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DEMAND FORECASTING WITH UNIVARIATE TIMES SERIES MODEL : A CASE STUDY IN ELECTRIC AND ELECTRONIC MANUFACTURING COMPANY

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Abstract—The Electric and Electronic manufacturing companies are among industries that need forecasting the most. The need to forecast in the management and operations is increasing in order to achieve its objectives. The company currently facing the problem of over produce inventory for some of the product and the problem might be due to inconsistent demand. Thus, data pattern of inventory demand need to identify before choosing the forecasting methods. Comparison among methods was conducted to determine the best method for the company in order to prepare them for future inventory. This study was conducted using the case study method. The data of demand for one of the product series for five consecutive years were collected and forecasted using Risk Simulator software for the purpose of this study. From the result, the selected forecasting methods to implement were: Single Moving Average, Single Exponential Smoothing, Double Exponential Smoothing, Double Moving Average, Regression Analysis and ARIMA (Autoregressive Integrated Moving Average). It were selected based on the trend and cyclical data patterns. The finding revealed that, Single Moving Average method is the best forecasting method when comparison forecast accuracy is made

Keywords— Demand Forecasting, Electric and Electronic Manufacturing Company, Univariate Times Series

I. INTRODUCTION

Nowadays, business environment was getting more and more competitive. Most manufacturing companies in developing countries determine product demand forecasts and production plans using subjective and intuitive judgments [19]. Inaccurate demand forecasting causes the company makes the wrongful decision in their planning. It also means they cannot satisfy their customer demand and this causes lost of sales. Most managers are aware of the need for improved forecasting but few are familiar with the variety of techniques that have been developed in the last few decades [8]. In other words, there

still limitation of the knowledge about the use of forecasting techniques among managers and it is one of the important measurement methods in decision making [18].

A short interview with the company revealed that, they have problem to forecast the demand because the uncertainty of market demand. According to [19], demand forecast is one among several critical inputs of a production planning process. It is also one of the greatest sources of uncertainty which companies face [13], and it is challenging to define level of predictability and the level of demand uncertainty that a company has to adapt to [9]. According to [16], visually identify the patterns of the data usually is a good starting point to discover the data features and components. This is supported by [14]. Hence, data pattern of demand need to identify before choosing the forecasting methods and comparison among methods was conducted to determine the best method for the company.

Background of the case study, demand forecasting and forecast accuracy is reviewed in next section. After that, pattern and methods selection are determined. Next, comparison between forecasting methods are explained. While the last section, provide some concluding remarks.

II. BACKGROUND OF STUDY

This study has used the data collected from one of the Electric and Electronic manufacturing company in Malaysia. The data included the sales unit of the product for five consecutive years. There are a lot of products produced from the company. The study focused on one of the product only.

Forecasting means estimating a future event or condition which is outside an organization's control and provides a basis for managerial planning [9].

There are three major types of forecasts in business; technological forecasts, economic forecasts, and demand forecasts [12]. Technology forecast is long-term forecasts that concerned with the rates of technological progress. Economic forecast is useful in business circles and it is used for planning their future activities based on the level of business growth. For the demand forecast, it is used in this study.

Demand is the need for a particular product or component and it can come from a number of sources (e.g., customer order or producer's good) [1]. Demand forecasting means estimate of most likely future demand for product under given conditions. Based on the study by [9], one of the fundamental managerial tasks is demand forecasting. Most companies have to make plans based on demand forecasts because they do not know their future demands. Demand forecasts are useful in making decisions with regard to production, sales, investment, expansion, employment of manpower etc.

Forecast horizon also known as the forecast period. According to Heizer and Render [7], forecasting can be classified into three categories based on the time horizons. There are three categories of forecast horizons. Short-range forecast where the forecast's time span is up to one year but not less than three months life spans. Medium-range forecast where the forecast's time span is in the range of three months to three years. Long-range forecast where the forecast's time span is more than three years.

According to [8], basic assumption that forecasters keep in mind is pattern exist in data and pattern will likely continue into the future, so the ability of a given technique to provide a good forecast in a specific situation depends largely on matching the pattern with a technique that can handle it. The data patterns are horizontal (stationary) pattern, trend pattern, seasonal pattern, and cyclical pattern.

A study by [7] shows that there are seven basic steps in forecasting process, which are determine the use of the forecast, select the item to be forecasted, determine the time horizon of the forecast, select the forecasting method(s), gather the data needed to make the forecast, make the forecast, and validate and implement the result. Therefore, this study started with the forecast was used to predict the future demand, the time horizon of forecast is short range forecast, the forecasting methods were selected based on identified data patterns, the sales data was gathered, forecast made by Risk Simulator Software, and finally validate the results based on forecast accuracy measurement with lowest values.

According to [11], considering the types of data patterns is an important step in selecting an appropriate forecasting method. The data pattern identification were carried out by visually identify the data pattern. A time series plot is plotted to

identifying the patterns in the data. Visually identify the patterns of the data usually is a good starting point to discover the data features and components [16].

Forecast accuracy is a significant factor when deciding among forecasting alternatives. The forecast accuracy measurements has directly generated and provided by the Risk Simulator Software except the Regression Analysis method and ARIMA method which only provided RMSE value. To compare all the forecasting methods, therefore the ranking for each forecasting method implemented is mainly reliance on RMSE value.

RMSE is a good measure of prediction accuracy and it used frequently to measure the differences between values predicted by a model or an estimator and the values actually observed from the thing being modelled or estimated [3].

$$RMSE = \sqrt{\frac{1}{n} \sum_{t=1}^n (Y_t - \hat{Y}_t)^2} \quad (2.1)$$

III. METHODOLOGY

Case study is suitable as the research method in this study as [20] stated that case study research method can be defined as an empirical inquiry that investigates a contemporary phenomenon within its real-life context. This is when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used. This study used single case study as defined by [20]. Single case study used to confirm or challenge a theory or to represent a unique or extreme case. Moreover, [20] emphasized that single case study ideal for revelatory cases when an observer may have access to a phenomenon that was previously inaccessible.

In this study, documentation of secondary data will be used. [20] stated that documents could be letters, memoranda, agendas, study reports or any items that could be added to the database. The data taken will be the past data kept by the respective company.

[20] stated that, data analysis can be done with examining, categorizing, tabulating, testing or combining both qualitative and quantitative evidence to address the initial propositions of a study. The data obtained in this study will be analyzed using Risk Simulator software. The rationale of Risk Simulator as a software because there are still lacks of research that apply this software in forecasting process. By applying Risk Simulator in the study, it provides reader to understand how Risk Simulator performs.

IV. DATA ANALYSIS AND RESULT

The data patterns for the collected data were identified, suitable forecasting methods were implemented and the forecast errors were compared to find out the best forecasting method. Before analyzing the data, the historical data is collected from studied company. The collected data was sales data from year 2007 until 2011. The data was collected in monthly basis. The Risk Simulator Software was used to generate the results.

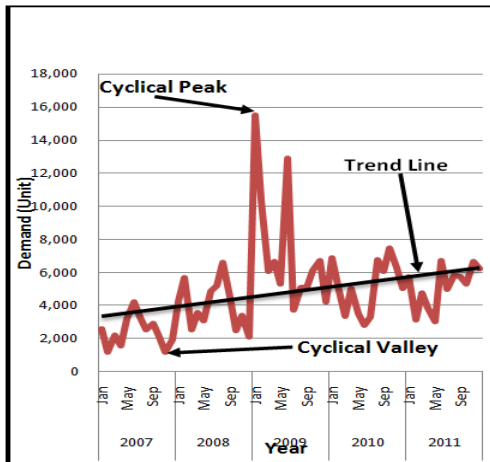


Figure 1: Time Series Plot

Based on Figure 1, it can be seen that there is a significant growth in the time series over an extended period of time. This means that there is a trend component in the time series plot. Since there is a significant trend component in the data, the horizontal component which knows as stationary data would definitely not the pattern of the data. Besides that, Figure 1 also shows that there is rises and falls fluctuation around the trend with no fixed period. This means that there is a cyclical component in the data. Therefore, it can be concluded as there is no horizontal pattern in the data but there are significant trend and cyclical pattern in the data.

The forecasting methods that suitable for the time series data were selected based on trend and cyclical components. The selected forecasting methods were selected based on the suggestion of [6] regarding which forecasting method were suitable to apply when the data have a trend and cyclical components.

The Selected Forecasting Methods	
1	Single Moving Average
2	Single Exponential Smoothing
3	Double Exponential Smoothing
4	Double Moving Average

5	Regression Analysis
6	ARIMA (Autoregressive Integrated Moving Average)

The best forecasting method to predict the demand of the selected product is the method of Single Moving Average. This is because this method has the lowest total error values of RSME which are also the least when compared with the other methods of forecasting.

The RSME value for Single Moving Average is only 2086.8621. The error value obtained by Single Exponential Smoothing is 2368.8310. Meanwhile, the RSME for Double Exponential Smoothing is 2382.3032, Double Moving Average is 2407.6925, Regression Analysis is 2361.7805 and ARIMA is 2278.2887.

The results of overall ranking started from the best method were Single Moving Average, ARIMA, Regression Analysis, Single Exponential Smoothing, Double Exponential Smoothing, and the last ranking Double Moving Average.

V. DISCUSSION AND CONCLUSION

This study investigates uncertainty demand for electric and electronic manufacturing company. The analysis was done by visually inspection of data patterns of the demand. There were trend and cyclical components in the data but there was no significant seasonal or horizontal component in the data.

There were six forecasting methods been selected to use in product demand forecasting. Since the identified patterns were trend and cyclical component, the selected forecasting methods were Single Moving Average, Double Moving Average, Single Exponential Smoothing, Double Exponential Smoothing, Regression Analysis, and ARIMA (Autoregressive Integrated Moving Average).

Based on the findings, the best forecasting method for studied company was Single Moving Average method. This method was chosen as the best forecasting method because it achieved the lowest values for Root Mean Squared Error (RMSE).

For future study, suggested that combining forecasting method is included in selection method. Finding from others study, shows that, combining forecast could yield lower forecast error on average [5], improved forecasting accuracy [15] and produce more accurate forecast for than individual method [4].

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