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Forecasting Sales of Hex Nut Using Trend Linier Line (TLL) Methode and Monte Carlo Simulation in PT. KMS East Java

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***Abstrac*t-This study presenting the result of forecasting sales of Hex Nuts between the Trend Linear Line (TLL) method and Monte Carlo Simulation. To determine the appropriate method, the Mean Average Percentage Error (MAPE) is used to evaluate theerror rate. We find that the Monte Carlo simulation outperforms the TTL method, where the MAPE value of the Monte Carlo simulation is 7,61%. Based on the result, the Monte Carlo simulation is the appropriate method to forecast the sales rate of Hex Nuts in the PT. KMS.**

Index Terms-About; Forecasting, MAPE, Monte Carlo simulation, Trend Linier Line method.

I. INTRODUCTION

PT. KMS is the nut distributor company that serves retail and end users. Nut sold by PT. KMS consists of many kinds of materials, types, and even sizes that can be adjusted according to the consumer demand. PT. KMS is not the only one nut distributor company in East Java. Therefore, the innovation, respondtothe consumer needs, and availability of materials needed by consumers are important factors that must be fulfilled by PT. KMS to compete with other distributors (Fran et Al, 2004, and Rahab, 2012) quoted by [1].

In reality, PT. KMS often runs out of nuts as a result of inappropriate planning. The company only orders materials that run out when the stock starts running low. This strategy results in a relatively long waiting time, even they repeatedly losetheorders from consumerssince the consumers look for other distributors. Therefore, it is necessary to forecast the stock of nut to fulfil the demand of Smoothing Method is applied by [2] to forecast the sales of embroidery products in Tasikmalaya. The result of this research is a computer application that combines three smoothing average methods to forecast the next period, based on trends and seasonality. The data taken to make forecasts arethe time series data that are collected sequentially. They find thatthe forecasting result has an accurate result if we may collect a lot of data. They also state that the forecasting is closely related to the uncertain events.

The Weighted Moving Average, Moving Average, and Exponential Smoothing methods needa lot ofcollecteddata to make the forecasting results close to accurate [3] and [4]. Forecasting results using these methods are carried out by looking at the pattern of the previous data, then making the average. The weakness of these methods is that they do not completely capture the decrease of the demand and even an increase outside the trend and season. The Trend Linear Line (TLL) method is similar tothe exponential smoothing method that use the time series data. [5] use TTL method to predict the demand of nuts. Using the forecasting results, the minimum stock availability is calculated using Economic Order Quantity (EOQ) and Period Economic Order Quantity (POQ).

In this article, we compare the forecasting result from the Monte Carlo simulation to TTL method. The reasons for using Monte Carlo Simulation arethat this method is practical, easy to understand, can be used in many fields [6].

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II. LITERATURE REVIEW

This section explainsboth methods and validity testing used in this article.

A. Trend Linier Line (TTL)

TLL is one of the methods used to forecast demand in the next few periods. This method uses a large amount of past data in order to obtain the information about fluctuations that may affect the level of demand for both production and demand in the past. The TTL method assumes that the more data are used, the better forecasting results so that it needs the appropriate data in the right time [7].

B. Monte Carlo Simulation

Simulation can be interpreted as an approach or technique for conducting experiments by taking data using sampling method on a system. The Monte Carlo simulation involves random numbers from a certain probabilistic distribution [8], [12].Meanwhile, the name Monte Carlo itself is taken from a city in Monaco which is very famous for its casino. In these casinos, the device used to generate random numbers is the roulette wheel [9].

The stages or procedures in the application of Monte Carlo simulations are adjusted according to its use. If the simulation is used to predict the amount of production in the next year, or the number of students who will attend or perhaps program a course, the steps are as follows [10] :

1). From the collected data, the probability is then determined. Note that the total probability value must be equal to one.
2). Calculate the cumulative probability value of each variable involved.
3). Create random numbers (obtained from excel or an existing formula), and then create intervals from those random numbers.
4). Simulations to predict the future demands can be done.

However, if it is used to measure the volume of an object, it is necessary to determine the object's area (x, y, z), determine the number of random points, and calculate the number of points that fall into the object's area [9].

C. Validity Testing

The results of forecasting using the TTL method and Monte Carlo simulation can be tested for validity or accuracy using several ways, including calculating the absolute relative error value and the coefficient of variation (CV). If the absolute relative error value and CV <1%, then the forecasting results have high accuracy and precision [9]. We can also calculate the percentage of the simulation results using the previous data. If the percentage results are close to 100%, it means that the forecasting results are accurate [6].Other ways that can be used are Mean Absolute Deviation (MAD) which calculates the average error with an absolute value (it cannot be negative), and Mean Square Error (MSE) which is generally used to measure the average of error. If the series test results show a small error, it can be concluded that the method has an accurate forecasting [13].

The following is the calculation used to find out the errors in forecasting [11].

1. Mean Absolute Deviation (MAD)
   MAD used to calculates the average error with an absolute value (it cannot be negative).

$$MAD = \frac{\sum |\text{actual data - forecasting}|}{n} \qquad (1)$$

2. Mean Square Error (MSE)
   MSE is used to measure the average of error from data which resulting from the reduction of the actual value with the forecasting that has been squared, then divided by number or periods.

$$MSE = \frac{\sum (\text{actual - forecast})^2}{n-1} \qquad (2)$$

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3. Mean Average Percentage Error (MAPE)
   MAPE is the magnitude of the percentage error of the forecasting that has been done.

$$MAPE = \frac{\sum(|actual - forecast|)\square 1}{n} \quad (3)$$

Table 1.
Criteria for the MAPE calculation

Value of MAPE	Conclusion
< 10 %	Forecasting results are very good
10 % - 20 %	Forecasting results are good
20 % - 50 %	Forecasting results are sufficient
> 50 %	Forecasting results are bad

In this study, the validity test used to compare the forecasting result from both the TTL method and Monte Carlo simulation is theMAPE value. The amount of the percentage of the MAPE value (as shown in Table 1), is a guide to evaluate the accuracy of the forecasting.

III. METHODE

This research starts from previous research, where forecasting is done using the TLL method. The forecasting results of the TLL method are then compared with the results of the Monte Carlo Simulation, to obtain precise information about which method is more appropriate to make the next forecast. Figure 1 shows the research flow.

IV. RESULT AND DISCUSSION

It should be noted that this research was conducted in early 2020, from January to March 2020. The data processed in this study used historical data and direct observations in the field. The data used for forecasting in 2020 is the sales data of 88 M12 Hex Nuts for the last 2 years i.e., from January 2018 to December 2019 as listed in Table 2. Figure 2 shows that the data has a Triangular distribution which means that it has the lowest sales value (a), the highest (b), and the possible value (m) where the value of m ≥ a but m ≤ b (a ≤ m ≤ b) (Sugito, 2017).

The result of the 2020 forecast is compared with real sales data in the company. Acomparison of the forecasting result between

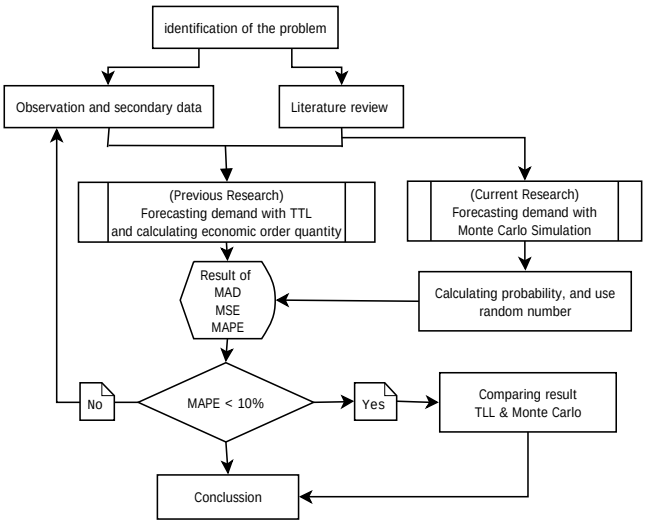

Figure 1. Flow Chart Reseach

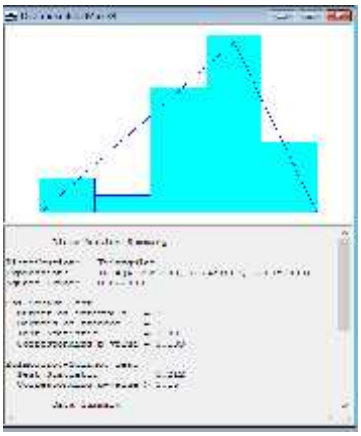

Figure 2. Triangular Distribution of the 88 M12 Hex Nuts

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the Trend Linear Line method and the Monte Carlo Method Simulation is investigated. Both methods are tested for sensitivity, and the one with the smallest MAPE value is used to forecast the following year.

Table 3 shows the forecasting result of both the TTL method and Monte Carlo simulation. To evaluate the performance of both methods, the results of the forecasting of both methods are compared with the actual sales data in 2020.

The results of the forecasting accuracy test of both TLL method and Monte Carlo simulation are then compared from the MAPE value as reported in Table 4. We adjust MAPE value in Table 4 with the percentage value in Table 1, where the MAPE with value by less than 10% means that the method has an accurate forecasting. Now, we compare the MAPE value between the TTL method and Monte Carlo simulation. It can be seen in Table 4 that the Monte Carlo simulation outperforms TTL methods in terms of MAPE value. We may use the Monte Carlo simulation for forecasting the demand of the 88 M12 Hex Nuts in PT. KMS.

Table 2. Sales Data of Mur Hex 88 M12

2018	Sales (Pcs)	2019	Sales (Pcs)
January	1.160	January	6.574
February	720	February	3.684
March	8.948	March	15.727
April	920	April	954
May	3.552	May	3.293
June	2.166	June	3.526
July	3.970	July	7.654
August	2.417	August	13.502
September	911	September	2.108
October	6.094	October	25.212
November	21.708	November	7.242
December	1.321	December	3.573

Table 3. Forecasting Result and the real sales in 2020

Month (2020)	Trend Linier Line (unit)	Monte Carlo Simulation (unit)	Real Sales in 2020 (unit)
1	10.171	18.701	3.115
2	10.495	1.425	584
3	10.819	16.549	386
4	11.142	947	986
5	11.466	11.144	968
6	11.790	21.445	2.592
7	12.114	2.835	4.147
8	12.438	15.261	282
9	12.762	13.861	2.405
10	13.086	11.469	647
11	13.410	8.224	2.388
12	13.733	14.521	2.419
Total	**143.426**	**136.382**	**20.919**

Table 4. Calculation of Forecasting Result Accuracy

Method	MAPE
TTL	7,75
Monte Carlo	7,61

V. CONCLUSION

In this study, the sales of nuts were forecasted by comparing the TLL method with the Monte Carlo simulation. Both methods have an accuracy forecast. However, the Monte Carlo simulation has the better performance than the TTL method in terms of MAPE value.

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