100 0,945 0,326 1039,5 358,6 0,894 0,106 0,308 9
 1050 -0,176 0,984 -184,8 1033,2 0,031 0,969 -0,173 10 1070 -1 - 0,022 -1070 -23,54
 1,000 0,000 0,022 11 1050 -0,132 - 0,991 -138,6 - 1040,55 0,018 0,982 0,131 12 1050
 0,959 - 0,284 1006,95 -298,2 0,920 0,080 -0,272 78 12560 -0,27 - 1,202 -225,3 - 1269,35
 6,439 5,561 -0,208 ?Y (15) $\sin = a \sin + ?^2 + c \sin \cos$ (16) $?c = ac + os^2 + ?n \cos$ (17)
 $12.560 = 12a - 0,270b - 1,202c$

(1) $-225,3 = -0,270a + 6,439b - 0,208c$ (2) $-1.269,35 = -1,202a + 5,561c - 0,208b$(3) Followed by the elimination of the data so that the acquired Function of Forecasting is: $332,771 \sin - 4.902,201 \cos$ The same calculations performed for sand raw materials with the Forecasting Function are $Y' = 20,191 + 0,957 \sin - 16,609 \cos$, Gravel Raw Material with forecasting function $Y' = 5,549 + 1,266 \sin - 127,897 \cos$. 5.

SEE Calculation Calculation error using the method of SEE (Standard Error of Estimation) by using the formula. SEE= (18) Cement Raw Materials 1). Constant Method Degree of freedom (f) = 1 Equation: = 1,046.67 and SEE calculations can be seen in Table 7. Table 7 Calculation of SEE for Constant Method of Cement Raw Materials Month (2017-2018) T Y August 1 1030 1.046,67 -16,67 277,89 September 2 1030 1.046,67 -16,67 277,89 October 3 1000 1.046,67 -46,67 2.178,09 November 4 1050 1.046,67 3,33 11,09 December 5 1000 1.046,67 -46,67 2.178,09 January 6 1050 1.046,67 3,33 11,09 February 7 1080 1.046,67 33,33 1.110,89 March 8 1100 1.046,67 53,33 2.844,09 April 9 1050 1.046,67 3,33 11,09 Mey 10 1070 1.046,67 23,33 544,29 June 11 1050 1.046,67 3,33 11,09 Juli 12 1050 1.046,67 3,33 11,09 Total 78 12560 12.560,04 -0,04 9.466,67 SEE = 29.336 2).

Linear Method Degree of freedom (f) = 1 Equation: = $1018,94 + 4,266t$ and SEE calculations can be seen in Table 8. Table 8 Calculation of SEE for Linear Method of Cement Raw Materials Month (2017- 2018) T Y August 1 1030 1023,206 6,794 46,15844 September 2 1030 1027,472 2,528 6,390784 October 3 1000 1031,738 -31,738 1007,301 November 4 1050 1036,004 13,996 195,888 December 5 1000 1040,27 -40,27 1621,673 January 6 1050 1044,536 5,464 29,8553 February 7 1080 1048,802 31,198 973,3152 March 8 1100 1053,068 46,932 2202,613 April 9 1050 1057,334 -7,334 53,78756 Mey 10 1070 1061,6 8,4 70,56 June 11 1050 1065,866 -15,866 251,73 July 12 1050 1070,132 -20,132 405,2974 Total 78 12560 12560,03 -0,028 6864,569 SEE = 26,200 3). Quadratic Method Degree of freedom (f) = 3.

Equation: $949,666 + 12,967t + 0,235t^2$ and SEE calculations, $SEE = 54,894$.
 Exponential Method Degree of freedom (f) = 2. Equation: $1018,412 e^{0,0041t}$ and SEE calculations, $SEE = 26,245$.
 Cyclical Method Degree of freedom (f) = 3. Equation: $548,143 - 332,771\sin(4.902,201 \text{ Cos})$, SEE calculations, $SEE = 3808,947$
 The recapitulation results of SEE value can be seen in Table 9.

Table 9 The recapitulation results of SEE value for Paving Block Making Forecast
 Methods Result of SEE Calculation
 Cement Sand Gravel Paint Constant 29.336 1,192
 0,742 2,629 Linear 26,200 1,028 0,774 2,811 Quadratic 54,89 1,026 1,768 2,924
 Exponential 26,24 1,031 0,775 3,093 Cyclical 3808,947 12,994 19,882 99,084
 Hypothesis Analysis Hypothesis Analysis is done by finding the smallest SEE value, taht is method of constant forecasting.

The Constant method cannot be used, because the result value by using the Constant method will be constant or the same every month. So the comparison taken is the second and third of the SEE value.
 a. Cement Raw Materials Hypothesis testing is done by comparing SEE Linear with exponential SEE. Testing statistics = $0,997 = 2,978$
 Conclusion: The method used to forecasting demand, the cement raw material in the month of August 2017 - July 2018 is a linear method with forecasting function: $Y' = a + b \cdot t$, $Y' = 0894 + 4,266t$. b.

Sand Raw Materials The method used to forecasting demand, the cement raw material in the month of August 2017 - July 2018 is a Quadratic method with forecasting function: $Y' = 978 + 06t + 0,029t^2$
 c. Gravel Raw Materials The method used to forecasting demand, the cement raw material in the month of August 2017 - July 2018 is a Linear method with forecasting function: $Y' = a + b \cdot t$, $Y' = 795 + 00t$ d.

Paint Raw Materials The method used to forecasting demand, the cement raw material in the month of August 2017 - July 2018 is a Linear method with forecasting function: $Y' = a + b \cdot t$, $Y' = 155 - 0,091t$
 7. Forecast verification The forecasting verification process is performed to determine whether the specified forecasting function is representative enough for the data to be foreseen. The results of the forecasting verification for cement raw materials can be seen in Table 10.

Table 10 Verification Results of Cement Raw Material Forecasting Month (2017- 2018) T
 Y August 1 1030 1023,206 6,794 0 September 2 1030 1027,472 2,528 4,266 October 3
 1000 1031,738 -31,738 34,266 November 4 1050 1036,004 13,996 45,734 December 5
 1000 1040,27 -40,27 54,266 January 6 1050 1044,536 5,464 45,734 February 7 1080
 1048,802 31,198 25,734 March 8 1100 1053,068 46,932 15,734 April 9 1050 1057,334
 -7,334 54,266 Mey 10 1070 1061,6 8,4 15,734 June 11 1050 1065,866 -15,866 24,266 July

12 1050 1070,132 -20,132 4,266 Total 78 12560 12560,03 -0,028 324,266 = 29,479
Moving Range Chart Demand of Cement Raw Material can be seen in Figure 6.

The image shows that all data is within the control limit. This method is assumed to be quite representative because all data is within the control limit so that linear method forecasting can be used. The forecasting result of demand for raw materials for paving blocks making in August 2017- July 2018 can be seen in Table 11-Table 14.

Figure 6 Moving Range Chart Demand of Cement Raw Material Table 11 The forecasting result of demand for cement raw materials for paving blocks making in August 2017- July 2018 Month (2017- 2018) X (t) Persamaan Unit (Sacks) August 13 1074 September 14 1079 October 15 1083 November 16 1087 December 17 1091 January 18 1096 February 19 1100 March 20 1104 April 21 1109 Mey 22 1113 June 23 1117 July 24 1121 Total 13,174 Raw material demand average per month = $13174/12 = 1098$ Sacks Table 12 The forecasting result of demand for Sand raw materials for paving blocks making in August 2017- July 2018 Month (2017- 2018) X (t) Persamaan Unit (Trucks) August 13 – $0,029t^2 + 22$ September 14 – $0,029t^2 + 22$ October 15 + $0,565t - 0,029t^2 + 22$ November 16 – $0,029t^2 + 21$ December 17 – $0,029t^2 + 21$ January 18 – $0,029t^2 + 21$ February 19 – $0,029t^2 + 20$ March 20 – $0,029t^2 + 19$ April 21 – $0,029t^2 + 19$ Mey 22 – $0,029t^2 + 18$ June 23 – $0,029t^2 + 17$ July 24 – $0,029t^2 + 17$ Total 239 Raw material demand average per month = $239/12 = 20$ Trucks Table 13.

The forecasting result of demand for Gravel raw materials for paving blocks making in August 2017- July 2018 Month (2017-2018) X (t) Persamaan Unit (trucks) August 13 8 September 14 8 October 15 $0,007t + 8$ November 16 8 December 17 8 January 18 8 February 19 8 March 20 8 April 21 8 Mey 22 8 June 23 $955 + 0,007t + 8$ July 24 8 Total 96 Raw material demand average per month = $96/12 = 8$ Trucks Table 14.

The forecasting result of demand for Paint raw materials for paving blocks making in August 2017- July 2018 Month (2017- 2018) X (t) Persamaan Unit (Sacks) August 13 $105,439 - 0,0035t$ 105 September 14 $105,439 - 0,0035t$ 105 October 15 $105,439 - 0,0035t$ 105 November 16 $105,439 - 0,0035t$ 105 December 17 $105,439 - 0,0035t$ 105 January 18 $105,439 - 0,0035t$ 105 February 19 $105,439 - 0,0035t$ 105 March 20 $105,439 - 0,0035t$ 105 April 21 $105,439 - 0,0035t$ 105 Mey 22 $105,439 - 0,0035t$ 105 June 23 $105,439 - 0,0035t$ 105 July 24 $105,439 - 0,0035t$ 105 Total 1,260 Raw material demand average per month = $1,260/12 = 105$ Sacks V.

CONCLUSION The conclusion showed that the forecasting method used to predict the demand of raw materials in the month of August 2017-July 2018 is Cement raw material is linear method, Sand raw materials is a quadratic method, raw materials of gravel and

paints are linear methods. With the result of the forecast that is the amount of raw material demand for the period of August 2017-July 2018 average per month is the cement is 1098 sacks, Sand is 20 trucks, the gravel is 8 trucks and the paint is 105 sacks. ACKNOWLEDGMENT Thanks to higher Education and LPPM-UNIMAL and UD.

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