Forecasting Analysis of Cement Selling (Non-Bulk) Using The Method of Triple Exponential Smoothing (Case study: PT. Lafarge Holcim Cement Indonesia)  
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ABSTRACT  
PT. Lafarge Holcim Cement Indonesia is one of the cement companies focusing on construction. The aim of this study is to analyze the sales forecasting applied to know the next period using Triple Exponential Smoothing. The results showed that the values of MAD, MSE and MAPE for PCC’s bag are 3980, 20925291 and 13%, respectively. Meanwhile, the values for OPC’s bag are 105, 19497 and 14%, respectively. Furthermore, the forecasting result of the next period of cement selling for PCC’s and OPC’s bag are 32498 and 792, respectively. Triple exponential smoothing method is a suitable method to forecast the case that has small bias, such as the case in PT. Lafarge Holcim Cement Indonesia.  
Keyword: Triple Exponential Smoothing; forecasting; selling.

INTRODUCTION  
Cement is the primary raw material in building construction. To date, nothing has replaced the function of cement itself. Moreover, with the development of increasingly advanced technology, public facilities, infrastructure and housing increases in the number and in population. This has made the demand for cement also increase. The competition of cement business is also experiencing rapid development. Thus, the companies must have their respective strategies to maintain their company’s continuity and success. PT. Lafarge Holcim Cement Indonesia (PT. LHCI), One of the cement companies in Aceh, produces two types of cement products, which are OPC (Ordinary Portland Cement) and PCC (Portland Composit Cement). Both have differences in the composition of raw materials based on the SNI standards.  
Currently PT. LHCI still has difficulty in predicting future sales for increasing company profits. This is due to the company has not implemented an appropriate method of sales forecasting
If the company takes the wrong action in predicting sales, the company might suffer losses. If the sales forecasting of the company is too high, the company might suffer losses due to the enormous production costs. Otherwise, if company management determines the sales forecasting too low, the company might also experience losses due to the inventory out of stock which not fulfilling consumer demand. Therefore, companies need to forecast their next selling using specific methods. This study aims to forecast cement selling using triple exponential smoothing method in PT. Lafarge Holcim Cement Indonesia.

LITERATURE REVIEW

Selling and Forecasting

Selling is buying and selling process of goods or services carried out in a place/market or online, using a legal payment instrument to make a profit. Forecasting is an objective calculation using past data to determine the future conditions. This forecasting has two methods, namely qualitative methods, and quantitative methods. The qualitative method is a method that simply analyzes the objective conditions. Meanwhile, quantitative methods analyze the patterns of product and sales development [1]. Quantitative forecasting have several methods, one of which is the triple exponential smoothing method. This triple exponential smoothing method is the analytical method for selling forecasting in this study.

Triple Exponential Smoothing Method

This method is proposed by Brown, using quadratic equations. This method is suitable for forecasting fluctuations. The forecasting procedure is as follows: [2]

1. Determining the value of $S'_t$ with the following formula:
   \[ S'_t = \alpha X_t + (1 - \alpha) S'_{t-1} \]
   For the first period, the value of $S'1$ cannot be found using the formula above but it can be determined freely. It is generally determined by the same value that occurred in the first period.

2. Determining the value of $S''_t$ using the formula:
   \[ S''_t = \alpha S'_t + (1 - \alpha) S''_{t-1} - 1 \]
   In the first period, the value of $S''_1$ is usually determined as the value that occurred in the first period.

3. Determining the value of $S'''_t$ with the following formula:
   \[ S'''_t = \alpha S''_t + (1 - \alpha) S'''_{t-1} - 1 \]
   For the first period, $S''_1$ is generally considered the same as the first period data.

4. Determining the $a_t$ value using the following formula:
   \[ a_t = 3 S'_1 - 3 S''_1 - S'''_1 \]

5. Determining the $b_t$ value using the following formula:
   \[ b_t = \frac{\alpha}{2(1-\alpha)} [ (6 - 5\alpha) S'_1 - (10 - 8\alpha) S''_1 + (4 - 3\alpha) S'''_1 ] \]

6. Determining the value of $c_t$ using the following formula:
   \[ c_t = \frac{\alpha^2}{(1-\alpha)^2} (S'_1 - 2 S''_1 + S'''_1) \]

7. Producing a forecast equation as follows:
   \[ F_{t+m} = a_t + b_t m + \frac{1}{2} c_t m^2 \]

$m$ is the forward period for how many future periods the forecast is carried out. $a_t$, $b_t$, $c_t$ are values calculated according to the formula above.

Calculating Forecasting Errors
There are several calculations commonly used to calculate the total forecast error. This calculation can be used to compare different forecasting models, as well as to monitor forecasts, and to ensure that the forecast properly function. The validation of forecasting methods, especially using the methods above, cannot be separated from the indicators in measuring forecasting accuracy. There are several indicators for measuring forecasting accuracy, but the most commonly used are the mean absolute deviation, mean squared error, and mean absolute percent error. [3]

1. **Mean Absolute Deviation (MAD)**
   Forecasting accuracy is high if MAD's values, mean absolute percentage error, and mean squared error are getting smaller. MAD is the absolute total value of the forecast error divided by the data. The formula for calculating MAD is as follows: [3]
   \[
   \text{MAD} = \frac{\sum |\text{Aktual} - \text{Peramalan}|}{n}
   \]

2. **Mean Squared Error (MSE)**
   The error value is calculated using the average squares difference between predicted and observed values. Mean Squared Error is also known as forecasting error. This forecasting error can also calculate the MAD value, which was discussed in the previous section. Forecast errors cannot be avoided in forecasting systems, but forecast errors must be appropriately managed. Management of forecast errors can be more effective if forecasters can take appropriate action regarding the forecast error. Various forecasting models provide different forecast values and different degrees of forecast error in a forecasting system. The average of square error strengthens the effect of large error rates but minimizes forecast error rates smaller than one unit. [3]
   \[
   \text{MSE} = \frac{\sum \left(\frac{(|\text{Aktual} - \text{Peramalan})^2}{n}\right)}{n}
   \]

3. **Mean Absolute Percent Error (MAPE)**
   The problem with MAD and MSE is that their value depends on the size of the element being forecasted. If the element is calculated in thousands, the values for MAD and MSE can be tremendous. To avoid this problem, we can use the Mean Absolute Percent Error (MAPE). MAPE is calculated as the average of absolute differentiation between predicted and actual values, expressed as a percentage of actual value. If we have predicted and actual values for n periods, MAPE can be calculated using the following formula: [3]
   \[
   \text{MAPE} = 100 \frac{\sum_{i=1}^{n} |\text{aktual}_i - \text{ramalan}_i|/\text{aktual}_i}{n}
   \]

**METHOD**

This research perform the field survey method (interviews and direct observation). The forecasting analysis in this research is using the method of triple exponential smoothing, which is also carried out by analyzing the forecast errors. This research data is taken from sales data from 2014 to 2016, at PT. Lafarge Holcim Cement Indonesia. The flowchart of this research at PT. Lafarge Holcim Cement Indonesia can be seen in Figure 1:
Data Analysis

The data used for data analysis is the actual sales data obtained from PT. Lafarge Holcim Cement Indonesia from 2014 to 2016 for each type of cement. These data are then analyzed using the triple exponential smoothing formula, which is then tested for accuracy using Mean Absolute Deviation (MAD), Mean Squared Error and Mean Absolute Percent Error (MAPE). Next is the selling forecast for each type of cement in the following years. The last is the conclusions and suggestions on how to forecast cement selling using the method of triple exponential smoothing.

RESULT AND DISCUSSION

First Data Discussion

Before calculating the sales forecast, the first thing to do is to record the actual sales. In this study, sales data were taken from 2014 to 2016. Data on sales of non-bulk cement at PT Lafarge Holcim Cement Indonesia can be seen in Table 1 below:

| Years | Times Index (Month) | Actual Sales (Ton) |
|-------|---------------------|-------------------|
|       |                     | PCC Bag | OPC Bag |
| 2014  | January             | 34525   | 750    |
|       | February            | 25760   | 783    |
|       | March               | 27950   | 850    |
|       | April               | 30490   | 940    |
|       | May                 | 28690   | 985    |
|       | June                | 32790   | 847    |
|       | July                | 27680   | 757    |
|       | Augusts             | 40987   | 987    |
| Months    | Times Index (Month) | Actual Sales (Ton) |
|-----------|---------------------|--------------------|
|           |                     | PCC Bag | OPC Bag |
| September |                     | 38790   | 725    |
| October   |                     | 42690   | 732    |
| November  |                     | 35462   | 780    |
| December  |                     | 36578   | 683    |
| January   |                     | 32659   | 705    |
| February  |                     | 21760   | 736    |
| March     |                     | 23950   | 850    |
| April     |                     | 25490   | 924    |
| May       |                     | 28750   | 970    |
| June      |                     | 30980   | 825    |
| July      |                     | 25680   | 598    |
| Augusts   |                     | 40672   | 786    |
| September |                     | 31260   | 985    |
| October   |                     | 42460   | 689    |
| November  |                     | 35470   | 758    |
| December  |                     | 38460   | 625    |
| January   |                     | 33419   | 602    |
| February  |                     | 23763   | 621    |
| March     |                     | 24944   | 750    |
| April     |                     | 24449   | 914    |
| May       |                     | 28917   | 958    |
| June      |                     | 29989   | 851    |
| July      |                     | 24866   | 964    |
| Augusts   |                     | 42572   | 1454   |
| September |                     | 32240   | 996    |
| October   |                     | 41446   | 496    |
| November  |                     | 32416   | 576    |
| December  |                     | 34426   | 675    |

Source: PT. LHCI

Figure 2. shows a graph of non-bulk cement selling of PCC for the period 2014 - 2016. The results depict that in every February the cement selling is decreasing while it significantly increase in every August and October.

![Graph of Non-Bulk Cement Selling of PCC Data for the Period 2014 - 2016](image)
Figure 3. Shows the graph of non-bulk cement selling of OPC data for the period 2014-2016. The significant increase of cement selling can be clearly observed in every August every year.

Discussion of Selling Forecasting for PCC Cement

The calculation of Triple Exponential Smoothing of non-bulk cement Selling for the PCC cement type can be seen in Table 2.

Table 2. Forecasting Calculation of PCC Non-Bulk Cement Selling

| Period (Month) | Demand (x) | S’t | S’’t | S’’’t | at  | bt  | ct  | Forecast t+1 |
|---------------|------------|-----|------|-------|-----|-----|-----|--------------|
| 1             | 34525      | 34525 | 34525 | 34525 | 0   | 0   | 0   | -            |
| 2             | 25760      | 33649 | 34437 | 34516 | 32150 | -250 | -9 | 31896        |
| 3             | 27950      | 30079 | 33592 | 34424 | 32885 | 16  | 4  | 32903        |
| 4             | 30490      | 32820 | 33053 | 34287 | 33588 | 203 | 12 | 33797        |
| 5             | 28690      | 32407 | 32778 | 34136 | 33021 | 184 | 12 | 33211        |
| 6             | 32790      | 32445 | 32411 | 33967 | 34067 | 366 | 20 | 34443        |
| 7             | 27680      | 31969 | 32397 | 33807 | 32520 | 176 | 12 | 32702        |
| 8             | 40987      | 32870 | 32059 | 33632 | 36067 | 635 | 29 | 36716        |
| 9             | 38790      | 33462 | 32930 | 33562 | 35160 | 325 | 14 | 35492        |
| 10            | 42690      | 34385 | 33555 | 33561 | 36052 | 283 | 10 | 36341        |
| 11            | 35462      | 34493 | 34396 | 33645 | 33935 | -139 | -8 | 33792        |
| 12            | 36578      | 34701 | 34514 | 33731 | 34294 | -115 | 7  | 34176        |
| 13            | 32659      | 34497 | 34681 | 33826 | 33275 | -258 | -13 | 33011        |
| 14            | 21760      | 33223 | 34370 | 33881 | 30442 | -501 | -20 | 29931        |
| 15            | 23950      | 32296 | 33131 | 33806 | 31302 | -129 | 2  | 31172        |
| 16            | 25490      | 31615 | 32228 | 33648 | 31810 | 116  | 10 | 31932        |
| 17            | 28750      | 31329 | 31587 | 33442 | 32668 | 336  | 20 | 33014        |
| 18            | 30980      | 31294 | 31325 | 33230 | 33136 | 424  | 23 | 33572        |
| 19            | 25680      | 30733 | 31238 | 33031 | 31515 | 238  | 16 | 31761        |
| 20            | 40672      | 31727 | 30832 | 32811 | 35495 | 756  | 35 | 36268        |
| 21            | 31260      | 31680 | 31722 | 32702 | 32576 | 210  | 12 | 32792        |
| 22            | 42460      | 32758 | 31788 | 32611 | 35521 | 517  | 22 | 36050        |
| 23            | 35470      | 33029 | 32785 | 32628 | 33360 | 47  | 1  | 33408        |
| 24            | 38460      | 33572 | 33083 | 32674 | 34140 | 72   | 1  | 34213        |
| 25            | 33419      | 33557 | 33571 | 32763 | 32722 | -189 | -10 | 32528        |
| 26            | 23763      | 32578 | 33495 | 32833 | 30189 | -442 | -19 | 29737        |
| 27            | 24944      | 31814 | 32501 | 32800 | 30739 | -165 | -5  | 30571        |
| 28            | 24449      | 31078 | 31740 | 32694 | 30705 | -7   | 4  | 30700        |
| 29            | 28917      | 30862 | 31056 | 32530 | 31947 | 271  | 16 | 32225        |
Discussion of Selling Forecasting for OPC Cement

The calculation of forecasting non-bulk cement selling using the triple exponential method for OPC cement type can be seen in Table 3.

Table 3. Calculation of OPC Non-Bulk Cement Selling Forecasting Using the Method of Triple Exponential Smoothing

| Period (Month) | Demand (x) | S’t | S’’t | S’’’t | at | bt | ct | Forecast t+1 |
|----------------|------------|-----|------|-------|----|----|----|-------------|
| 1              | 750        | 750 | 750  | 750   | 0  | 0  | 0  | -           |
| 2              | 783        | 753 | 750  | 750   | 759| 1  | 0  | 760         |
| 3              | 850        | 763 | 752  | 750   | 784| 4  | 0  | 788         |
| 4              | 940        | 781 | 755  | 751   | 829| 8  | 0  | 837         |
| 5              | 985        | 801 | 759  | 751   | 877| 12 | 0  | 890         |
| 6              | 847        | 806 | 764  | 753   | 878| 12 | 0  | 890         |
| 7              | 757        | 801 | 768  | 754   | 854| 8  | 0  | 863         |
| 8              | 987        | 819 | 773  | 756   | 896| 12 | 0  | 908         |
| 9              | 725        | 810 | 776  | 758   | 859| 7  | 0  | 866         |
| 10             | 732        | 802 | 779  | 760   | 830| 4  | 0  | 833         |
| 11             | 780        | 800 | 781  | 762   | 819| 2  | 0  | 821         |
| 12             | 683        | 788 | 782  | 764   | 784| -2 | 0  | 782         |
| 13             | 705        | 780 | 782  | 766   | 761| -4 | 0  | 757         |
| 14             | 736        | 776 | 781  | 767   | 751| -5 | 0  | 746         |
| 15             | 850        | 783 | 781  | 769   | 774| -2 | 0  | 772         |
| 16             | 924        | 797 | 783  | 770   | 813| 2  | 0  | 815         |
| 17             | 970        | 814 | 786  | 772   | 857| 6  | 0  | 864         |
| 18             | 825        | 815 | 789  | 774   | 853| 5  | 0  | 859         |
| 19             | 598        | 794 | 789  | 775   | 788| -2 | 0  | 786         |
| 20             | 786        | 793 | 790  | 777   | 786| -2 | 0  | 784         |
| 21             | 985        | 812 | 792  | 778   | 839| 4  | 0  | 842         |
| 22             | 689        | 800 | 793  | 780   | 801| -1 | 0  | 800         |
| 23             | 758        | 796 | 793  | 781   | 789| -2 | 0  | 787         |
| 24             | 625        | 779 | 792  | 782   | 743| -7 | 0  | 736         |
| 25             | 602        | 761 | 789  | 783   | 700| -11| 0  | 689         |
| 26             | 621        | 747 | 784  | 783   | 670| -13| 0  | 657         |
| 27             | 750        | 747 | 781  | 783   | 682| -11| 0  | 671         |
| 28             | 914        | 764 | 779  | 782   | 737| -4 | 0  | 733         |
| 29             | 958        | 783 | 779  | 782   | 794| 2  | 0  | 796         |
| 30             | 851        | 790 | 780  | 782   | 811| 4  | 0  | 814         |
| 31             | 964        | 807 | 783  | 782   | 855| 8  | 0  | 863         |
| 32             | 1454       | 872 | 792  | 783   | 1023| 25 | 1  | 1049        |
Calculation of Accuracy Value in Forecasting of Non-Bulk Cement Sales

After collecting and processing the data, the sales forecasting results are obtained. Furthermore, the accuracy value of the method that has been done is measured. To calculate the accuracy value, the MAD, MSE, and MAPE methods are used. The forecasting and accuracy values for two types of cement, namely the PCC and the OPC type can be seen in table 4 below:

| No | Type of Cement | Forecasting Method | Total Sales | Forecasting Accuracy |
|----|----------------|--------------------|-------------|----------------------|
|    |                |                    | MAD        | MSE                  | MAPE                 |
| 1  | PCC bag        | Triple Exponential Smoothing | 32498      | 3980                 | 20925291             | 13 %                 |
| 2  | OPC bag        | Triple Exponential Smoothing | 792        | 105                  | 19497                | 14 %                 |

CONCLUSION

After collecting and processing data using predetermined forecasting methods, it can be concluded that the sales forecasting method using the Triple Exponential Smoothing method is very suitable for forecasting a fluctuative case due to its small bias.

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