A STUDY ON DEMAND FORECASTING IN TEXTILE INDUSTRY

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this report is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Industrial Technology Management with Honors.

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STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for the quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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DEDICATION

This Final Year Project Report (FYP)
Is dedicated to
My beloved parents and friends
Who support me all the way during my study.

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ABSTARCT

Numerous operation decision are based on the proper forecast of future demand. For this reason, textile industry considered forecasting is crucial process for effectively guiding several activities. The objectives of this research are to identify demand forecasting method applied by the company, to analyses the sales data using several forecasting method and to propose the most suitable forecasting method to the company. The forecasting method involves in this study is Time Series Forecasting Method. The forecasting method was analyzed by using forecast error measurement tools includes Mean Absolute Deviation (MAD), Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE) and Tracking Signal to monitor the forecast result of various method. The result of this study showed that the Additive Decomposition (Seasonal) of forecasting method is the most suitable method to apply and proposed to the textile Industry. This method comes out with the accurate result and least forecast errors.

ABSTRAK

Kebanyakan ramalan operasi adalah berdasarkan ramalan yang tepat untuk masa hadapan. Atas sebab ini, ramalan industri tekstil menganggap proses ramalan ini penting untuk membimbing beberapa aktiviti. Objektif kajian ini adalah untuk mengenal pasti kaedah ramalan yang digunakan oleh syarikat, untuk menganalisis data jualan dengan menngunakan beberapa kaedah ramalan dan akhir sekali mencadangkan kaedah ramalan yang paling sesuai digunakan oleh syarikat tekstil. Kaedah ramaln yang digunakan dalam kajian ini adalah 'Time Series Forecasting Method'. Dalam menentukan ketepatan kaedah ramalan, 'Mean Absolute Deviation', 'Mean Squared Error', 'Mean Absolute Percentage Error' dan 'Tracking Signal' digunakan untuk menganalisa ketapatan kaedah ramalan. Hasil kajian menunjukkan 'Additive Decomposition (Seasonal Method' adalah kaedah yang paling sesuai untuk dicadangkan kepada industry textile. Kaedah ini menunjukkan keputusan yang tepat dan kesilapan ramalan yang paling sedikit.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Demand forecasting is the estimation of demand for goods and services over a specific period of time. By doing this, it will makes much easier to adjust production schedules. Then the accurate result of demand can be achieved. By combining production with demand, it can help business to keep their inventories low, which helps to cut expenses as well as lower the taxes assessed on finished goods.

Manufacturers using demand forecasting as a tool to planning production schedules. The process basically involves by looking at historical data regarding orders placed by regular customers, trends of general industry, and any other factors. The result of the research, manufacturers trying to determine how many units of each product in their line need to be produced in the specific of time in order to meet consumer demand in the upcoming time period. When the projection is complete, the placement of orders for raw materials become easy. If the forecast proves to be accurate, the benefit of keeping inventories low will be get by the manufacturer, but it still enough to meet the demand.

Besides that, retailers also used technique of demand forecasting in the purchasing products process at their stores. By accurately evaluating the demand for the products, it is possible to have the product enough on hand to satisfy customer needs. In addition, demand forecasting can be particularly helpful when dealing with seasonal products, especially when deciding how many units they can purchase and reasonably expect.

Therefore, demand forecasting is very important in the production and business. It is important in the making of decision process which is in purchasing or buying product to meet sufficient demand and keep enough of inventory. But then, when the inaccurate demand forecasting occur, it will affected to the company profit, inventory and performance.

1.2 BACKGROUND OF STUDY

Jay Heizer and Barry Render stated that, forecasting is an art and science of predicting future events. It may include by taking historical data and projecting them into the future with some type of mathematical model. Numerous operational decisions are based on the proper forecast of future demand. Forecasting is a critical process for efficiently controlling some events in the company. Many companies need a reliable forecast for the future demand in operating the business and to make sure supply chain operate effectively. Therefore, demand forecasting is a main issue in decision making process to get accurate forecast in order to choose proper action (Pamela Danese, 2010). Furthermore, (Raul Poler, 2007) stated demand forecasting is one of the process which greatly influence decision making. So that, forecasting is a very important process in a business especially in decision making.

Andrea Pumi and Arianna Peppe (2013) said that demand forecasting is considered a vital to process of supply chain management and it plays a crucial role especially in the long-term and to identifying the direction of the business strategy. However, all levels of production systems will be affected by forecast accuracy, from the generation of production plans to the calculation of material requirements and to supply chain management. In addition, an accurate forecast can make the cost savings, reducing working capital in safety stocks, strengthening the customer relationships and will increase the competitiveness.

In fact, demand forecasting refers to predicting future demand or sales, assuming that the factors which affected demand in the past and are affecting the present will still have an influence in the future. Kerkanen, Korpela, Huiskonen (2009) stated that the imitation of concepts, targets and principles of forecasting method are

risk for unrealistic accuracy targets and deceptive error measures. Thus, suitable situation should be analyzed before any method or techniques are applied. (Wilson and Keating, 2009). Therefore, the objectives of this paper is to analyses the demand forecasting technique adopted by the textile company and implement sale's data of companies using several other forecasting methods. Then evaluate among different forecasting methods and determined or choose the best suitable technique or method to forecast the demand.

According to Ho and Ireland (1998), excess inventories or lost sales are the causes of inaccuracies in forecasting and it can influence the impacts of cost on the manufacturing systems. Therefore, accurateness of forecasting is the most important criterion in selecting forecast approaches.

1.3 PROBLEM STATEMENT

In order to succeed in a high competitive economic environment, a company should make forecasting as an important task. Inventory planning is an important part in the textile operations. Good retail inventory management will help to balance the demand and supply. But then, it depend on heavily on accurate forecast of future demand. However, the uncertainty that exist in supply chain will affect the accuracy of forecasting.

As we know that, demand forecasting is a crucial issues in driving efficient operation of management plans. This is especially the case in textile industry. Sometimes company make decision without knowing what will be in the future which mean that they order an inventory without knowing what sales will be in their business. Apart from that, in textile industry there are problem such demand uncertainty and lack of historical data.

The inventory problem can arise when management does not forecast the demand accurately. Compared to the other industry, textile industry has very difficult task in demand forecasting because of the demand unpredictable. Without a good forecast, it can lead the company to unstable stock of inventory. As a result, company

got problem with high stock of goods which could not be in sale. Unsold goods will cause cash flow problem to the business. Sometimes company does not have enough stock to supply to the customer in time. Then it will affect the inventory management and supply chain. At the same time company may lost the profit in the business.

1.4 RESEARCH OBJECTIVES

1) To identify the demand forecasting method use by the textile company.
2) To analyses the sales data using several forecasting methods.
3) To propose the most suitable forecasting method to the textile company.

1.5 RESEARCH QUESTIONS

1) What is the forecasting method implemented by the textile company?
2) Which forecasting techniques can be used to analyses the sales data?
3) What is the most suitable forecasting method can be used by the company?

1.6 SCOPE OF THE STUDY

This study focuses on the demand forecasting that refer to predicting future demand or sales of the textile company. The aims is to provide an overview and analysis of the current demand forecasting techniques adopted by the forecasters. This study focused on a Textile Company, small and medium enterprise company in Kelantan Malaysia. This study will utilize the data from the company. The data that will be collected includes the order unit and sales unit of the product for twelve consecutive month.

After that, this study will examine and take the demand forecast result by using the several different forecasting methods based on the sales data. In addition, objective of this study is to suggest the most suitable demand forecasting method to the company in order to help the company manage their inventory or goods effectively and efficiently. This study is to help the planner to forecast the demand timely and

accurately to make effective and quick supply chain management and facilitate the company to make the best decision for predicting the future.

1.7 SIGNIFICANCE OF STUDY

Forecasting is the process of preparing for the future. It includes predicting the future outcome of the business decisions. Forecasting is important for any business because it can make the profit when having an inventory at the right time. In order to produce the right amount of good for consumer, a business must have the right amount of materials. If the business cannot handle this, then either the business will not be able to serve the customer due to shortage or will have to hold extra products and need to incur storage costs.

This study will help the planner in the textile industry to have a better understanding about sales or demand forecasting method in doing inventory planning. Therefore, by taking the time to forecast and plan the sales activity, it will help company to have a better understanding on seasonal peaks and though, determining the actual cost of sales, determining the time to order new inventory and determining the right time to launch a new product.

Furthermore, this study can also help company to make the right decision in demand or sales forecasting in their business in terms of how many product should be produce and what product should be made based on the customers requirement or demanding.

In this research, POM software will be used in order to make the forecasting calculation job. The forecasting method that will be used in this study are simple moving average, weight moving average, exponential smoothing, trend-adjusted exponential smoothing, trend projection and additive decomposition (seasonal).

1.8 OPERATIONAL DEFINITION

Demand Forecasting:

Demand forecasting is a processes of decision making that need an accurate forecasts in order to select proper actions in the production planning, sales budgeting, new product launches and so on.

Supply Chain:

A supply chain involve all parties whether directly or indirectly and including of manufacturers, suppliers, transporter, warehouses, retailer and customers to fulfilling the customers requirement.

Inventory:

Inventory is the stocks or any items or resources used in an organization to support the production which including raw material, subassemblies, work in process and finished goods.

Inventory Management:

Inventory management is the process of control the continuous flow of goods into and out of an existing inventory. The purpose of this process is to prevent the inventory from becoming too high, or declining to levels that could put the operation of the company into risk.

Demand Uncertainty:

The business will get trouble in accurately projecting customer demand in future is an effect of demand uncertainty, this will makes inventory hard to control and manage.

Warehouse:

A place where to store and handle the goods and materials.

Quantitative Method:

Quantitative forecast use variety of mathematical models that rely on historical data and associative variables to forecast demand.

Qualitative Method

Qualitative forecast include the factors of decision maker's intuition, emotions, personal experiences and value system in reaching a forecast. It also involves the information such as human factor, personal opinion and judgmental.

1.9 EXPECTED RESULT

The expected result from this research can be used to identify the method that can be applied by the textile company. From this research, researcher can define the types of forecasting method that can be used by the company and also able to find the problem that company had currently.

The second expected result from this research is to enable the company to forecast the demand data by using several forecasting method. From this research, researcher can identify the most suitable method to be forecast the data and select from the six of forecasting methods that will be studied. The method that have less in error will be choose.

Last, is to enable researcher to propose the suitable forecasting method to the company. When the most suitable method have been chosen in previous objective, then researcher will propose that method to the company.

By adopting the most suitable forecasting method in business, it will help the company to balance between the supply and demand. It also can improve the inventory management and decision planning in the company.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Literature review plays a critical roles in the research. This chapter will examine and evaluate the key points of a body of works. It also looks at the different theories and concepts that have been presented, to check their validity or how they have changed.

2.2 THE SIGNIFICANT AND ROLE OF DEMAND FORECASTING

In supply chain management, inventory control is one of the important task. Accuracy of demand forecasting is one of the critical success factor in the inventory management. Companies that operate in consumer markets are commonly applied the demand forecasting (Bon, et al, 2009). Therefore, demand forecasting is very important in the business especially in managing inventory system and satisfy the customers.

In manufacturing companies, demand forecasting is the main issues. The process of decision making is to make the right forecasts in order to select most suitable actions that applicable to sales budgeting, production planning, promotion planning and new product launches. Therefore, (Wright et al., 1986; Armstrong, 2001; Caniato et al., 2002a, b) stated that there need to focus on how the forecasting can be improved to increase forecast accuracy. So that, accurate forecasting is very important to the company when in decision making process. Besides that, Pamela Danese (2010) also claimed that the most important issues in the Industry is the process of demand forecasting.

Therefore, Pumi and Peppe (2013) said that demand forecasting is plays a crucial role especially in the long-term, in identifying the direction of the business strategy and considered a key to operate supply chain management. However, all levels of production systems are affected by the forecast accuracy from the generation of production plans to the calculation of material requirements and to supply chain management. In addition, an accurate forecast can lead to weighty cost savings, to reduce working capital in safety stocks, to strengthen the relationship of customers and to increase competitiveness.

According to Katz, Pagell and Bloodgood (2003), inaccurate forecasting can affect the performance of supply chain efficiency. Thus, is necessity to reduce such inefficiency with some strategies. Taylor and Fearne (2006) described inaccurate forecasting in the food supply chain as a critical problem that caused negative impacts on the supply chain efficiency and product flow. Besides, the improvement in demand forecasting was described as a key factor for enhancing supply chain operation in food industry supply chain (Aghazadeh, 2004). Furthermore, (Ebert and Lee, 1995) said that to continuing challenges of forecasted inaccuracy it has an impact on rescheduling and (Kalchschmidt and Zotteri, 2007) also proved that additional cost difficulties for manufacturing and might be cause the performance of logistic in the way that affected the delivery of timeliness and quality

According to Armstrong (2001), demand forecasting is basically play a significant role in most manufacturing companies. Demand forecasting is vital to supplier, manufacturer or distributor. Forecast will measure the appropriate quantities that should be purchased, manufactured and shipped. Wu, Chiang and Tu (2004) claimed the role of forecasting existed in controlling the relationship between customer demand and finish good flow. They further stated that forecasting for demand part continues to be a key concern in many organization. In general practice, accurate demand forecasts lead to efficient operation and high level of customer service, while inaccurate forecasts will caused the decrease of production process with high cost operation and poor customer services.

Forecasting management covers the decision of information gathering process and tools which is what and how the information's should be collected. Then, it also covered on organizational approaches to be approved in terms of people must be control

the forecasting and the task must be created. Other than that, forecasting management cover on intercompany collaboration for developing a shared forecast by using different sources of information within the company or supply network. Lastly the measurement of accuracy using the proper metric and defining proper incentive mechanisms. Thus, the understanding of how to improve forecasting in minimizing forecast error requires a study not only on the relationship between forecasting techniques and forecast accuracy, but also the impact of other forecasting devices linked to forecasting process management. The researchers are mentioned as crucial forecasting variables for significantly reducing forecast errors (Fildes and Hastings, 1994; Mentzer and Bienstock, 1998; Moon et al., 2003)

Thus, in order to achieve more accurate forecasts, it is very important to improve the forecasting process. The accuracy of forecast is measured as a requirement because high error of forecast commonly disturb companies' operational performance particularly cost and delivery performance (Kalchschmidt et al., 2003). Therefore, improving the forecasting process will have a positive indirect result on operational performance through forecast accuracy developments. In fact, an appropriate process of forecasting will gives companies the chance to more comprehend customers' behaviors and dynamic of market, reducing an uncertainty on future events, and to provide useful analysis and information to the company's functions. So, it can effect cost and delivery performance.

In the recent years, the role of prediction has become essential as the competitive market pressures increasingly realizing requirements for predictive accuracy. Information technology (IT) has enabled the prediction to drive the whole supply chain and creating a regulatory environment to compress cycle times. As customers are increasingly demanding shorter response times by improving quality, efficient forecast became critical in helping organizations to identify new market opportunities, anticipates future demand, production schedules more effectively and reduce the inventory.

2.3 APPLICATION OF DEMAND FORECASTING IN INDUSTRY

In a competitive and changing business environment need forecaster to forecast both planning long-term business strategies and ensuring that the supply chain operates effectively on a day-to-day basis.

In the consumer goods business, product range are wide and delivery times to the trade are short. According to Quelch and Kenny (1994), a widely used of strategy to increase demand for product variety is a caused of product range become wide. However, demand hardly increases proportionally with the increasing of variation product. A high delivery service is continued by supplying from stock. To improve the supply chain efficiency, the producers must strive to forecast future sales. If the effort is successful it has potential to reduce safety stock levels while maintaining a good service level.

At the present time, to enhance supply chain performance and value users, suppliers, wholesalers and the retailer must work together. Collaboration between the trading and suppliers is known under the acronym ECR, meaning "an effective consumer backlash". The objective of the supply chain participants is to enhance the user. When all the user needs is the effective address in trade, so the supply chain will have benefit.

However, Figure 1.1 below shows the background of demand forecasting process. In the competitive market, demand forecasts may be described in terms historical data, parent data, and transaction input. There is a lot of demand for forecasting purposes. This forecasts be used as the input for both the planning requirements materials and financial planning. Therefore, the output from the process is measured in the quantity and points of logistics units.

Input transactions like the activities which generate the company to influence the demand. Key input transactions are exchange price, promotion and various. Customer definitions and product is the holding data of process demand forecasting. To improving the forecasting process, he need to provide feedback to the sales and marketing is important. Therefore, it is necessary to be able to handle requests on a more meaningful level of sales and marketing people (Holmstrom, 1998).

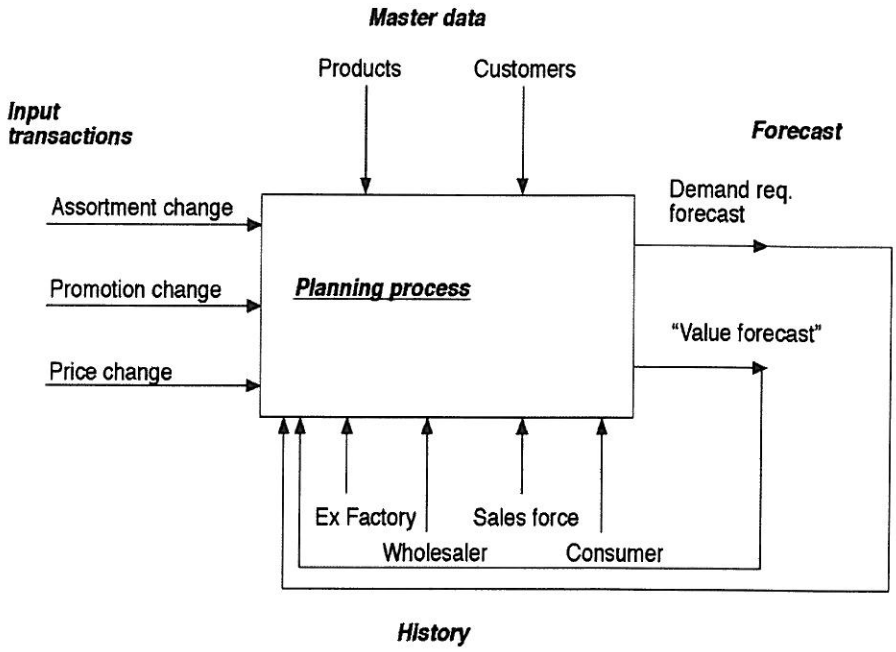

Figure 1.1: Chart of forecasting process in competitive market

Besides that, history of data available from different levels of the supply chain. In the competitive environment of any changes in the market should react quickly and reduce the need to keep large stockpiles. Reaction improved by controlling the demand is closed to customers. Consequently, the ideal history of sales to end users provided.

2.4 THE VARIABLES AND FACTOR IN FORECASTING PROCESS

It is difficult for a company to choose suitable method that can be used in forecasting process. There are needs several factors or approaches to identify the most suitable method in forecasting. Most company established an objective to improve their performance by using efficient forecasting process and to identify forecasting variables that relates to the performance. To improve forecast accuracy, most companies focusing their efforts in different ways. Some authors consider the techniques applied by the company, the combination of information to elaborate forecasts and the role of forecasting in associate decision making within the company. (Danese, Kalchschmidt, 2011)

Researcher had found that there are different elements established and the criteria of forecasting process and different framework of analysis have been proposed

by some authors. According to Armstrong (1987), forecasting process based on four dimensions which are forecasting method, data available, uncertainty analysis and costs and benefit. Which means that forecasting method is the number of technique used, followed by data available where a central database is accessible which gather information from different sources.

Then Fildes and Hastings (1994) considered that forecasting process consist of three variables which is forecaster and decision makers, information flow and technical characteristic of forecast. In technical view, that consideration concerned about the planner's training and use forecast for different decision making process using information on the environment as well as accuracy and bias were considerate.

Forecasting management was divided by Mentzer and Bienstock (1998) into four parts which is an acceptable method for describing the projection, the projection system that allows the predictor to use similar information in the company and use data from suppliers and customers, the management of different forecasting methods, taking into account the level and information from different data sources used, and also stage in the company's decision was based on a single measurement, prediction and forecasting, assessment types of metrics used to measure the accurateness prediction and simulation operations related to the forecasting process.

Lastly, Moon et al. (2003) recommend a model of forecasting collected of four scopes which is functional integration where emphasis the coordination between functional area, approach systems and performance measurement, the kind of technique used, central system in providing information and performance assessment for accuracy. There have many forecasting technique or design that can be used for the company in order to achieve their target or accurate forecast result in their business.

Moon et al. (2003) claims that forecasting techniques are not enough to improve forecast accuracy, if they are not accompanied by proper specific procedures and approaches for managing the forecasting process. Usually, an information collected is to define forecasts and the role of forecasting to make decisions within the company. The combination of data and information from different parties which is dealers and consumers will give more knowledge about the future demand and change future trend

that have potency be linked to better accuracy. (Kekre et al., 1990; Fisher et al., 1994; Bartezzaghi and Verganti, 1995; Chen et al., 2000)

In addition, other functions within the company forecasts that are used to finance a different decision and processes like sales and budget preparation, production planning or the development of new products. In other words, all of the decisions have been generate within a company and also in the supply chain must be based on mutual prediction (Mentzer and Bienstock, 1998).

2.5 Forecasting Approaches

There are two general approaches to forecasting which are quantitative analysis and qualitative approach. According to Haizer and Render, quantitative forecast use variety of mathematical models that rely on historical data and associative variables to forecast demand. Qualitative forecast incorporate such factors as the decision maker's intuition, emotions, personal experiences and value system in reaching a forecast.

Quantitative methods are divided into two basic types time-series methods and explanatory methods. Time-series methods make forecasts based only on the historical patterns associated with the data explanatory methods add in other factors. There is no "right or wrong" way to forecast, but a lot of business owners prefer the explanatory method because it takes into account more than just sales numbers (Cavanagh, n.d). According to Zou H.F, et al (2007), time series forecasting is an important areas of forecasting in which observation of the same variable are collected and analyze to develop a model describing the underlying relationship. This modelling approach is particularly useful when little knowledge is available or when no satisfactory explanatory variables is relate to the other explanatory variables. Quantitative forecasting method includes the Naïve forecasting method, the simple moving average method, the weighted moving average method and the exponential smoothing method.

Qualitative forecasting models is another way to approach the future. These forecasting models predict the future using judgment or intuition rather than records of past data. Delphi technique is a qualitative method whereby a group of experts develop a forecast. An individual expert could be a decision maker, an industry expert or an

employee. Each party is questioned individually about his estimated demand. The experts then forward their responses anonymously to an independent party, who summarizes these forecasts and support arguments and sends them back to the experts with further questions. This process is repeats until a consensus is reached. It is an effective method for long-range forecasting (Diana Wicks, n.d).

There are many different approaches to demand forecasting. In the previous research, there have a different about the relationship between the forecasting adoption and accuracy (Wacker and Sprague, 1998). There are enormous arguments about the effectiveness of the quantitative methods such as exponential smoothing or regression analysis while qualitative methods such as the judgment forecast and Delphi method. It is very important to select the suitable approach for the forecasting purpose where judgment forecast will be chosen where there is little or no historical data is given and the business activity has high demand uncertainty and could be affected by previous activities (Sanders and Manrodt, 2003). Beside that, quantitative approach will be choose in the case that a few forecast is needed to be develop for variety of products when the good quality data exist and demand show a stable pattern (Makridakis, Wheelwright and Hyndman, 2008).

Therefore, a combination of quantitative and qualitative method also has been proposed in the demand forecasting process (Sanders and Ritzman, 2001; Franses and Legerstee, 2009). Combining forecasts based on different methods or data has emerged as one of the most important way to improve forecasting performance. The combination of quantitative and judgmental forecasts can give dimension for forecasting and has actually been a key research area over the past three decades. In light of the complementary nature of quantitative and judgmental forecasting method, the forecasts generated by integrating statistical and judgmental finding are likely to be more accurate than those generated by one of the method alone (Blattberg & Hoch, 1990).

There are few studies on forecasting methods that require reasoning and quantitative procedure. These studies provide clues level longitudinal changes in the role and practice of forecasting methods. For example, Mentzer and Cox (1984) investigate the habits, applications, performance, and the satisfaction with managers forecast the current sales forecasting techniques. Then, a similar study conducted by Mentzer and Khan (1994) reviewed the use of various methods of forecasting in

business. The results showed that managers overwhelmingly in favor of the method of forecasting consideration on quantitative methods

According to (Sanders NR and Manrodt KB, 2003) stated that their field of study while forecasts sophisticated methodological issues like the design of neural networks or Bayesian belief networks, practitioners continue to generate forecasts judgmentally or dependent on simple quantitative model like a simple average of exponential moving average or . There are two issues of this observation. First, the prediction as a field of study is only responsible for creating the methodology advances. Second, it studies have demonstrated reasoning methods usually lead to lower predictive performance for bias in existence in human decision making

Some survey evidence suggest that one reason to use judgmental method is the lack of relevant of quantitative data (Sanders and Manrodt, 1994). Some study speculate that judgmental forecast may be beneficial in forecasting highly variable time series if the variability is caused by temporary change in the environmental in which expert is knowledgeable (Armstrong, 1985).

Among the forecasting techniques, the quantitative method shown the characteristics of being objective, stable, able to process enormous data and take account of correlation between different variables. Huge amount of data is required in this method. Therefore, when there is some change in the data that are not integrated in the model, the result of forecast is inaccurate. In contrast, the qualitative method can combine the general knowledge of the expert in particular field, expertise experience and judgment which is known information to develop forecast. Judgmental approaches often caused forecasting error due to the different expertise's opinions as inherent bias. However this forecasting method has biases that cause forecasting error.

Many companies realized when they implement the quantitative method through variety of forecasting methods, the performance is not exactly better than the adoption of qualitative approaches in their company. Hence, researchers believed that the implementation of forecasting techniques whether qualitative or quantitative technique is useful for the company as it helps minimizing the judgmental bias and the influence of inappropriate information (Makridakis, 2008). Based on the previous research of sales forecasting method generally claimed that quantitative methods are preferable to

be used by company rather than qualitative method. A wide range of research support the effectiveness of quantitative forecasting method in most situation instead (Dalrymple,1987). However, it is clear the forecasting methods that used in production are not suitable for different material types. It is difficult to adopt a suitable technique in forecasting process in order to get accurate demand.

In the textile industry, mostly of demand forecasting is complex. Company in this particular sector run with a large variety of short life cycle product, deeply influenced by the seasonal sales, promotional events, weather condition and advertising marketing campaign. Furthermore, textile industry have a short selling seasons. Fashion market place is highly competitive and the constant need to 'refresh' product ranges means that there is an inevitable move by many retailers to extend the number of 'seasons', i.e., the frequency with which the entire merchandise within a store is changed (Maria Elena Nenni and Luca Pirolo, 2013). They also observed that fashion sales forecasting is accomplished by the statistical methods. In fact, a lot of statistical methods have been used for sales forecasting, which include linear regression, moving average, weighted average, exponential smoothing (used when a trend is present but not linear), exponential smoothing with trend, double exponential smoothing, Bayesian analysis, and so forth

Nowadays, the competition in the business is become fiercer and many type series forecasting techniques has been proposed. According to De Gooijer and Hyndman (2005), time series forecasting software tools commonly offer an enormous of methods, some of which offer the user to determine the parameter automatically. In the business environment, forecaster might need to use various techniques time series of forecasting in order to generate the reliable forecast for decision making. It is crucial to provide the firm with an expert forecasting system that capable to deal with the automatic parameterization of specific forecasting models or expert system that able to select the most appropriate forecasting technique from a set of forecasting model in the system. Time series forecasting models are conducted to identify trends, cycle, seasonal pattern and random variables that might affect forecast accuracy. The analysis is integrated to generate forecast to the companies. As for product with consistent demand with available historical sales, the analysis based on the time series models are very accurate while for new products, forecasts are inaccurate (Smith et al, 1996).

Although they are numerous types of approaches used to forecast demand, in real business environment the time series approach is usually the most suitable and the most accurate technique to develop the large amount of short term range. The application of every forecasting method has the objectives to generate accurate and unbiased prediction of the future event with the existence of uncertainty. Usually, companies will integrate two or more forecasting techniques to produce an accurate demand forecast. The implementation of forecasting approaches can be better used as the forecaster acquired experience and complexity, yet there is a factor to be considered with the forecaster's judgment and opinion might has the risk to inherent bias and error (Smith et al, 1996)

2.6 TIME SERIES MODEL OF QUANTITATIVE FORECASTING METHOD

In this research, time series model of quantitative forecasting method will be used to forecast. Time-series methods make forecasts based solely on historical patterns in the data. Time-series methods use time as independent variable to produce demand. In a time series, successive point or over successive period are taken as a measurement. The measurements may be taken every year, month, week, day or hour. A first step in using time-series approach is to gather historical data. The historical data is representative of the conditions expected in the future. Time-series models are adequate forecasting tools if demand has shown a consistent pattern in the past that is expected to recur in the future (Hiray, 2008).

2.6.1 Simple Moving Average

Simple moving average is one of the time series model. The simple moving method is a quantitative forecasting method that relies on an adjustable set period. Moving averages are a form of lagging indicator, which plots average asset prices over time. A smoothing device used to verify the emergence of new trends which is shorter-length-average have a tendency to follow changes in underlying asset prices more closely. Longer-length averages alternatively desensitize asset price movements emphasizing only major trends and will generate fewer and future signals than a shorter-length average. Regardless of their length (short or long), moving average systems

perform generally poorly in ranging markets characterized by no clear trend in movement (Ellis C. A. and Parbery S. A., 2005).

The technical indicators, which come from the mathematical formula a based on volume and stock price can be applied to predict the future price fluctuation and also be provided for investors to determine the timing of buying or selling the stocks. Moving average is one of the most widely known trading rules used by financial traders. Moving average is one of technical analysis methods and has added a significant increase of interest in the academia. Additionally, stock market investors usually make their short-term decisions based on recent stock information such as the latest price fluctuations.

Thus, simple moving average is mathematical formula and it can be applied to predict the future price fluctuation can determine the timing for buying or selling stock.

2.6.2 Weight Moving Average

Weighted moving method can be used to evaluate an evaluation period. It is similar to the simple moving method but with a different weight given to each month in the period. The weighted moving method is most effective at evaluating trends with expected monthly changes, such as the sale of seasonal clothing.

According to the Charles C. Holt (2004), an exponentially weighted moving average is a means of smoothing random fluctuations that has the desirable properties. The properties are easy to compute, minimum data are required and declining weight is put on the data. A new value of the average is obtained merely by computing a weighted average of two variables which is the value of the average from the last period and the current value of the variable.

In the previous research, they study about the note on detecting outliers in short auto correlated data using join estimation and weight moving average methods. Comprehensive results for the joint estimation outlier detection method and the exponentially weighted moving average method with regard to their performance as statistical process control methods or outlier detection methods for short-run auto correlated data are reported.as the result, the findings of this research suggest that both

joint estimation weight moving average work well for the detection of the outlier when it is the last observation in a short auto correlated time series (Wright and Hu, 2003)

2.6.3 Exponential Smoothing

The exponential smoothing method allows to evaluate data, considering recent results as more significant than older periods. This method is ideal for evaluating quantitative data in fields and markets with rapidly changing values, such as sales figures in a volatile market.

The exponential smoothing methods are quite simple but robust approaches to forecasting. They are widely used in business for forecasting demand for inventories (Gardner, 1985). They are also have performed amazingly well in forecasting competitions against more sophisticated approaches (Makridakis & Hibon, 2000).

Besides that, Bermudez, ´ Segura, & Vercher (2008) stated that exponential smoothing methods are forecasting techniques which are used widely for the analysis of time series due to their simplicity and robustness as automatic forecasting procedure.

In the analysis of dependent time series, the series which are subject to correlated random disturbance or where the observations of a time series are related to the past and present values of other series, the use of multivariate time series models allows information to be borrowed from one series in order to improve the predictions of another series. On such cases, some multivariate generalizations of the exponential smoothing method have been shown to provide more satisfactory results than those derived from the univariate analysis of each series (de Silva, Hyndman, &Snyder, 2007). Thus, exponential smoothing method is a good method in the analyses of dependent time series.

2.6.4 Trend Adjusted Exponential Smoothing

According to the Hammond (u.d) trend adjusted exponential smoothing is similar to the exponential smoothing method. Trend-adjusted method can be used to forecast an expected result by comparing the recent market volatility as well as changes

in trends. This technique is important when evaluating the expected changes to a market from marketing campaign or changes to the overall market desire for product.

2.6.5 Trend Projections

According to Lavenderangel (2012), Trend projection method is a classical method of business forecasting. This method is basically concerned with the study of movement of variable through time. This method requires a long and reliable time series data. The trend projection method is used under the assumption that the factors responsible for the past trends. Jay heizer state that, this technique fit a trend line to a series of historical data points and project the line into the future for medium to long range forecast.

2.7 ACCURACY MEASUREMENT OF FORECASTING TECHNIQUE

It is important to recognize the impacts of demand forecast errors on the supply chain. The learning of the role of forecasting and the impacts of forecast errors makes a base for defining a accurate target for forecast accuracy, identifying the most important customer or products to be forecasted and finding a appropriate way to measure performance of forecasting.

Heizer (2001) stated that, most studies of forecasting start from the principle of the using of forecasts and the requirement to define forecast accuracy before the approach for choosing of forecast.

Kerkka¨nen et al. (2006) have summarized, causes for forecast error are different and they might be exist at the same time or in the same place. The causes includes playing a game which means that sales person used forecasting to his personal purpose, low motivation which mean that sales person does not see somewhat point in forecasting and lack of ability which means that sales person lack the tools and skills to produce reliable forecast.

According to Chopra and Meindl (2001), there have two main purposes of measuring accuracy. First, to determine whether the current forecasting method predict the systematic components of demand accurately or not, manager may use an error analysis to determine it. Second, manager estimate forecast error because any possibility plan must account for such an error.

There are different types of effect in production planning and inventory level with different types of forecast error (Kerkkanen et al, 2009). Choosing the most suitable forecast measurement is a necessity in order to get better forecast accuracy. From the previous research, there are several assessment of forecast accuracy and recommendation have been made by several studies on which tools should be used in evaluate the accuracy of the forecast techniques. There are some measures for forecasting performance and the most popular ones are mean absolute deviation (MAD), mean absolute percentage error (MAPE), mean square error (MSE), cumulative error and average error or bias (Mentzer and Moon, 2005).

Mean Absolute Deviation (MAD) is the first measure of the overall forecast error. This value is computed by taking the sum of the absolute values of the individual forecast error (deviations) and dividing by the number of period. This forecast error measure is easy to determine and simple enough to understand.

Formula MAD:

$$\mathbf{MAD} = \frac{\sum|\,\mathbf{Actual}-\mathbf{Forecast}|}{\mathbf{n}}$$

In statistics, the Mean Square Error (MSE) is one way to evaluate the difference between an estimator and the true value of the quantity being estimated. MSE measures the average of the square of the "error," with the error being the amount by which the estimator differs from the quantity to be estimated (Curtis Seubert, n.d).

Formula MSE:

$$\mathbf{MSE} = \frac{\sum(\mathbf{Actual}-\mathbf{Forecast})2}{\mathbf{n}}$$

According to the Mentzer and Beinstock (1998), Mean Absolute Percentage Error considered as the most popular measurement tools for forecasting accuracy in the real business. MAPE is the average of the absolute differences between the forecast and actual values, express as a percent of actual value.

Formula MAPE:

$$\textbf{MAPE} = \frac{\sum 100|\text{Actual} - \text{Forecast}\ |/\text{Actual}}{\mathbf{n}}$$

MAPE has become popular as a performance measurement tool because it is easiness to interpret and understandable (Lam, Mui and Yuen, 2001). This measure was applied by the several companies and consistent that implemented by previous survey.

According to some authors, measuring forecast errors improves forecast accuracy (Mentzer and Moon) and the smaller the forecast error is, the more accurate the forecasting method will be (Ryu, 2002). Therefore in this study, all accuracy measurements that have been discussed, applied to find the best forecasting method.

The forecast error is generally normal distributed, which shows that the forecast in control. Tracking signal is used to assess the larger deviation up and down in actual value in forecast error. This measurement used to monitor if the actual demand does not perform the assumptions in the forecast about the distribution and predict level in demand profile. Tracking signal reflect if there is a persistent tendency for actual value to be exceed a certain limit. Although the control limits in range ± 3 to ± 8, the acceptable limits for tracking signal are usually within 4 with correspond to three standard deviation. (Chockaligam, 2009)

$$\textbf{Tracking Signal} = \sum \textbf{(At-Ft) / MAD}$$

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Research methodology is the most important element in a research. This chapter will determine the technique that will be used by the researcher to investigate research problem and achieve research objectives. The process used to collect data and information for the purpose of making decision. It offers the overview of the research design and data collection method and also the data analysis method.

3.2 RESEARCH DESIGN

Research design is a detailed outline of how a study will take place. A research design will normally include the way to make data collection, what tools will be employed, how the tools will be used and analyzing data collected.

Research method that will be used in this research is the case study method. As Yin (2003) stated that case study method can be defined as an experimental review that examines a current phenomenon within its real-life context. This study is single case study. As defined by Yin (2003), single case study might be used to confirm or contest a theory or to represent a special or extreme cases. Moreover, Yin (2003) emphasized that single case study suitable for revelatory cases when an observer may have access to a phenomenon that was previously inaccessible.

3.3 DATA COLLECTION TECHNIQUE

In this type of research study, data collection techniques is very important. The information, knowledge and process about demand forecasting will be determined in several ways including survey, interview, journals, articles, reference books and also website to make sure any relevant studies or methods from local and international research are correct. One textile company have been chosen to be interview and make survey about demand forecasting technique and also the inventory problem of company. In this study the data will be collected from major sources.

So that, primary and secondary data will be used in this research. Primary data is information collected by the researcher directly from the respondent through method such as surveys and interviews. In this research, primary data will be collected through interview. The researcher will need to go to the company to interview a respondent to take the data accurately. In this study, the data that will be collected consist of the company's monthly sales unit for the sample product.

Secondary data, on the other hand, is basically primary data collected by someone else. In this research documentation of secondary data will be used. Documents could be letters, memoranda, agendas, study reports or any items that could be added to the database (Yin,2003). So, secondary data will be obtained through journal, articles and website and documented report of company.

3.3.1 Interview

The interview is the primary technique for information collection during the systems analysis phases of a development project. It is a skill which must be mastered by every analyst. The interviewing skills of the analyst will determine what information is gathered, and the quality and depth of that information. Interviewing and research are the primary tools of the analyst. This method allows the finding of clarification and elaboration and provide more latitude for investigation.

In this research, face-to-face interview will be used during the data collection process. The manager of the company will be interviewed and asked several questions

related to the subject matter. The interview session will be focused on the method that company use to forecast the demand and variables that affected the forecasting process. It also focused on the types of problems that influence the inventory management of the company.

Interview is very important because researcher can know background of the company and the problem about the demand forecasting of company. From that, researcher can make a decision to choose the most suitable of forecasting method to the company.

3.4 DATA ANALYSIS TECHNIQUES

(Yin, 2003) claimed that, the data analysis consists of examining, categorizing, tabulating, testing or otherwise joining both the quantitative and qualitative evidence to report the initial propositions of a study.

In this research, quantitative forecasting will be applied. Quantitative forecast that employ mathematical modeling to forecast the demand. Time series forecast methods will be used to analyses the data collected from the company. The time series forecast method that will be used are simple moving average, weight moving average, exponential smoothing, trend-adjusted exponential smoothing, trend projection and additive decomposition seasonal. These models look at what has happened over a period of time and use a series of past data to make a forecast. A time series based on a sequence of evenly space such as weekly, monthly, quarterly and so on. The data might be measurement of demand, profit, quality or sales.

In this research, the data analysis will be carried out using four individual forecasting methods. POM software will be used to generate the forecasting result. The forecasting result will be measured using three forecast errors.

3.4.1 The Forecasting Method

There are six types of forecasting methods that will be used on this research. There are simple moving averages, weight moving average, exponential smoothing,

trend adjusted exponential smoothing, trend projection and additive decomposition (seasonal).

1) Simple Moving Average

A moving average forecast uses a number of historical actual data values to make a forecast. The moving average forecast can be computed using the following equation:

$$\textbf{Moving Average} = \frac{\sum \text{Demand in previous } n \text{ period}}{n}$$

2) Weight Moving Average

A weight average is similar to the moving average, except that is assigns more weight to the most recent values in a time series. Note that the weights sum must be 1.00 and that the heaviest weight are assigned to the most recent value.

$$\textbf{Weight moving average} = \frac{\sum(\textbf{Weight } n)(\textbf{Demand } n)}{\sum \textbf{Weights}}$$

3) Exponential Smoothing

Exponential smoothing is a sophisticated weight moving average forecasting method that is still easy to use. It involves very little record keeping of past data.

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

Where:

F_t = new forecast

F_{t-1} = previous period's forecast

α = smoothing (or weighting) constant ($0 \leq \alpha \leq 1$)

A_{t-1} = previous period's actual demand

4) Trend-Adjusted Exponential Smoothing

A variation of simple exponential smoothing can be used then there have random variations or trends in the historical data. When gradual, long-term up or down movement of the variable occurs, the adjusted exponential smoothing

forecasting method will be the most accurate method to use. Also, when the historical data show a cyclical pattern, a seasonal pattern or a combination of one of these with a trend, the method being presented will still be very accurate. The trend-adjusted forecast consist of two elements: a smoothed error and a trend factor.

Forecast including trend (FIT) = $Ft + Tt$

Where:

F_t = Exponential smoothed forecast

T_t = Exponential smoothed trend

And:

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

$T_t = \beta(F_t - F_{t-1}) + (1 - \beta)$

Where:

α= smoothing constant for average

β= smoothing constant for trend

5. Trend Projection

The simplest and most widely use form of regression involve in linear relationship between two variables. The object in linear regression is to obtain an equation of straight line that minimize the sum of squared vertical deviation of data point from the line.

$$\mathbf{Y_c = a = bx}$$

Y_c = Predicted (dependent) variable

x = Predictor (independent) variable

b = slope of the line

a = value of Y_c when x = 0

5) Additive Decomposition (Seasonal)

In the additive model, an original time series is expressed as a sum of components which are the trend cycle components, the seasonal effect and the irregular fluctuation. The additive decomposition is expressed by the following equation:

$$O_t = TC_t + S_t + I_t$$

3.4.2 Accuracy Measurement

In this research, several measures are used to calculate the overall forecast error. These measures will be used to compare different forecasting models, as well as to monitor forecast to ensure they are performing well. There are three most popular measure which is mean absolute deviation (MAD), mean square error (MSE) and mean absolute percent error (MAPE).

Forecast Error = Actual demand – Forecast value

$$\textbf{MAD} = \frac{\sum|\ \text{Forecast Error}\ |}{n}$$

$$\textbf{MSE} = \frac{\sum(\text{Forecast Error})2}{n}$$

$$\textbf{MAPE} = \frac{\sum 100\ |\ Actual - Forecast\ |\backslash Actual}{n}$$

Tracking signal = ∑ (At – Ft) / MAD

3.5 POM SOFTWARE

In this research, POM software will be used in order to carry out the forecasting calculation job. This software is reliable and acknowledge by the industry and also academic field. Most company used POM software in their operation and production management. In order to have more understanding about the operation of POM software in forecasting, the general operation step are provided as below:

Step 1: Start POM Windows and select the "Forecasting" from the [Module] menu.

Step 2: In the [File] tool, click "New" and select the "Time Series Analysis" forecasting method.

Step 3: In the data input screen, specific the forecasting title and the number of past period demand information as well as the row label.

Step 4: On the data input matrix screen, select the "Method" tool. There will be listing all the "Time Series" model including Moving Average, Weight Moving Average, Exponential Smoothing, Exponential Smoothing with Trend and Linear Regression. Next select the forecasting technique that will be used.

Step 5: In the data capture dialog box, identify and enter the data that need to analyze and specify the data contain date as well as the descriptive label.

Step 6: Select [Solve] and the report including forecast results, details and error analysis and graph will appear.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 INTRODUCTION

This chapter shows the findings and result of the forecasting analysis conducted on the data collected. It is structured by showing the variables to determine the forecasting model, result of several forecasting model and result of the forecast error. At the end of the chapter, there is a summary of the entire forecasting technique model used.

4.2 DATA COLLECTION

This study analyses the data collected from a Company Y (Textile Industry) for several forecasting method. The information were collected during the interviewed including sales data and the method that company used to forecast the demand. According to the manager of the company, they did not used any sophisticated method of forecasting before. They just assumed that the demand for the next period is equal to the demand in the most recent period. That technique is called Naïve approaches which is the simplest way to forecast the demand.

This study involved analysis of the demand forecasting of product M. The sales data collected for product M is a one year which is year 2013. The demand forecasting in this study was focus on year 2014. Therefore, time series forecasting model was chosen as the forecasting techniques in this study.

The table below is the sales data obtained from the Company Y.

Table 4.1: Actual demand for product M in 2013

MONTH	ACTUAL DEMAND (Dozen)
JANUARY	210
FEBRUARY	200
MARCH	250
APRIL	140
MAY	130
JUNE	110
JULY	200
AUGUST	105
SEPTEMBER	140
OCTOBER	150
NOVEMBER	210
DECEMBER	250

4.3 DATA ANALYSIS

Based on the historical data given by the Company Y, time series forecasting method will be used in this study. Time series method are popular known as statistical analysis of historical data to make forecast for the future. This method use time as the independent variable to produce demand. The time series model that used in this study are simple moving average, weight moving average, exponential smoothing, trend-adjusted exponential smoothing and additive decomposition seasonal.

In this study, time series method will be used to analyze the four factors which is trend, seasonality, cycle and random variation. Trend is the gradual upward or downward movement of the data over time. Seasonality might be when the data pattern that repeats itself after a period of months and years. The Cyclical Fluctuation is the wavelike up and down fluctuations about the trend that is attributable business

conditions like life cycle of product. Random variation in the data caused by chance and unusual situation. They follow no discernible pattern, so they cannot be predicted.

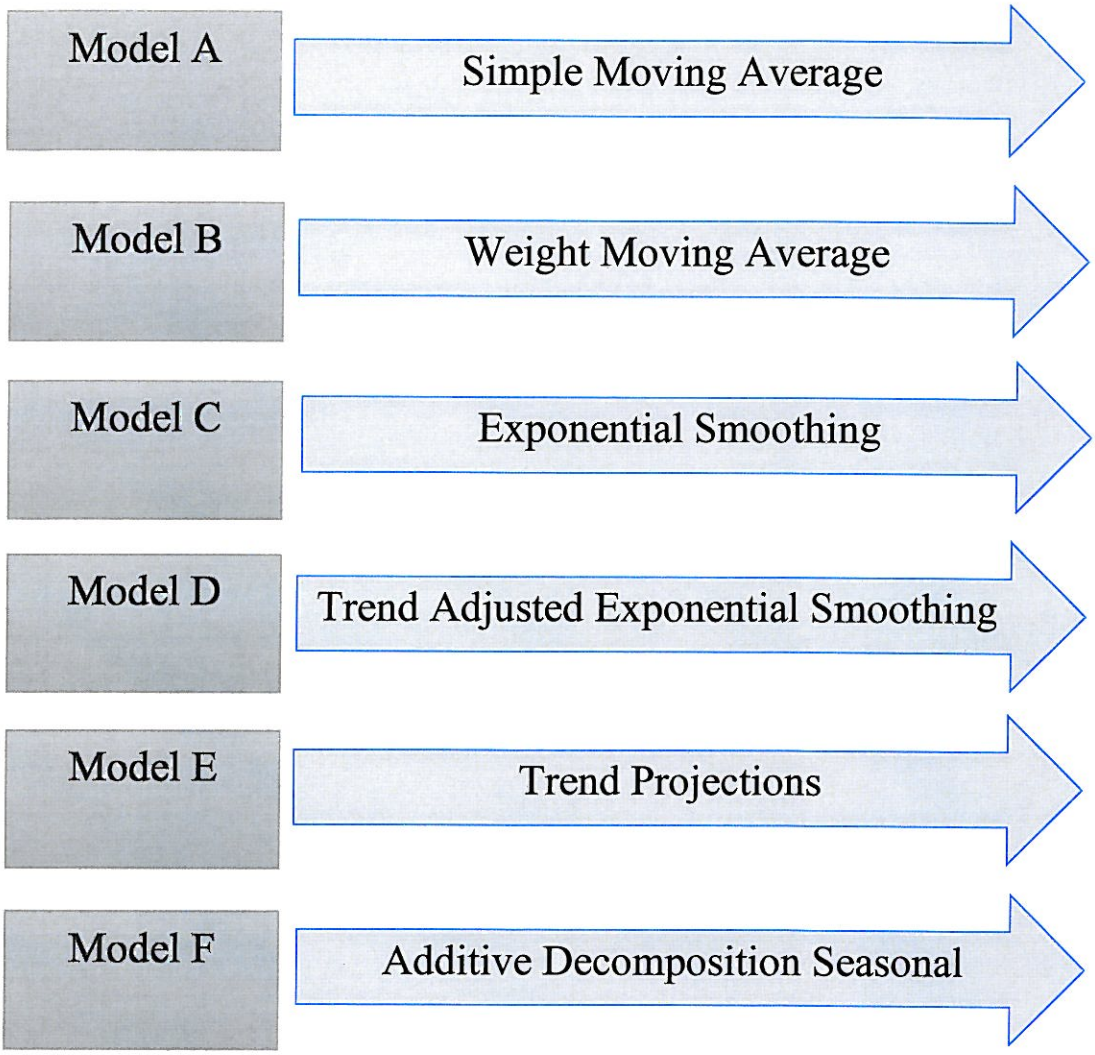

Table 4.2: Model of Forecasting Method

4.3.1 Simple Moving Average (Model A)

A simple moving average uses a two month moving average to generate a forecast for demand by using actual historical data. This model will produce a smooth or better estimate of the mean in the time series if the mean are constant or change slowly by averaging the past two month data. This practice tends to smooth out short term irregularities in the data series.

Table 4.3: Two-Month Moving average Forecasting Method (Model A)

Months	Actual Demand (units)	Forecast Demand (units)
January	210	
February	200	
March	250	205
April	140	225
May	130	195
June	110	135
July	200	120
August	105	155
September	140	152.5
October	150	122.5
November	210	145
December	250	180

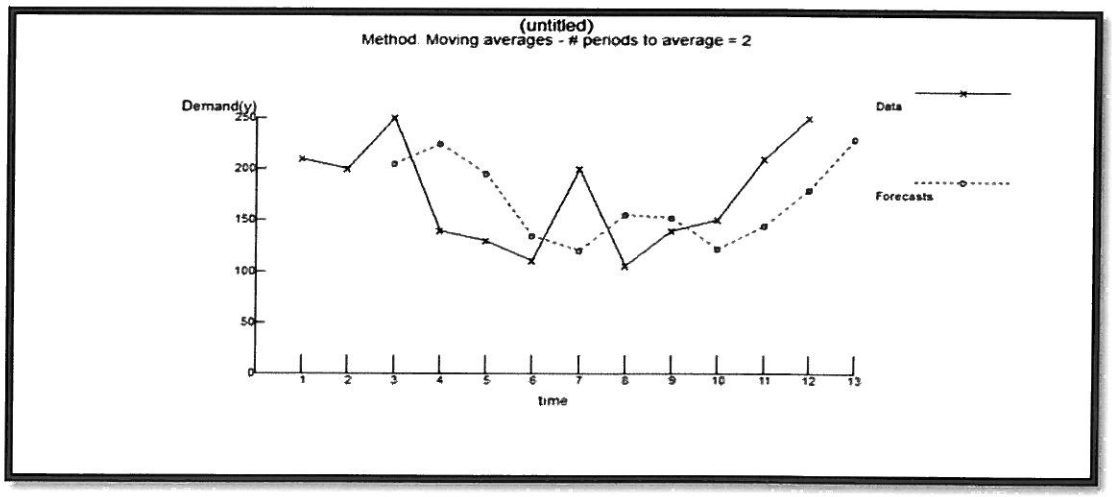

Figure 4.1: Comparison between actual and forecast demand (Model A)

4.3.2 Weight Moving average (Model B)

A weighted moving average similar to moving average, except that it assigns more weight to the most recent value in the time series. The most recent value has been assigned a weight of 0.60 and next most recent value a weight of 0.40. There are trend emerging for the product demand therefore this model are more responsive to react the actual demand.

Weighted choose for this study are 0.6 for demand last month and 0.4 for demand last two month. The total of weight is 1.

Table 4.4: Weighted Moving Average Forecasting Method (Model B)

Months	Actual Demand (units)	Forecast Demand (units)
January	210	
February	200	
March	250	204
April	140	230
May	130	184
June	110	134
July	200	118
August	105	164
September	140	143
October	150	126
November	210	146
December	250	186

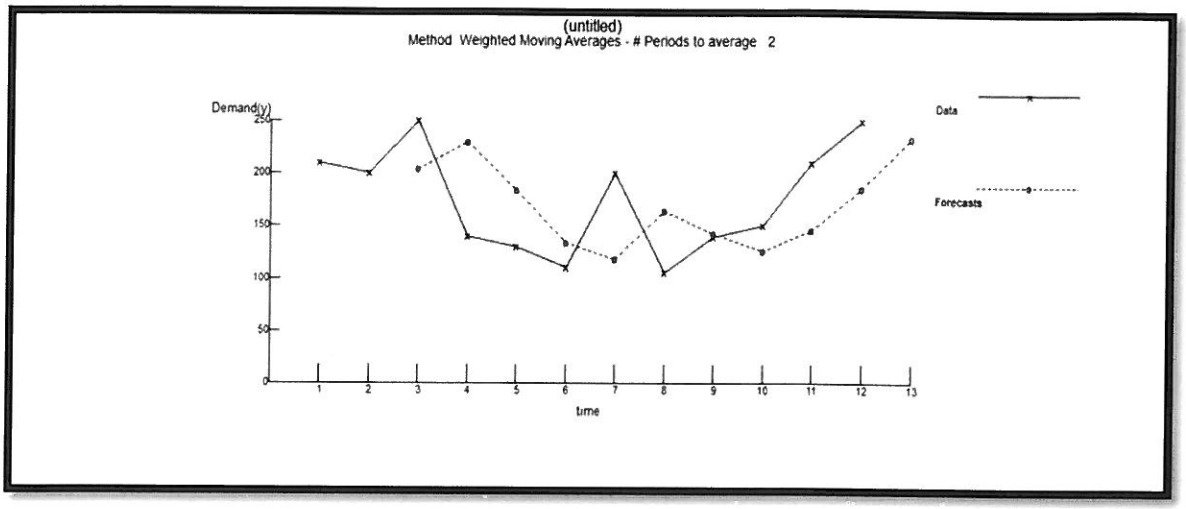

Figure 4.2: Comparison Actual and Forecast demand (Model B)

4.3.3 Exponential Smoothing (Model C)

Exponential smoothing forecasting method is a sophisticated weight moving average forecasting method that is easy to understand. It is fairly easy to use and involves a little keeping record data. In order to get most accurate forecast, smoothing constant α used in this study is 0.8

Table 4.5: Exponential smoothing Forecasting model (Model C)

Months	Actual Demand (units)	Forecast Demand (units)
January	210	
February	200	210
March	250	202
April	140	240.4
May	130	160.08
June	110	136.02
July	200	115.2
August	105	183.04
September	140	120.61
October	150	136.12
November	210	147.22
December	250	197.44

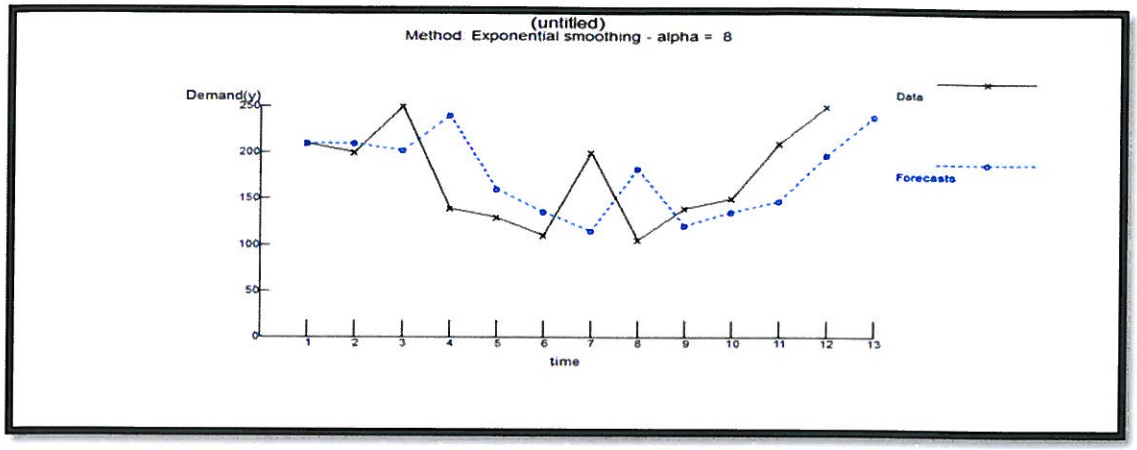

Figure 4.3: Comparison between actual and forecast demand (Model C)

4.3.4 Trend Adjusted Exponential Smoothing (Model D)

The trend adjusted exponential smoothing not similar to exponential smoothing technique because it can deal with trends. The addition of trend adjustment factor make it possible for the forecast more quickly approach the actual value. The value of constant $\beta = 0.2$higher than $\alpha = 0.8$

Table 4.6: Trend Adjusted Exponential Smoothing Forecasting Method (Model D)

Months	Actual Demand (units)	Forecast Demand (units)
January	210	
February	200	210
March	250	200.4
April	140	246.42
May	130	150.59
June	110	120.13
July	200	96.42
August	105	180.25
September	140	108.98
October	150	127.69
November	210	143
December	250	204.78

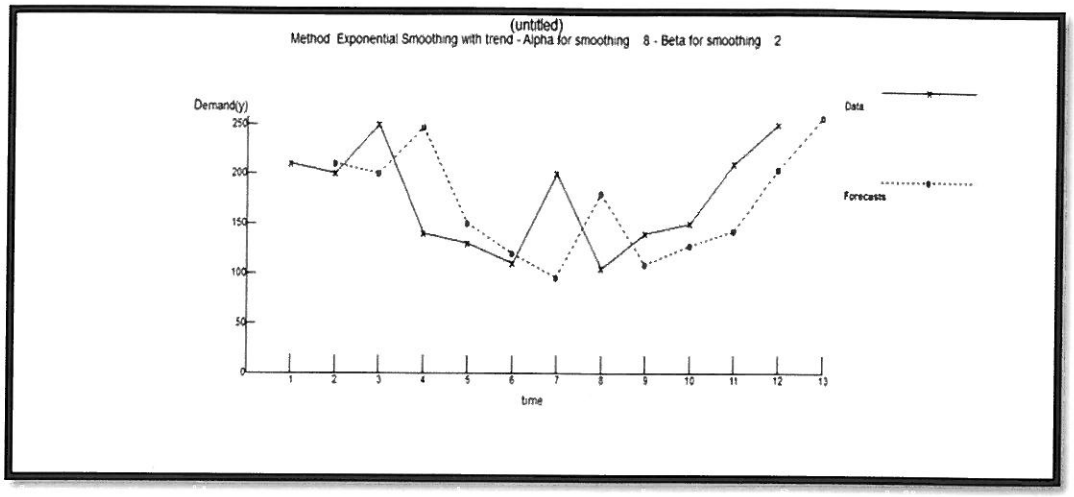

Figure 4.4: Comparison between Actual and forecast demand (Model D)

4.3.5 Trend Projection (Model E)

Trend projection technique one of time series forecasting method that fits a trend line to a series of historical data points and then project the line into future for forecast

Table 4.7: Trend Projection Forecasting Method (Model E)

Months	Actual Demand (units)	Forecast Demand (units)
January	210	177.56
February	200	177.02
March	250	176.48
April	140	175.94
May	130	175.4
June	110	174.85
July	200	174.31
August	105	173.77
September	140	173.23
October	150	172.69
November	210	172.14
December	250	171.6

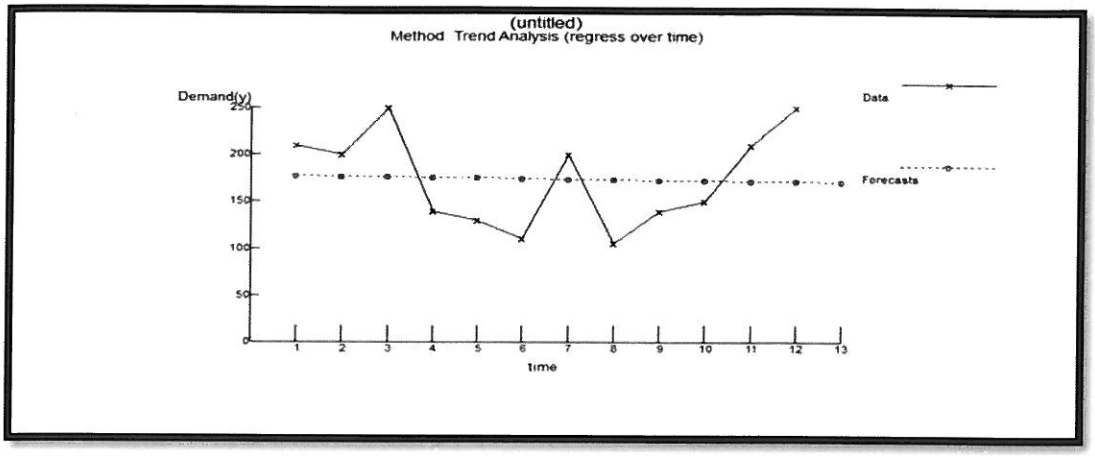

Figure 4.5: Comparison between actual and forecast demand (Model E)

4.3.6 Additive Decomposition Seasonal (Model F)

In the additive model, an original time series is expressed as a sum of components which are the trend cycle components, the seasonal effect and the irregular fluctuation.

Table 4.8: Additive decomposition (seasonal) Forecasting Method (Model F)

Months	Actual Demand (units)	Forecast Demand (units)
January	210	179.07
February	200	218.63
March	250	179.03
April	140	141.09
May	130	140.66
June	110	176.89
July	200	216.45
August	105	176.84
September	140	138.91
October	150	138.47
November	210	174.7
December	250	214.26

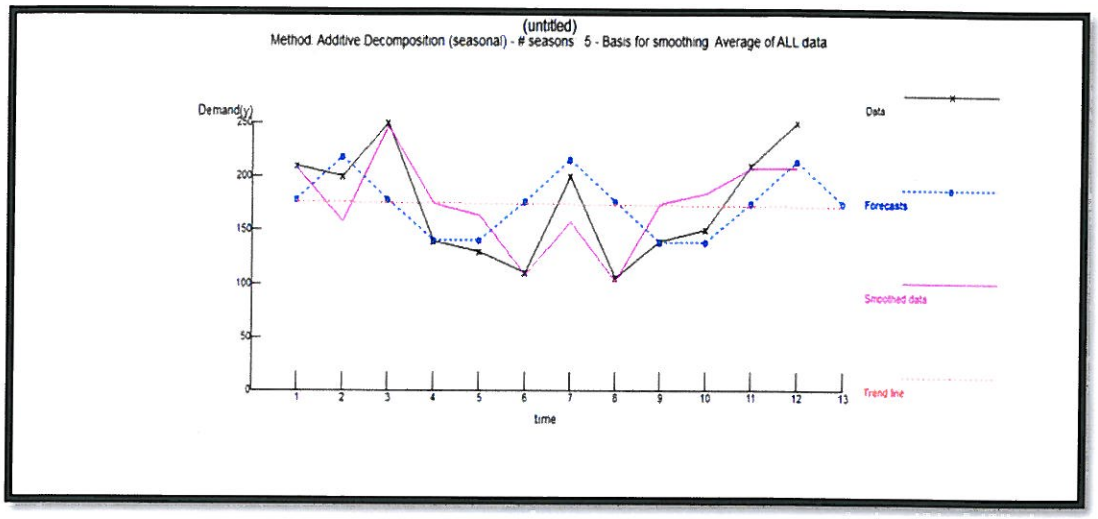

Figure 4.6: Comparison between actual and forecast (Model F)

4.4 Evaluation of Forecasting Method

In order to evaluate or measure the forecasting accuracy, there are four types forecasting error measurement including mean absolute deviation (MAD), mean square error (MSE), mean absolute percentage error (MAPE) and tracking signal. The forecasting error shows how the performance of the time series models using historical data. In this study, the method that comes with smallest forecast error is the most suitable method that will be choose.

4.4.1 Tracking Signal

Tracking signal is computed to determine the larger deviation whether in plus or minus of forecast error in various model. Tracking signal is mathematically defined as the sum of forecast error divide by the mean absolute deviation. When the tracking signal exceed an upper and lower limit, there is a problem with the method. In this study, the limit were acceptable are ± 4. Whenever the movement of tracking signal between the +4 and -4, the forecast result in control and the model working correctly.

4.4.1.1 Forecast Error Measurement for Simple Moving Average (Model A)

Model A Solution						
	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
January	210					
February	200					
March	250	205	45	45	2025	.18
April	140	225	-85	85	7225	.61
May	130	195	-65	65	4225	.5
June	110	135	-25	25	625	.23
July	200	120	80	80	6400	.4
August	105	155	-50	50	2500	.48
September	140	152.5	-12.5	12.5	156.25	.09
October	150	122.5	27.5	27.5	756.25	.18
November	210	145	65	65	4225	.31
December	250	180	70	70	4900	.28
TOTALS	2095		50	525	33037.5	3.25
AVERAGE	174.58		5	52.5	3303.75	.33
Next period forecast		230	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	64.26	

Model A Solution								
	Demand(y)	Forecast	Error	RSFE	|RSFE|	Cum Abs	Cum MAD	Track Signal
January	210							
February	200							
March	250	205	45	45	45	45	45	1
April	140	225	-85	-40	85	130	65	-.62
May	130	195	-65	-105	65	195	65	-1.62
June	110	135	-25	-130	25	220	55	-2.36
July	200	120	80	-50	80	300	60	-.83
August	105	155	-50	-100	50	350	58.33	-1.71
September	140	152.5	-12.5	-112.5	12.5	362.5	51.79	-2.17
October	150	122.5	27.5	-85	27.5	390	48.75	-1.74
November	210	145	65	-20	65	455	50.56	-.4
December	250	180	70	50	70	525	52.5	.95

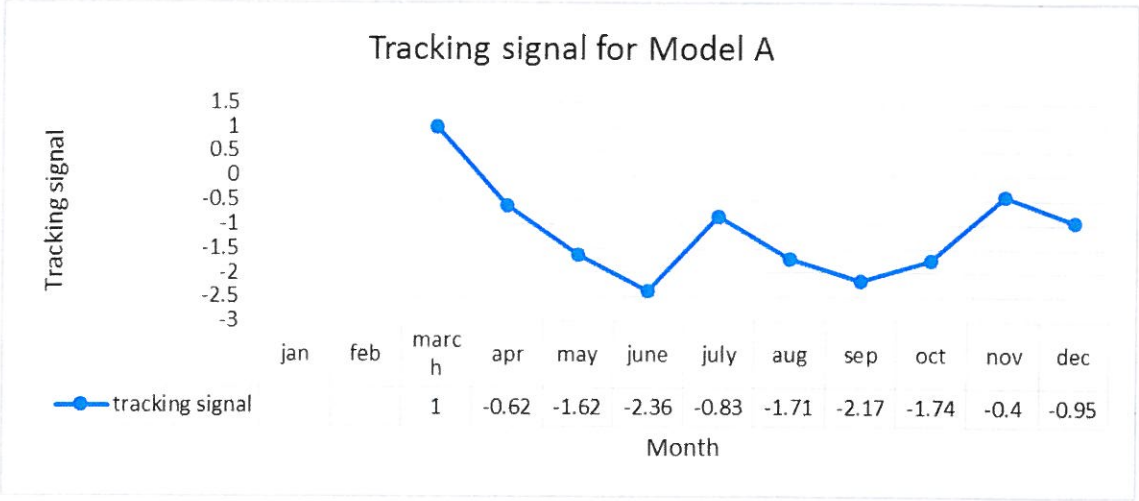

Figure 4.7: Tracking Signal for Model A

4.4.1.2 Forecast Error Measurement for Weighted Moving Average (Model B)

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
January	210					
February	200					
March	250	204	46	46	2116	.18
April	140	230	-90	90	8100	.64
May	130	184	-54	54	2916	.42
June	110	134	-24	24	576	.22
July	200	118	82	82	6724	.41
August	105	164	-59	59	3481.0	.56
September	140	143	-3	3	9	.02
October	150	126	24	24	576	.16
November	210	146	64	64	4096	.3
December	250	186	64	64	4096	.26
TOTALS	2095		50	510	32690	3.17
AVERAGE	174.58		5	51	3269	.32
Next period forecast		234	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	63.92	

Model B Solution								
	Demand(y)	Forecast	Error	RSFE	|RSFE|	Cum Abs	Cum MAD	Track Signal
January	210							
February	200							
March	250	204	46	46	46	46	46	1
April	140	230	-90	-44	90	136	68	-.65
May	130	184	-54	-98	54	190	63.33	-1.55
June	110	134	-24	-122	24	214	53.5	-2.28
July	200	118	82	-40	82	296	59.2	-.68
August	105	164	-59	-99	59	355	59.17	-1.67
September	140	143	-3	-102	3	358	51.14	-2
October	150	126	24	-78	24	382	47.75	-1.63
November	210	146	64	-14	64	446	49.56	-.28
December	250	186	64	50	64	510	51	.98

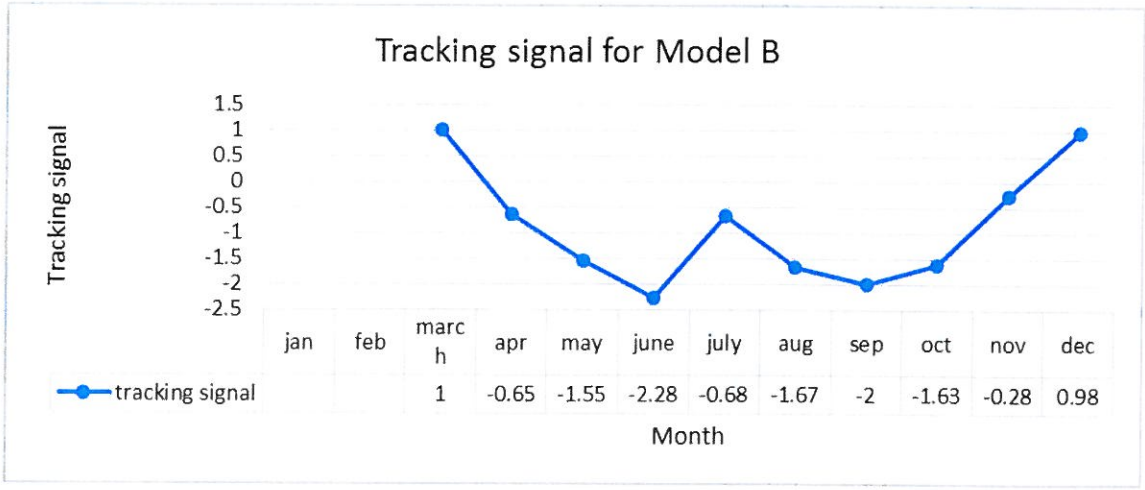

Figure 4.8: Tracking Signal for Model B

4.4.1.3 Forecast Error Measurement for Exponential Smoothing (Model C)

Model C solution						
	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
January	210					
February	200	210	-10	10	100	.05
March	250	202	48	48	2304	.19
April	140	240.4	-100.4	100.4	10080.16	.72
May	130	160.08	-30.08	30.08	904.81	.23
June	110	136.02	-26.02	26.02	676.83	.24
July	200	115.2	84.8	84.8	7190.5	.42
August	105	183.04	-78.04	78.04	6090.34	.74
September	140	120.61	19.39	19.39	*376.04*	*.14*
October	150	136.12	13.88	13.88	*192.61*	*.09*
November	210	147.22	62.78	62.78	*3940.79*	*.3*
December	250	197.44	52.56	52.56	*2762.04*	*.21*
TOTALS	2095		36.86	525.93	*34618.12*	*3.33*
AVERAGE	174.58		3.35	47.81	*3147.1*	*.3*
Next period forecast		239.49	(Bias)	(MAD)	*(MSE)*	*(MAPE)*
				Std err	*62.02*	

Model C Solution								
	Demand(y)	Forecast	Error	RSFE	|RSFE|	Cum Abs	Cum MAD	Track Signal
January	210			.				
February	200	210	-10	-10	10	10	10	-1
March	250	202	48	38	48	58	29	1.31
April	140	240.4	-100.4	-62.4	100.4	158.4	52.8	-1.18
May	130	160.08	-30.08	-92.48	30.08	188.48	47.12	-1.96
June	110	136.02	-26.02	-118.5	26.02	214.5	42.9	-2.76
July	200	115.2	84.8	-33.7	84.8	299.29	49.88	-.68
August	105	183.04	-78.04	-111.74	78.04	377.33	53.9	-2.07
September	140	120.61	19.39	-92.35	19.39	396.73	49.59	-1.86
October	150	136.12	13.88	-78.47	13.88	410.6	45.62	-1.72
November	210	147.22	62.78	-15.69	62.78	473.38	47.34	-.33
December	250	197.44	52.56	36.86	52.56	525.93	47.81	.77

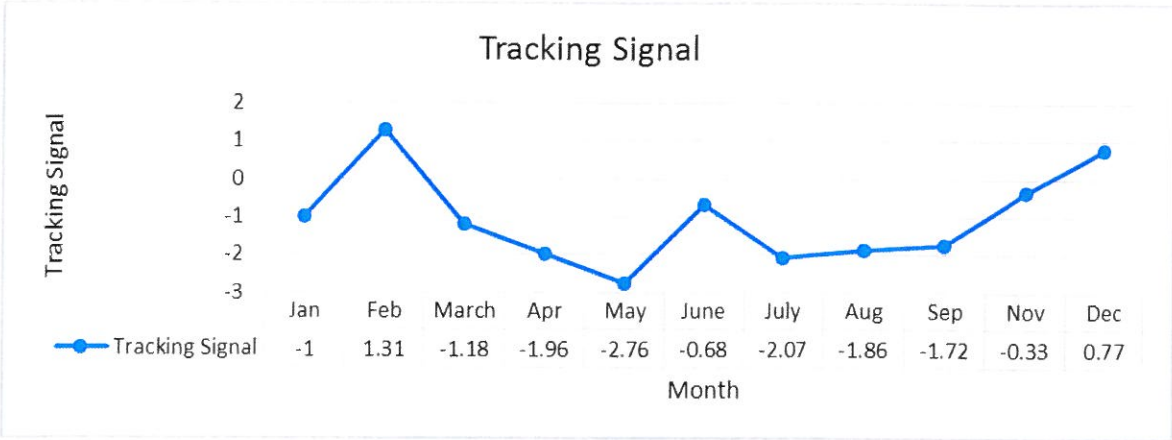

Figure 4.9: Tracking Signal for Model C

4.4.1.4 Forecast Error Measurement for Trend Adjusted Exponential Smoothing (Model D)

Model D solution								
	Demand(y)	Smoothed Frcst, Ft	Smoothed Trend, Tt	Frcst Inc Trend,FITt	Error	|Error|	Error^2	|Pct Error|
January	210							
February	200	210	0	210	-10	10	100	.05
March	250	202	-1.6	200.4	49.6	49.6	2460.16	.2
April	140	240.08	6.34	246.42	-106.42	106.42	11324.37	.76
May	130	161.28	-10.69	150.59	-20.59	20.59	424.06	.16
June	110	134.12	-13.99	120.13	-10.13	10.13	102.68	.09
July	200	112.03	-15.61	96.42	103.58	103.58	10728.83	.52
August	105	179.28	.97	180.25	-75.25	75.25	5662.58	.72
September	140	120.05	-11.07	108.98	31.02	31.02	962.48	.22
October	150	133.8	-6.11	127.69	22.31	22.31	497.95	.15
November	210	145.54	-2.54	143	67.0	67.0	4489.36	.32
December	250	196.6	8.18	204.78	45.22	45.22	2044.83	.18
TOTALS	2095				96.35	541.13	38797.3	3.36
AVERAGE	174.58				8.76	49.19	3527.03	.31
Next period forecast		240.96	15.42	256.37	(Bias)	(MAD)	(MSE)	(MAPE)
						Std err	65.66	

Model D Solution								
	Demand(y)	Forecast	Error	RSFE	|RSFE|	Cum Abs	Cum MAD	Track Signal

January	210							
February	200	210	-10	-10	10	10	10	-1
March	250	200.4	49.6	39.6	49.6	59.6	29.8	1.33
April	140	246.42	-106.42	-66.82	106.42	166.02	55.34	-1.21
May	130	150.59	-20.59	-87.41	20.59	186.61	46.65	-1.87
June	110	120.13	-10.13	-97.54	10.13	196.74	39.35	-2.48
July	200	96.42	103.58	6.04	103.58	300.32	50.05	.12
August	105	180.25	-75.25	-69.21	75.25	375.57	53.65	-1.29
September	140	108.98	31.02	-38.19	31.02	406.6	50.82	-.75
October	150	127.69	22.31	-15.87	22.31	428.91	47.66	-.33
November	210	143	67.0	51.13	67.0	495.91	49.59	1.03
December	250	204.78	45.22	96.35	45.22	541.13	49.19	1.96

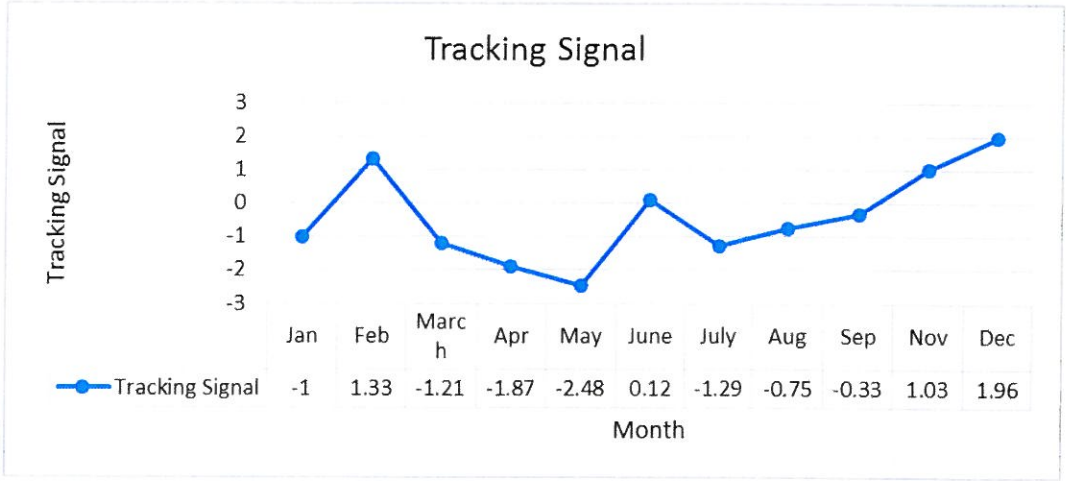

Figure 4.10: Tracking Signal for Model D

4.4.1.5 Forecast Error Measurement for Trend Projection (Model E)

Model A Solution									
	Demand(y)	Time	x^2	x * y	Forecast	Error	|Error|	Error^2	|Pct Error|
January	210	1	1	210	177.56	32.44	32.44	1052.09	.15
February	200	2	4	400	177.02	22.98	22.98	527.98	.11
March	250	3	9	750	176.48	73.52	73.52	5405.17	.29
April	140	4	16	560	175.94	-35.94	35.94	1291.56	.26
May	130	5	25	650	175.4	-45.4	45.4	2060.82	.35
June	110	6	36	660	174.85	-64.85	64.85	4206.08	.59
July	200	7	49	1400	174.31	25.69	25.69	659.86	.13
August	105	8	64	840	173.77	-68.77	68.77	4729.37	.65
September	140	9	81	1260	173.23	-33.23	33.23	1104.13	.24
October	150	10	100	1500	172.69	-22.69	22.69	514.68	.15
November	210	11	121	2310	172.14	37.86	37.86	1433.04	.18
December	250	12	144	3000	171.6	78.4	78.4	6146.16	.31
TOTALS	2095	78	650	13540		0	541.75	29130.91	3.42
AVERAGE	174.58	6.5				0	45.15	2427.58	.29
Next period forecast					171.06	(Bias)	(MAD)	(MSE)	(MAPE)
Intercept	178.11						Std err	53.97	

Model E Solution								
	Demand(y)	Forecast	Error	RSFE	|RSFE|	Cum Abs	Cum MAD	Track Signal
January	210	177.56	32.44	32.44	32.44	32.44	32.44	1
February	200	177.02	22.98	55.41	22.98	55.41	27.71	2
March	250	176.48	73.52	128.93	73.52	128.93	42.98	3
April	140	175.94	-35.94	93	35.94	164.87	41.22	2.26
May	130	175.4	-45.4	47.6	45.4	210.27	42.05	1.13
June	110	174.85	-64.85	-17.26	64.85	275.12	45.85	-.38
July	200	174.31	25.69	8.43	25.69	300.81	42.97	.2
August	105	173.77	-68.77	-60.34	68.77	369.58	46.2	-1.31
September	140	173.23	-33.23	-93.57	33.23	402.81	44.76	-2.09
October	150	172.69	-22.69	-116.25	22.69	425.5	42.55	-2.73
November	210	172.14	37.86	-78.4	37.86	463.35	42.12	-1.86
December	250	171.6	78.4	0	78.4	541.75	45.15	0

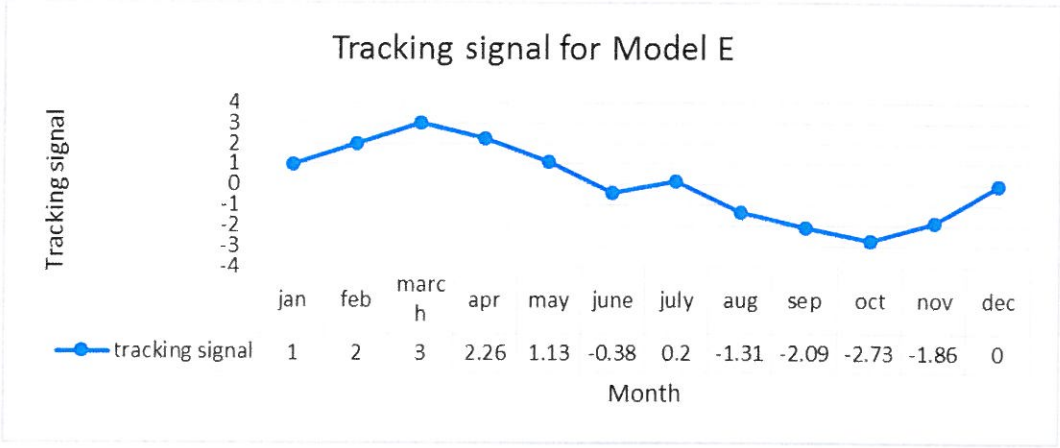

Figure 4.11: Tracking Signal for Model E

4.4.1.6 Additive Decomposition Seasonal

Model F solution												
	Demand (y)	time	Overall average	DIFFERENCE	SEASONAL	SMOOTHED	Unadjusted forecast	Adjusted forecast	Error	|Error|	Error^2	|Pct Error|
January	210	1	174.58	35.42	2.08	207.92	176.99	179.07	30.93	30.93	956.63	.15
February	200	2	174.58	25.42	42.08	157.92	176.55	218.63	-18.63	18.63	347.21	.09
March	250	3	174.58	75.42	2.92	247.08	176.11	179.03	70.97	70.97	5036.78	.28
April	140	4	174.58	-34.58	-34.58	174.58	175.68	141.09	-1.09	1.09	1.19	.01
May	130	5	174.58	-44.58	-34.58	164.58	175.24	140.66	-10.66	10.66	113.54	.08
June	110	6	174.58	-64.58	2.08	107.92	174.8	176.89	-66.89	66.89	4473.63	.61
July	200	7	174.58	25.42	42.08	157.92	174.36	216.45	-16.45	16.45	270.54	.08
August	105	8	174.58	-69.58	2.92	102.08	173.93	176.84	-71.84	71.84	5161.62	.68
September	140	9	174.58	-34.58	-34.58	174.58	173.49	138.91	1.09	1.09	1.19	.01
October	150	10	174.58	-24.58	-34.58	184.58	173.05	138.47	11.53	11.53	132.93	.08
November	210	11	174.58	35.42	2.08	207.92	172.62	174.7	35.3	35.3	1246.1	.17
December	250	12	174.58	75.42	42.08	207.92	172.18	214.26	35.74	35.74	1277.15	.14
TOTALS	2095								0	371.12	19018.52	2.38
AVERAGE	174.58								0	30.93	1584.88	.2
Next period forecast								174.66	(Bias)	(MAD)	(MSE)	(MAPE)
										Std err	61.67	

Model F Solution								
	Demand(y)	Forecast	Error	RSFE	|RSFE|	Cum Abs	Cum MAD	Track Signal
January	210	179.07	30.93	30.93	30.93	30.93	30.93	1
February	200	218.63	-18.63	12.3	18.63	49.56	24.78	.5
March	250	179.03	70.97	83.27	70.97	120.53	40.18	2.07
April	140	141.09	-1.09	82.17	1.09	121.63	30.41	2.7
May	130	140.66	-10.66	71.52	10.66	132.28	26.46	2.7
June	110	176.89	-66.89	4.63	66.89	199.17	33.19	.14
July	200	216.45	-16.45	-11.82	16.45	215.61	30.8	-.38
August	105	176.84	-71.84	-83.66	71.84	287.46	35.93	-2.33
September	140	138.91	1.09	-82.57	1.09	288.55	32.06	-2.58
October	150	138.47	11.53	-71.04	11.53	300.08	30.01	-2.37
November	210	174.7	35.3	-35.74	35.3	335.38	30.49	-1.17
December	250	214.26	35.74	0	35.74	371.12	30.93	0

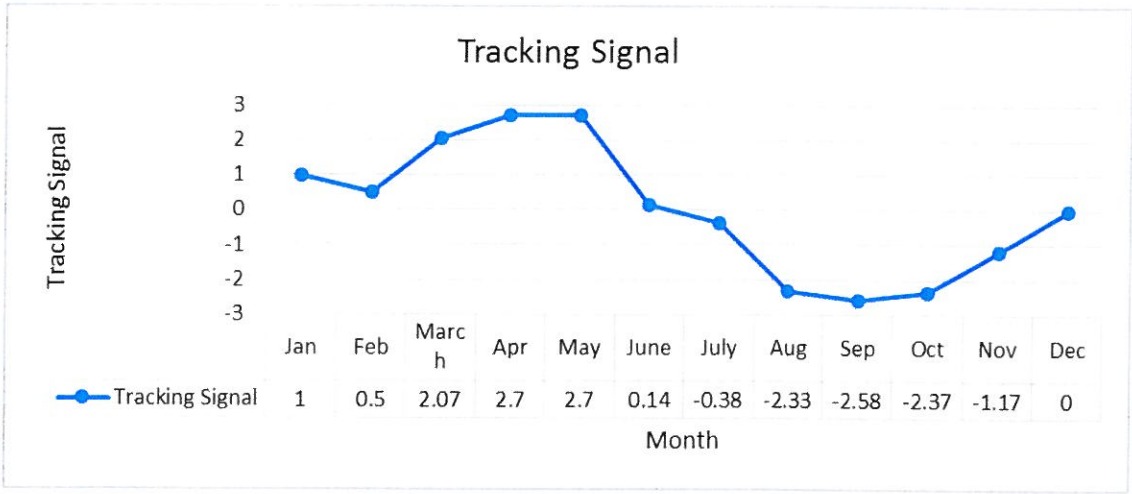

Figure 4.12: Tracking Signal for Model F

4.4.2 Comparison of Forecast Error among Forecasting Method

Table below shows the comparison forecasting error by the forecast measurement among the forecasting technique of time series. By comparing the accuracy of the method, the method that have least in error will be selected and proposed to the Company A.

Table 4.9: Comparison forecast error among forecasting methods

Forecast Error / Forecasting Model	Mean Absolute Deviation (MAD)	Mean Squared Error (MSE)	Mean Absolute Percentage Error (MAPE)	Tracking Signal
Simple Moving Average (Model A)	52.5	3307.75	0.33	±3
Weighted Moving Average (Model B)	51	3269	0.32	±3
Exponential Smoothing (Model C)	47.81	3147.1	0.30	±3
Trend Adjusted Exponential Smoothing (Model D)	49.19	3527.03	0.31	±3
Trend Projection (Model E)	45.15	2427.58	0.29	±3
Additive Decomposition (Seasonal) (Model F)	30.93	1584.88	0.20	±3

Based on the table above, Simple Moving Average (Model A) and Weighted Moving Average (Model B) has higher value in term of MAD, MSE and MAPE compared to the other models. These two methods produce large forecast error and not suitable to select and implement in the Company A. Simple Moving Average cannot predict the future demand very well as unable to produce accurate forecast if the data has cycle or seasonal variation. Like simple Moving Average, Weighted Moving Average have to be multiple by some weight and it causes the calculation more difficult.

Trend Adjusted Exponential Smoothing method (Model D) is sensitive to specification of the smoothing constant. This method cannot make an accurate forecast if the past data has cyclical or seasonal variation and it also failed to handle the trend.

Exponential Smoothing (Model C) has lower value in MAD, MSE and MAPE compared to the model A, B and D. Tracking signal of Model C shows the control limit is ± 3 standard deviation which mean that is in control forecast within acceptable limit. But then, this model has high bias in the forecasting method which is high in cumulative error. If the forecast consistently higher and lower than the actual demand value, then there implies a bias as not a good tracking signal.

As shown in the Table 4.9 above, Trend Projection (Model E) has lower error in term of MAD, MSE and MAPE compare to the model A, B, C, and D. But the historical data in this study shown the seasonal variation which are regular up and down movement, so Model E is not suitable to be applied by the Company A. Besides that, when sudden fluctuation in data arise, Model E will not appropriate. Additive Decomposition Seasonal (Model F) has lower measuring forecast error in term of MAD, MSE and MAPE compared to the other models. From the previous research there stated that, many company focus on the MAPE to monitor the forecast accuracy. The result shows the MAPE of Model F has the lowest value compared to the other model. So this model is the most accurate. Besides that, tracking signal also shows this model is in control of forecasting.

Additive Decomposition Seasonal (Model F) is suitable compared to the other model because the graph analysis shows the seasonal. Seasonal variation occur when regular up and down movement in the data series. Since Company A is a textile company, there have seasonality of demand in their business.

In conclusion, Additive Decomposition Seasonal (Method F was suggested as the most suitable forecasting method to be adopted or applied by the Company F)

CHAPTER 5

CONCLUSION AND ROCOMMENDATION

5.1 INTRODUCTION

This chapter will summarize about all the findings on the data analysis in various types of forecasting method to determine the most suitable forecasting method that will be selected and propose to the company. Besides that, there are some recommendation and suggestion provided in this chapter as well as to improve the performance of the forecasting technique.

5.2 CONCLUSION

Forecasting is very important in every business especially in textile industry. It plays a critical role in running a business. Most of the operation in textile industry are based on the some kind of forecast method for future demand. In this study has discussed the method and process of forecasting that suitable to use in the selected company.

In the business, every planner of the company must understand about the forecasting in order to meet the customer demand. In this study, forecasting will predict the correct amount of inventory to supplies to the customer based on the previous sales. Besides that, forecasting also can reduce an inventory problem in the selected company.

This research involve three objectives. First is to identify demand forecasting method applied by the company. Second is to analyses the sale data of the company using several forecasting method. Third is to propose the most suitable forecasting method to the company. This research were conducted by having face to face interview with the owner of the Company A. The data were collected which is the previous sale

data of product M for twelve consecutive month were analysis in this study. The sale data collected was the previous sales in 2013. Company A just used assumption that demand for the next period is equal to the demand in the most recent period. That technique is called Naïve approaches which is the simplest way to forecast the demand.

In this research, time series analysis technique were used and applied on the previous data for selecting the most suitable forecasting method that can be used and selected to forecast the future events in the business. Time series forecasting method involves in this research are simple moving average, weight moving average, exponential smoothing, trend adjusted exponential smoothing and trend projection. This forecasting method were applied to generate the forecast for Product M. Then, forecast error were used to analyze the performance of the forecasting method for select the most suitable method to be applied in the future planning. POM software were used in this research to run the previous sale data.

In order to measure the performance and accuracy of forecasting method, forecast error which are mean absolute deviation (MAD), mean absolute percent error (MAPE), mean squared error (MSE) and tracking signal were used in this research. These measures were used to compare different forecasting model as well as to ensure they are performing well. In this study, measuring forecast error improved forecast accuracy and the model that have smallest forecast error is the most suitable forecasting model that were selected.

The most suitable forecasting method for the demand forecasting in Company A is Additive Decomposition Seasonal model. The forecast error in this method comes with the lowest compared to the other models in term of MAD, MAPE and MSE. Since Company A is a textile company, there have seasonality of demand in their business. Besides that, tracking signal is a measurement of how well a forecast is predicting actual value. Tracking signal monitor whether forecast error exceed the control limit which is upper and lower limit. In this study, the tracking signal of Additive Decomposition Seasonal is within the acceptable limit which is ± 4. As long as this model within the acceptable limit, the forecast result in control and working correctly.

This model is suitable to propose to the Company A because the time series decomposition model do not involve a lot of mathematic or statistic, they are relatively

to explain to the user. This method can be applied when the pattern of seasonal variation is roughly stable over the year. For example when the seasonal movement are same from year to year.

5.3 RECCOMENDATION

Forecasting can be generally considered as a method or a technique for estimating many future aspects of a business or other operation. No forecasting method is perfect under all situation. Even management have found satisfactory approach, it must still monitor and control forecast to make sure error do not get out of limit.

In this research, POM software were used to carry out the calculation job. But then, there are software that can be apply for forecasting. For example of the forecast software includes Forecast PRO, SPSS, Excel, Sage 50 forecasting and Forecast X Wizard. Forecast software are provide a basic foundation for organization's planning by offer the number of capabilities that enable users to quickly develop reliable forecast using time series data. Forecast software is very convenient tool for the forecaster to obtain the information need at the quickly time as the software give an instruction on every step.

Other than that, planner can applied other forecasting method that can give more advance in the forecasting. For example of the other time series model is ARIMA. ARIMA model is generalization of ARMA model. These models are fitted to time series data either to better understand the data or to predict future points in the series. Most of the studies have found that particularly for short-term forecasts ARIMA models do provide good forecasting ability.

Besides that, in order to enhance the forecast accuracy, forecast combination known as ensemble forecasting that has been proposed by the researcher. Forecast combinations have frequently been found in empirical studies to produce better forecasts. Researcher has been suggested that forecast accuracy can be improved by integrating multiple forecast technique and reduce the variability of the combined forecast. Forecast combination can be helpful when forecaster are uncertain about the situation, confuse about the best method and when they want to avoid large error.

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APPENDIX

Interview Questions

1. What is current forecasting technique adopted by company?
2. How accurate the forecasting tools?
3. How effective the forecasting technique adopted by company?
4. What data will be considered in selecting the forecast method?
5. What step have been used in forecast for product M?
6. What difficulty will be faced when forecast the demand of product M?
7. Is the demand forecast result accurate compared to the actual demand for the product M using current forecasting technique?