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Article

Forecasting Car Demand in Indonesia with Moving Average Method

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A B S T R A C T

The automotive industry is an industry that requires a long process and high manufacturing costs. improper can have fatal consequences if not planned properly will cause financial losses. Production planning using statistical tools such as statistical process control can control the right amount of production according to customer demand. Part of the statistics that makes planning for future production planned is forecasting. Precise production quantities require the specialized abilities of technicians experienced in forecasting. The approach used in forecasting uses a quantitative approach using production data, and sales data of the Gabungan Industri Kendaraan Bermotor Indonesia 2020. The use of the Moving Average method in forecasting will determine the number of production limits so that excess production can be avoided, and the automotive industry in Indonesian has many opportunities to develop its production.

1. BACKGROUND

1.1 Introduction

The Automotive Industry is an industry that meets the demand for passenger cars and commercial cars. Passenger cars are one of the cars that are often found in cities which are commonly referred to as family cars. A commercial car is a car that has a function to carry out heavy business work on the track, such as mining cars, trucks and 4x4 pickups. in the automotive industry the manufacture of cars requires a very long and expensive process. There was an overproduction in the Automotive Industry in Indonesia, totaling 28,012 units in March, thus causing all automotive industry companies in Indonesia to experience a significant decline in production. The cause of this problem has an impact on the sales of passenger cars and commercial cars throughout the Indonesian automotive industry. Unexpected problems due to the Covid 19 virus caused several regions in Indonesia to decrease sales in various fields and greatly impacted car sales[1].

With the development of statistical tools the quality and quantity of products can be predicted, controlled and improved[2]. This statistical tool in the industry is known as *Statistical Process Control*. The use of *Statistical Process Control* is considered efficient to represent problems in a company[3]. Its use will be more difficult due to the variety of industrial processes [4]. Forecasting is the utility of the SPC tools which functions to predict the amount of production. Statistical forecasts are easier to perform because they are practical, can be done on a large scale, and are more responsive in responding to unexpected changes[5]. Statistical Forecast calculations only provide value, and do not guarantee accurate results because accuracy in forecasting requires the expertise of a technician to take advantage of the forecast value[6]. What is needed to perform statistical estimates is historical data that has numerical values. For example, previous year's sales data can be used in forecasting sales forecasts for the following year, so that if the company is new it seems impossible to make forecasts because there is no historical data.

Statistical data for forecasting uses Indonesian Car Production statistical data obtained from the Association of Indonesian Automotive Industries. The data used is production and sales data for the all production car in Indonesian[7]. Forecasting will be carried out using the Moving Average method using the Microsoft Excel application to estimate the total production of the car production until the end of 2020. This calculation is used to recommend the number of cars produced in order to meet the demand. Other advantages such as reduced inventory costs, production costs and labor costs are the main points of forecasting.

Forecasting for the case of Indonesian automotive industry production uses the moving average method. Moving average is mathematical average of recent periods of actual demand. From the results of the moving average data, there is forecasting data that is backward to the actual line or what we call production lagging data, which is the data used to determine future production planning[6]. Moving average consists of simple moving average, weighted moving average and Simple Exponential Smoothing, these three tools will generate several options that will be compared to see the error rate used as the basis for selecting the optimal alternative. The accuracy of the results of the moving average will be a good result if it is done with several alternative approaches[8].

1.2 Research Purposes

Evaluating the data to take the appropriate production action used as a recommendation to limit the amount of production in the Indonesian automotive industry using the moving average forecasting method is the main objective of this report. production quantity limitation data is illustrated by the forecasting results presented by the moving average method. coverage for data includes 42 data on the automotive industry in Indonesia. There are several problems in this report because we model the locomotive industry forecasting data into one so that the data cannot be used in real terms in each automotive industry, but it can present the number of cars demands that will be used as production limits in a competitive scope.

2. LITERATURE RIVIEW

2.1 Forecasting

Forecasting is a technique that requires past experience to predict future events. There are many types of forecasting, this report uses short-range forecasting. Short-range forecast is used for particular product demand, used for scheduling, and launching production. The main point in forecasting is that the results of forecasting are not the substitution of data for calculating demand, the problem of calculating forecasting is not only right and wrong, but calculating potential errors used for planning discussions[6].

2.2 Simple Moving Averages

Simple Moving average is mathematical average of recent periods of actual demand. The forecast for any time period then becomes the average of the actual demand for the previous periods selected[6].

$$F_t = \frac{A_{t-n}+A_{t-n-1}+\ldots+A_{t-1}}{n} \quad (1)$$

$F_t =$ Forecasting Data
$A_t =$ Actual Data

2.3 Weighted Moving Average

Weighting the actual data gives an average result that is different from the simple moving average, the weight assigned to each past demand poin used in calculation with the rule of sum of weights equal to one[6].

$$F_t = W_1 A_{t-n} + W_2 A_{t-n-1} + \ldots + W_2 A_{t-1} \quad (2)$$

$$\sum_{i=1}^{n} W_i = 1$$

$F_t =$ Forecasting Data
$A_t =$ Actual Data
$W =$ Weighting Constant

2.4 Simple Exponential Smoothing

Smoothing the random fluctuations in the demand pattern is a simple exponential smoothing. The method used to smooth out random fluctuations in demand patterns is by using an alpha constant that is between zero and one[6].

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1}) \qquad (3)$$

$$0 \leq \alpha \leq 1$$

$F_t =$ Forecasting Data
$A_t =$ Actual Data
α = Smoothing Constant

2.5 Forecasting Error Analysis

There are two important values that must be considered in forecasting the first is the forecast value, and the second is the error value. error in a forecast is a major consideration in using data compared to the results of forecasting, because if forecasting has a big error value, the forecast will not be used. [6]

2.6 Mean Forecast Error

Mean forecast error is the mathematical average forecast error over a specified time period. MFE can estimate the error by involving adding all the forecasts and dividing by the number of errors[6].

$$MFE = \frac{\sum_{t=1}^{n}(A_t - F_t)}{n} \qquad [6]$$

2.7 *Mean Absolute Deviation*

Mean absolute deviation is the average of the mathematical absolute deviations of the forecast errors (deviations). MAD represents the number of mean estimates which are important because it shows the average estimated value with a positive value over a certain time period compared to MFE which sometimes results in negative because there is no absolute sign of the sum[6].

$$MAD = \frac{\sum_{t=1}^{n}|A_t - F_t|}{n} \qquad [6]$$

2.8 *Tracking Signal*

The tracking signal has a similar function as a control in statistics. method to determine when the forecasting method should be evaluated or not. By using a number as the ratio tracking signal which has no unit value, the figure represents the signal of the calculation[6].

Tracking Signal = (n*MFE)/MAD

Tracking Signal = RSFE/MAD [6]

3. METHODOLOGY

This section introduces the steps taken in predicting the amount of production of the Indonesian automotive industry in 2020. the method used in the report uses quantitative methods that use data production and sales data for 2020, all production of the Indonesian car industry that has been registered with the Motor Vehicle Industry Association in Indonesia, which ranges from around 42 car industry companies.

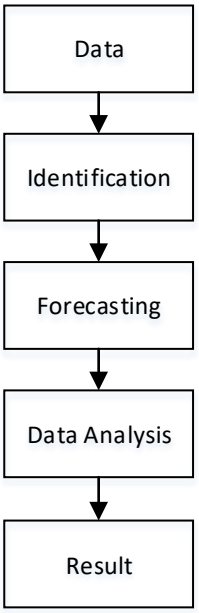

Fig 3. Methodology research diagram.

The identification phase is carried out to determine the causes of the decline in sales in mid-March by reading the literature on activities related to economic problems in mid-March. The problems that have been identified are approached by analyzing sales data for 2020, then forecasting using the Moving Average method to estimate sales in the next 6 months.

4. Results and Discussion

4.1 Identification

Based on the analysis of data that has been represented in statistical form, automotive companies in Indonesia registered with the Indonesian Automotive Industry Association increased their production volume to 89,934 passenger cars, and 21,836 commercial cars in March. This step to increase production is actually the right choice based on forecasting results before knowing the future, but there was a significant drop in sales in mid-March. Based on the conditions that occurred, the Covid-19 virus outbreak was the main cause of the decline in industrial automotive sales. Covid-19 not only affects the Indonesian automotive sales, but also affects an economy

on a global scale[9]. quarantine, social distancing, and fear of contracting the virus cause people to be afraid to leave their homes, and prioritize themselves to survive with the available money, and make donations to those in need so that no one thinks to buying expensive items such as cars during the Covid-19 pandemic, only people with excess finances can buy a car.

The impact of the corona has caused demand for passenger and commercial cars to fall by 3,551 units in May, This value is 20 times smaller than the March demand which could reach 76,811 units. this causes overproduction and then there are other problems caused by overproduction such as costs, labor and production plans. Excess production makes workers unable to provide output because existing output still exceeds market demand, this can result in layoffs of employees and the closure of several automotive industries in Indonesia due to these losses[1], [10]. After a two-month drop in sales, car sales continued to increase slowly through August despite the coronavirus outbreak.

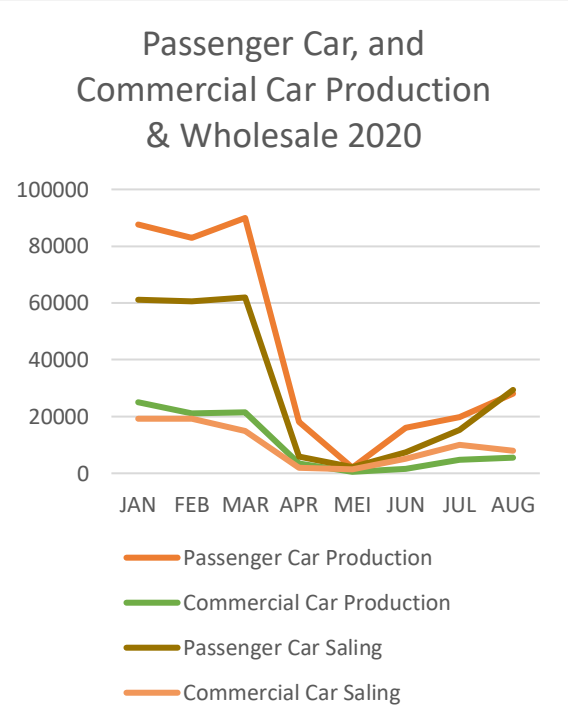

Fig 3. Passenger car, and commercial car production & wholesale 2020 statistic.

4.2 Forecasting

The data used is forecasted using a three period moving average. The range of data used is production, and sales data Gabungan Industri Kendaraan Bermotor Indonesia from January to August 2020. This forecasting value is only used as a basis for making decisions, it is not used as a reference value for the amount of production.

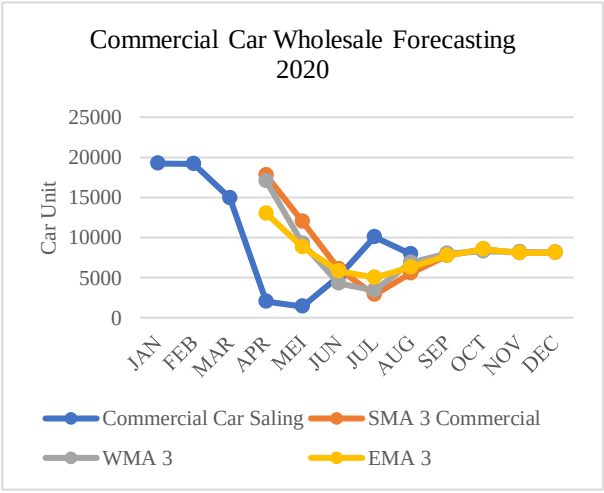

Fig 4. Commercial Car Wholesale Forecasting 2020 Statistic.

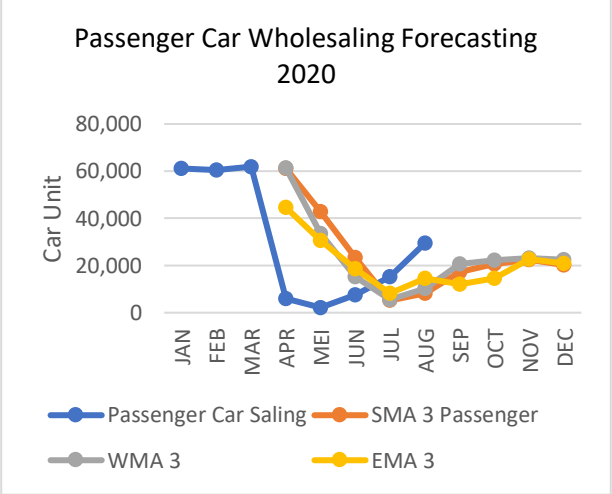

Fig 5. Passenger Car Wholesale Forecasting 2020 Statistic.

The forecast used in the calculation is SMA, WMA, and EMA to forecast demand until the end of the year. In forecasting calculations using WMA for passenger cars, and the weight of commercial cars used is W_1=0.2,W_2= 0.3, and W_3= 0.5. Forecasting calculations with EMA use $\alpha = 0{,}7$.

Table 1. Mean Absolute Deviation comparison of each moving average calculation

Car Types	Moving Average	MAD
Passenger Car	SMA 3	18.630
	WMA 3	17.673
	EMA 3	14.182
Commercial Car	SMA 3	5.390
	WMA 3	5.346
	EMA 3	4.857

Table 2. Passenger car tracking signal comparison

Month	Passenger Car Tracking Signal		
	SMA	WMA	EMA
APR	-1	-1	-1
MEI	-1	-1	-1
JUN	-1	-1	-1
JUL	1	1	1
AUG	1	1	1
SEP	-1	-1	-1
OCT	-1	-1	-1
NOV	-1	-1	-1
DEC	-1	-1	-1

Table 3. Commercial car tracking signal comparison

Month	Commercial Car Tracking Signal		
	SMA	WMA	EMA
APR	-1	-1	-1
MEI	-1	-1	-1
JUN	-1	1	-1
JUL	1	1	1
AUG	1	1	1
SEP	-1	-1	-1
OCT	-1	-1	-1
NOV	-1	-1	-1
DEC	-1	-1	-1

4.3 Data Analysis

Forecasting calculations found many errors in tracking signals because historical data has a significant difference in sales data for March and April. the calculated value of the forecast that is carried out does not mean it cannot be used, but identifies that another approach is needed to predict future estimates. Humans adapt from negative experiences to get used to dealing with those experiences[11]. After several months the Covid-19 virus has emerged several actions, and efforts have been made by the community, and the government to restore stability to the country, even though it is still unable to fight the growth of the Covid-19 virus. The government is trying to reduce the growth of this virus by providing policies for the people to restore the economic situation, one of which is by providing a stimulus fund package[12]. With an increase in demand in May and August, this indicates a recovery in sales of the automotive industry in Indonesia due to the community, as well as government support to fight the Covid-19 virus so that it can adapt and resume activities by following health protocols.

Since the results of the moving average calculation cannot provide a calculation result that reflects the conditions of economic recovery in Indonesia, an approach using linear regression forecasting is used to forecast demand until the end of the year.

4.4 Linear Regression

The linear regression calculation is carried out using data from May to August, because if all the data is used, the result will be a diagonal line that drops down, this is contrary to the state of economic recovery in Indonesia.

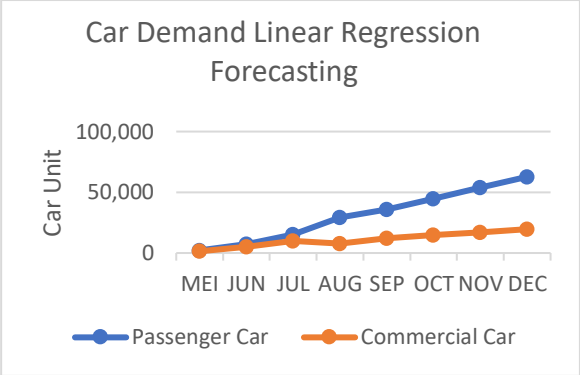

Fig 6. Car demand linear regression forecasting 2020 statistic

Table 4. Car demand linear regression forecasting 2020 table.

Month	Passenger Car	Commercial Car
MEI	2.165	1.386
JUN	7.452	5.171
JUL	15.232	10.051
AUG	29.369	7.922
SEP	35.903	12.255
OCT	44.842	14.703
NOV	53.781	17.152
DEC	62.720	19.601

Based on the results of calculations using linear regression forecasting the value of car demand in Indonesia in September 35,903 Units, October 44,842 Units, November 53,781 Units, and December 62,720 Units. This value identifies the demand for passenger and commercial cars in Indonesia based on linear regression forecasting calculations using Gabungan Industri Kendaraan Bermotor Indonesia 2020 data.

5. CONCLUSION

The occurrence of the corona pandemic means that forecasting cannot be done using only one method, the inaccuracy of the forecast value does not mean that the value is wrong, but this dubious value is taken into consideration in taking further action in planning car production. Industrial companies must be responsive to changes in market demand for forecasts of future production. Results The calculated numerical value can be used as a car demand figure based on linear regression forecasting so that the automotive industry can prepare production quantities to compete to meet car demand in Indonesia.

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