INVENTORY IMPROVEMENT BY APPLYING TIME SERIES FORECASTING: A CASE STUDY OF THAI TRADING COMPANY

By

SURAJES KHAMSAWAD

A Final Report of the Six-Credit Course
SCM 2202 Graduate Project

Submitted in Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE IN SUPPLY CHAIN MANAGEMENT

Martin de Tours School of Management
Assumption University
Bangkok, Thailand

November 2012

INVENTORY IMPROVEMENT BY APPLYING TIME SERIES FORECASTING: A CASE STUDY OF THAI TRADING COMPANY

By

SURAJES KHAMSAWAD

A Final Report of the Six-Credit Course
SCM 2202 Graduate Project

Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE IN SUPPLY CHAIN MANAGEMENT

Martin de Tours School of Management
Assumption University
Bangkok, Thailand

November 16, 2012

THE TIME SERIESS FORCASTING TO AVOID INVENTORIES SURPLUS: A CASE STUDY OF A TRADING COMPANY

By

SURAJES KHAMSAWAD

Submitted in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Supply Chain Management
Assumption University

Examination Committee:

1. Dr. Ismail Ali Siad (Chair) .....
2. Dr. Piyawan Puttibarncharoensri (Member) .....
3. Dr. Athisarn Wayuparb..... (Advisor) .....

Approved for Graduation on: November 16, 2012

Martin de Tours School of Management
Assumption University
Bangkok, Thailand

November 2012

Assumption University
Martin de Tours School of Management and Economics
Master of Science in Supply Chain Management

Declaration of Authorship Form

I, Surajes Khamsawad

declare that this thesis/project and the work presented in it are my own and has been generated by me as the result of my own original research.

Inventory Improvement by Applying Time Series Forecasting: A Case Study of Thai Trading Company

_____

_____

I confirm that:

1. This work was done wholly or mainly while in candidature for the M.Sc. degree at this University;

2. Where any part of this dissertation has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;

3. Where I have consulted the published work of others, this is always clearly attributed;

4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this dissertation is entirely my own work;

5. I have acknowledged all main sources of help;

6. Where the thesis/project is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;

7. Either none of this work has been published before submission, or parts of this work have been published as: [please list references in separate page]:

Signed _____

Date _____

Assumption University
Martin de Tours School of Management and Economics
Master of Science in Supply Chain Management

Student Name: ____ Mr. Surajes Khamsawad
ID: _____512-9373_____

ADVISOR'S STATEMENT

I confirm that this thesis/project has been carried out under my supervision and it represents the original work of the candidate.

Signed _____

(Dr. Athisarn Wayuparb)

Date _____November **16,** 2012_____

ACKNOWLEDGEMENTS

I have invested effort in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them.

I am highly indebted to the Managing Director Mr. Charoonpan Siriwetcahdaruk, and to the General Manager Ms. Anoma Kulthamrong for their guidance and constant supervision as well as for providing necessary information regarding the project and also for their support in completing the project.

I would like to express my gratitude towards my parents and member of BPS UNITED CO., LTD for their kind co-operation and encouragement helped me to complete this project.

I would like to express my special gratitude and thanks to my advisor, Dr. Athisarn Wayuparb for giving me attention and time. I also would like to express gratitude to the other committees, Dr. Ismail Ali Siad, and Dr. Piyawan Puttibarncharoensri for all the commentaries who provides feedback.

At last but not least, my thanks and appreciations also go to my Family for their love and support and their encouragement for the completion of this mission.

Surajes Khamsawad
Assumption University
November 16, 2012

ABSTRACT

The goal of every single business is to keep customer satisfaction at the high level and have the least expenses simultaneously. Another thing, that should not be looked over is the accessibility of products, which is particularly essential as well. Parenthetically, to do thus, it is not an effortless action. Of course, to keep the customer satisfaction at the maximum level, the company has to make the products availability to be ready at all times, which means the company has to pile up the inventories to serve those customers when their demand approaches. This is somewhat in contrast to another principle that the company has to keep its expenditure at the lowest, because to pile up the inventories the company has to invest a lot of effort and money. To solve such a problem, procurement improving plays an important role, which means the company has to have the capability to predict what is going to happen in the near future by forecasting the demand.

Since, all of the procurement managers know that forecasting demand is one of the milestones in the supply chain management. This paper will investigate the methodical thinking to solve the company's inventories surplus problem and develop the forecasting methods for future use. The mission started with collecting data, studying the pattern, and forecasting the monthly demand. The project selected four time series forecasting techniques; Simple Moving Average, Weighted Moving Average, Exponential Smoothing, and Trend Adjust Exponential Smoothing. The accurateness of forecasting by comparing it with the current result of the company is then determined.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Assumption University

Martin de Tours School of Management

Master of Science in Supply Chain Management

Form signed by Proofreader of the Graduate Project

I Asst Prof. Dr. June Bernadette D'Souza, has proofread this Graduate Project entitled The Time Series forecasting to Avoid Inventory Surplus: A Case Study of a Trading Company

Mr. Surajes Khamsawad

and she hereby certifies that the verbiage, spelling and format is commensurate with the quality of internationally acceptable writing standards for a Master Degree in Supply Chain Management.

Sign

Asst Prof Dr. June Bernadette D'Souza

Contact Number / Email address dbjune2006@yahoo.com

Date: 20th December 2011

CHAPTER I

GENERALITIES OF THE STUDY

In numerous supply chains and businesses, one of the prevailing costs is the inventory. To make more effective supply chain management more effective a lot of managers realize that the inventory levels and its costs must be reduced. In the matter of fact, the actual objective of effective inventory management in the supply chain is to have the accurate stock at the precise time and place to decrease the cost while customer satisfaction is yet required (Simchi-Levi, Kaminski, and Semchi-Levi, 2008)

Simchi-Levi et al (2008) al also stated that to manage inventory is characteristically difficult, since inventory related resolutions can have a considerable crash on the customer service level and supply chain cost. A classic supply chain includes suppliers, and those makers, who alter raw materials in to completed products, and warehouses and distribution centers, from which finished goods are dispensed to clients. Thus inventory can materialize in many positions, and in more than a few types, such as; raw material inventory, Work-in-Process (WIP) inventory, and Finished manufactured goods inventory. Incidentally, those inventories do need its individual inventory manage systems or approaches. Regrettably, to conclude these mechanisms is easier said than done, since capable manufacturing, distribution, and inventory manage approaches that decrease costs and develop service levels must consider the relations of the various levels in the supply chain. Nonetheless, the advantage of shaping the inventories manage mechanism can become massive. Then Nakano (2008) stated that to accomplish soaring logistics and production performance, means superior customer service, minor manufacturing and logistics expenditures, and optimal inventory levels. So many organizations bring in supply chain management (SCM). To initiate the idea of SCM in practice, companies ought to integrate business procedures in the supply chain. Generally, there are quite a few types of sub-procedures in the supply chain process. For example, manufacturing flow management order fulfillment, and demand management. But no one can prove that

the incorporation of those sub-procedures can produce a significant effect on the supply chain.

This paper stresses on the forecasting procedure, which plays a significant part in managing SCM effectively. Also a main contribution of this paper is to increase a measure forecasting of BPS United Co., Ltd.

1.1 Background of the Company

BPS UNITED CO., LTD is a SME trader of all types of advertising tools. The company provides products and services to both local and overseas markets. Resulting from a broad category of the company's products, the company now holds more than 500 stocks keeping units (SKU) of vinyl products, Inkjets, Printers, Laser Cutters and Engravers, Laminators, and Ink.

BPS emphasizes on sourcing and developing of all types of vinyl products, inkjets, printers, laser cutters and engravers, laminators, and ink in order to continue to satisfy customers with standard modern machines and technology. Besides, the company also affiliates with worldwide quality certificated suppliers which build up more confident to customers such as: 3M, Hewlett Packard, ONYX and etc.

But the product that is widely used and the main cash cow product of the company is vinyl. A vinyl is generally used in the advertising business. With the growth of the business and the company, the company faced the inventory problem in the last recent years. The common inventory problem of the company is an inventory surplus. As mentioned earlier, by the continuous growth of the market and by the nature of the advertising increase which make more potential players to jump into the market to get some shares. Details shown in Figure 1.1 and Figure 1.2 are sales of vinyl product called SK-000-IJ0127 and the inventory of the SK-000-IJ-127 in December, 2012 respectively.

Figure 1.1 Sale of Product **SK-000-IJ127** Year 2008 – 2010

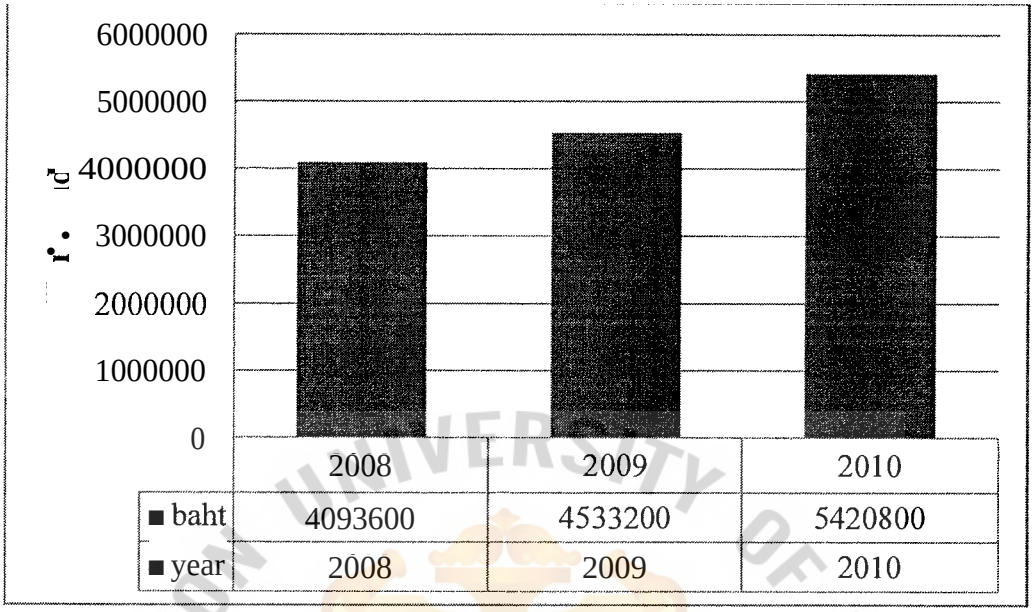
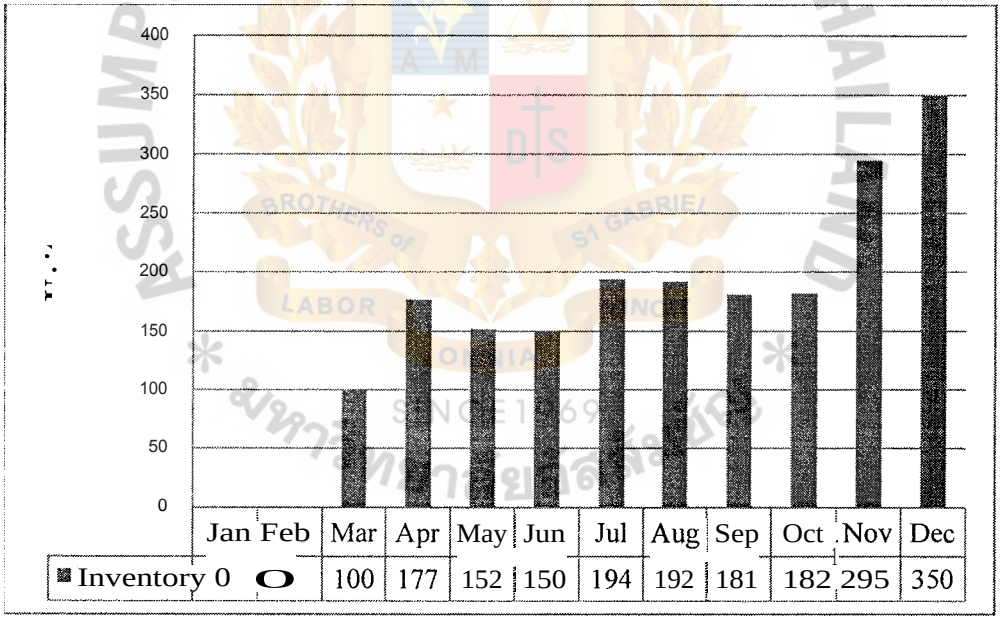


Figure 1.2 Inventory of **SK-000-IJ127** each month at the End of December, 2010



To decrease the inventory holding cost problem the company must be able to forecast customer real demand. Doing thus, the company will not only solve the current inventory surplus problem but the company also increasing its cash flow simultaneously.

1.2 Statement of the Problem

An increasing number of the players in the industry cope with the fierce competitive in the market. This entails the company stocking up inventory because the customers will turn to competitors when the company is not able to serve them. Moreover, the company lacks knowledge and the forecasting technique to aid the procurement department. So the company does not know how much or how often to purchase at a time. Generally, the company makes decision by the expertise and experiences of the authorized person who is in charge of the procurement department. To compose a proper purchasing order, the company must be able to understand and be aware of what customers really need. Also the company is expected to have a sufficient knowledge of demand forecasting. So the company can perform better to serve its customers from time to time.

1.3 Research Objectives

- To improve procurement planning
- To discover a suitable forecasting technique for the company
- To reduce the overstock problem of the company
- To use that suitable forecasting method to keep customers satisfaction in a high level

1.4 Scope of the Research

- This research is concentrated to study the presented forecast actions, and performance of the BPS United which have an effect on the level of the inventories of the company
- To study and observe the impact and potential of each forecasting method which will provide the best result for the company
- To propose a proper forecasting practice as a tool for BPS United for the forecasting

1.5 Significance of the Research

This project suggests the principles of how to plan to purchase products by applying the forecasting demand to avoid overstock circumstances. Besides, fierce competitive in the market, the company is required to discover techniques to eliminate the redundant overheads. Moreover, the Company should have the ability to sustain and develop the customers' satisfaction while keeping the inventory cost at the lowest.

1.6 Limitations of the Research

Even though, the paper has accomplished its plans, there were some inescapable limitations. First, the research relied on one company only. So, the result may not be implemented by other companies. Second, the study interviewed only key staff of the company only two departments were observed which were the purchasing department and the sales department. So it seems not to provide sufficient information for the more advance a demand forecasting methods.

1.7 Definition of Terms

Cash cow - a business or a product entity that produces extraordinarily high profit margin: so high that it is accountable for a great sum of a company's operating earnings.

Customer Demand - how much of something that customers desire. With the present, economic environment, consumers are being extra careful and choosy with their spending cash.

Demand Forecasting - the action which most companies used for foreseeing the upcoming demand. The data that can be used maybe varies between companies. Qualitative information and or quantitative information can be used as valuable data for the demand forecasting.

Inventory Cost - the cost of the keeping products which is being held by the company as an inventory.

Inventory Management - primarily about identifying the figure and percentage of stocked products. It is required at different places inside a facility or within many places of a supply system to head the standard and planned course of manufacturing and stock of resources.

Inventory Surplus - a company's inventory has an excess quantity of what is required, whether it is for product progress or an overload of products for the company's own set limit.

Small and Medium Enterprise (SME) - a small and medium size companies that have employees of not more than 200 people or a company that holding not more than 200 million baht of total assets.

Stock Keeping Units (SKU) - the smallest unit which is normally uses to count products.

Supply Chain Management (SCM) - the management of a system of interrelated businesses concerned with the provision of products and services required by the consumers in a supply chain.

Vinyl - Sheet vinyl is made of PVC, or polyvinyl chloride, coloring and resin. By combining it all together, raw materials are used as fillers. It comes in both a clear version and one that is made of different shapes that are heated together in various colors. A vinyl coating on the surface provides long lasting finish.

Work in process (WIP) - set of incomplete objects for goods in a manufacture progression. These objects are not yet finished but each only being fabricated or waiting in a queue for additional processing or in a buffer storage.

CHAPTER II

REVIEW OF RELATED LITERATURE

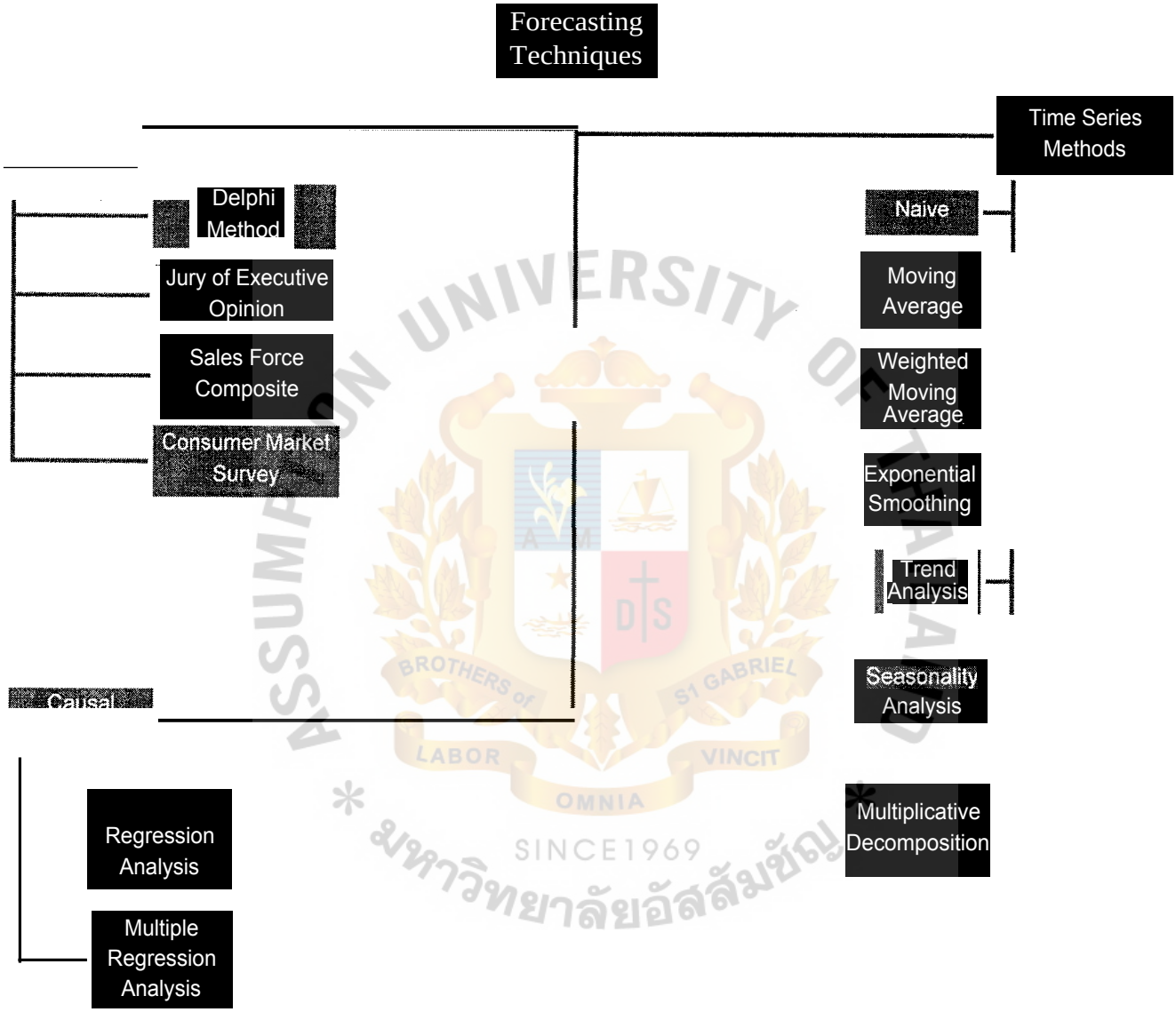
The purpose of this study is to produce an effective and efficient procurement model to facilitate purchasers in their procurement activities with the least amount of the inventory cost. This chapter consists of the definitions, advantages and disadvantages along with the details of several forecasting techniques.

2.1 Principle of Forecasting.

Forecasting is a significant component of demand management. Since all firms deal with a mysterious future, some error between forecast and actual demand is anticipated. Therefore, the objective of a good forecasting practice is to minimize the divergence between the actual demand and the forecasted (Wisner, Tan, Long, 2008). (Wisner et al 2008) also stated that in today's business competitive environment most of the organizations are moving in the direction of a more effective "demand driven" supply chain to allow them to take action promptly in reallocating customers requirements. This statement even entails that managing demand has become one of the important keys to success of numerous firms. According to Smith III, Herburg, Milewicz and, Golden (1996) in examination more than 92 percent of hundreds of companies respondents supported that forecasting is an essential tool for a company's accomplishment. Forecasting is a chief constituent of the business decision making practice. Moreover, forecasting also plays a significant part in every major functional area of business management. The estimates produced may be exploited in a variety of ways. Such as, setting advertising appropriations, productions planning, sales force planning, evaluating the need for modernization or diversification, estimating cash flows, and in considering the general position of the organization in the future (Hanke, Reitsch, and Arthur, and Wichen, 2001)

2.2 Forecasting Techniques

Figure 2.1 Forecasting Techniques



Knowing that a forecast is very often inaccurate does not mean that nothing can be done to improve the forecast. Seeking inputs from the trading partners could be a way to improve the qualitative and the quantitative forecasts. Qualitative forecasting methods are based on opinions and intuition is used in qualitative forecasting, whereas to generate forecasts in the quantitative method, mathematical models and

relevant historical data are exploited instead. According to Krajewski, Ritzman and Malhotra (2007), qualitative forecasting methods do not require data in the same manner as quantitative forecasting methods. The inputs required depend on a specific method and are mainly the product of judgment and accumulated knowledge.
On the other hand quantitative forecasting can be applied when three conditions exist:

1. Information about the past available.
2. This information can be quantified in the form of numerical data.
3. It can be assumed that some aspects of the past pattern will continue into the future.

2.2.1 Qualitative Forecasting Methods

Qualitative Forecasting Methods are approaches to forecasting based on institution or judgmental development and are normally used when data are restricted, unavailable, or not currently appropriate. Although, this approach can be very economical, the helpfulness depends to a great amount on the ability and know-how of the forecasters and the quantity of time and relevant information available. There are four common qualitative forecasting methods which are as follows (Hanke and Wichern, 2009):

1. **Jury of Executive Opinion Forecast** is a group of senior management executives who are well-informed about the market, competitors, and the business environment collectively develop the forecast. The Jury of Executive opinion forecast is appropriate for a long-range preparation and new products overtures.

2. **Delphi Method Forecast** is a group of internal and external professionals who are examined during several rounds in terms of prospect actions and long-term forecasts of demand. Group members do not actually meet and therefore circumvent the situation where one or few experts could direct an argument. The iterative procedure goes until an agreement is achieved. The course of action can be both time consuming and very costly. This approach is appropriate for high-risk technology forecasting; great, expensive projects; or

main, innovative manufactured goods and introductions. The excellence of the forecast depends principally on the comprehension of the experts.

3. **Sales Force Composite Forecast** is created based on the sales forces' acquaintance of the marketplace and guesstimates of customer needs. Owning to the immediacy of the sales staff to the patrons, the forecast has a tendency to be trustworthy except individual prejudice could harmfully collision the efficiency of this approach. For example, if bonuses will be rewarded when actual sales surpass the forecast there is a predisposition for the sales force to under forecast.

7U

4. **Consumer Survey Forecast** uses the questionnaire that seeks contribution from customers on essential concerns such as upcoming buying behaviors, new products inspiration and opinions concerning presented products. The survey is direct through telephone, mail, Internet, or individual discussions. Information accumulated from the survey are evaluated using statistical tools along with judgments to obtain a set of momentous results

2.2.2 Quantitative Forecasting Methods

According to Render, Stair,and Hanna (2009) Quantitative Forecasting Methods make use of mathematical techniques that based on historical data and can include causal variable to forecast demand. There are two common methods which are as follows:

1. **Time Series Method.** A time series is derived from a series of constantly spaced (weekly, monthly, quarterly, and so on) data points. Forecasting time series data necessitates that prospect assessments are calculated introverted from the history values of that variable. And those other variables no matter how potentially significant are ignored.

2. Causal Method. "So called because it enlarges *cause and effect* relationship between demand and other variable". This method is the most useful for the medium-to-long-range forecasts. The best known of this model is called "Regression" in which the main variable is experimented mathematically for the relationship with other variables. There are both Regression analysis and Multiple Regression analysis. (Waddel, and Sohal 1994)

2.3 Forecasting models for the time series method

Render et al (2009) pointed out four forecasting techniques for the time series which are simple moving average, weighted moving average, exponential smoothing, and trend adjusted exponential smoothing. All models use historical data as a primary source to perform a forecasting prospect demand. Each technique is dissimilar in details of computations as shown below:

2.3.1 Simple Moving Average Model.

This model uses historical data to engender a forecast and work in good health when the demand is literally constant eventually.

Moving Average Forecast = Sum of Demands in Previous *n* Periods
n

$$F_{t+1} \quad \frac{D_{t} + D_{t-1} + D_{t-2} + \cdots + D_{t-n+1}}{n}$$

Where

= actual demand in the period *t*

n = total number of periods in the average

F_{t+1} = forecast for the period *t +1*

2.3.2 Weighted Moving Average Forecasting Model.

The model permits superior emphasis to be placed on extra current data to replicate alteration in demand patterns. Weights used also are liable to be based on know-how of the forecaster. Even though the forecast is more reactive to fundamental changes in demand, the forecast still lags demands because of the average effect. As such, the weighted moving average method does not do a good job of following trend changes in the data.

$$\text{Weight Moving Average} = \frac{\sum (\text{Weight in Period } i)(\text{Actual Value in Period})}{\sum (\text{Weights})}$$

$$F_{t+1} = \text{Weight}_1(D_t) + \text{Weight}_2(D_{t-1}) + \text{Weight}_3(D_{t-2}) + \cdots + \text{Weight}_n(D_{t-n+1})$$

Where

D_t = actual demand in the period t

Weight$_i$ = weight for ith observation

F_{t+1} = forecast for the period $t+1$

2.3.3 Exponential Smoothing Forecasting Model.

This is a more complicated weighted moving average forecasting where the forecast for the next period's demand is the present period's forecast adjusted by a portion of the diversity between the existing period's genuine demand and its forecast. This approach requires fewer data to be kept than weighed moving average method since merely two data points are needed. Due to its straightforwardness and its negligible data requirement, exponential smoothing forecasting is one of the more popular techniques. This model is similar to the other time series models, and is apposite for data that shows little trends or seasoned patterns.

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

Where

= new forecast (for time period t +1)

F_t = previous forecast (for time period t)

a = smoothing constant ($0 < a < 1$)

2.3.4 Trend-Adjusted Exponential Smoothing Forecasting

This model can be modified to comprise a trend factor when the time series demonstrate a methodical upward or downward trend in the area overtime. This method parenthetically obliges two smoothing constants, one of the smoothed forecasts (a) and the other for the trends (13).

$$A_t = \alpha D_t + (1-\alpha)(A_{t-1} + T_{t-1})$$
$$T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1}$$
$$F_{t+1} = A_t + T_t$$

Where

A_t = exponentially smoothed average of the series in period t

T_t = exponentially smoothed average of the trend in the period t

a = smoothing parameter for the average, with a value between 0 and 1

β = smoothing parameter for the trend, with a value between 0 and 1

F_{t+1} = new forecast (for time period t +1)

2.4 Forecasting model for the Causal Method

Regression analysis uncovers the best line fit to past data by discovering the smallest overall inaccuracy points then comparing it with the actual demand. The line is then projected into the upcoming period to achieve forecast (Caruana, 2001).

2.4.1 Simple Linear Regression

$$= b_0 + b_1 x$$

Where

$\hat{Y}$ = Forecast or Dependent Variable

x = Explanatory or Independent Variable

b_0 = Vertical Axis Intercept of the Line

b1= Slope of the Line

2.4.2 Multiple Regressions

$$\hat{Y} = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_k x_k$$

Where

$\hat{Y}$ = Forecast or Dependent Variable

x_k = k^{th} Explanatory or Independent Variable

b_0 = Constant

b_k = Regression Coefficient to the Independent Variable x_k

2.5 Forecasting accuracy

To achieve the accurate and unbiased result is the heart of every single forecasting method, because the expenditure of the error in the forecasting may cost managers much more than they even imagine (Weisner, 2005).

2.5.1 The Mean Absolute Deviation (MAD)

MAD is a generally used forecast accuracy measurement, since it provides the evaluator the simplest way compared to other forecasting approaches. If an MAD equals to zero, it can be assumed that the forecasting closely calculated demand in excess of the valuation phase. Those positive values specify the forecasting underestimate demand. When comparing forecasting techniques then the evaluator looks for the technique resulting in the lowest MAD over the evaluation period.

$$\text{MAD} = \text{)Forecast Error|}$$

$$\text{MAD} = \frac{\sum |E}{n}$$

2.5.2 The Mean Absolute Percentage Error **(MAPE)**

This is determined by dividing the absolute forecast error the actual demand and multiplying the outcome by one hundred to get the absolute percentage error by summing up and computing for the average. The mean absolute percentage error has the advantage of providing the correct perspective of the magnitude of the forecast error.

$$\text{MAPE} = \text{Error}$$
$$\text{Actual}$$
$$\text{n}$$

$$\text{MAPE} = \frac{(\sum |E\_/\underline{D}\ )(100\%)}{\text{n}}$$

2.5.3 Mean Squared Error **(MSE)**

This is another widely used measure of forecast accuracy. MSE is a measure analogous to variance in statistics. With MSE, large forecast errors are heavily penalised because the error are squared, summed, and then average.

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

$$MSE = \frac{\sum E_t}{n}$$

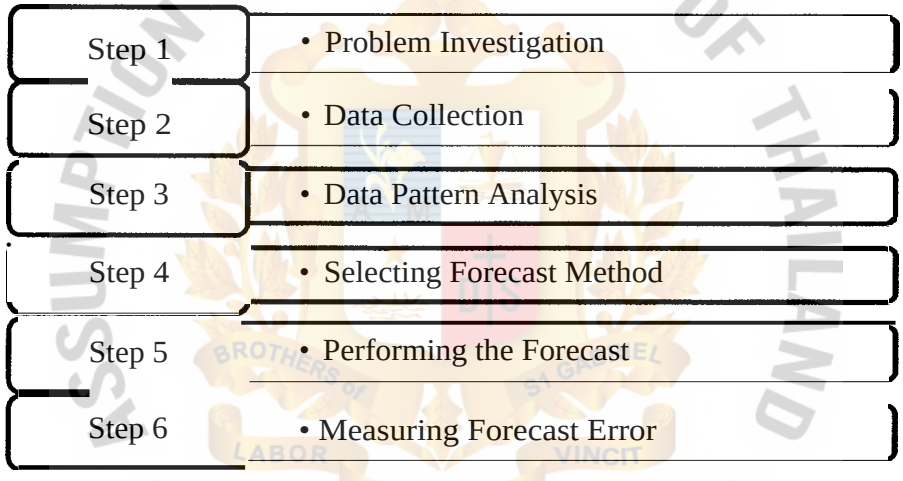
CHAPTER III

RESEARCH METHODOLOGY

This paper applies case study methodology to study the objective of improving the forecast performance over the existing qualitative forecasting method. So, the main idea is to conduct and planning the purchasing process and the inventories.

3.1 Research Methodology Procedure

Figure 3.1: Research Methodology



3.2 Problem Investigation

This process started with a conferencing, interview with company's staff and manager also furthermore, empirical experiences of the author are used to identify the problems. Referring back to the Chapter one the company tries to stay competitive and keep customers' satisfaction at the high level by piling up the stock. Doing such a thing causes the company a surplus inventory.

3.3 Data Collection

The product SK-000-IJ-127 is one of the top seller products of the company. It is also the product which has a problem of inventory surplus. So, the productions preferred for this study. The data that used in this paper is from January 1st 2008 to December 31st 2010.

Table 3.1 Historical Demand Data of Product SK-0001J127 (Unit)

period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	113	104	136	128	122	134	135	123	102	123	109	133
2009	144	115	143	124	145	141	111	125	120	155	149	147
2010	166	130	153	125	162	176	152	151	169	167	195	190

Figure 3.2 Demand of SK-000-1J127 (2008-2010) (Unit)

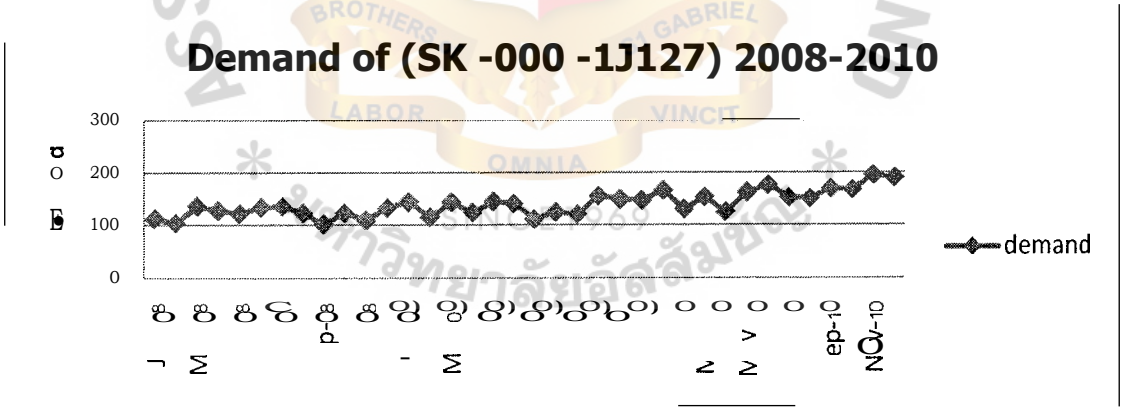


Figure 3.2 shows the pattern of the demand of SK-000-IJ127 after putting in the data from table 1.1 into the Microsoft Excel.

3.4 Data Pattern Analysis

The significant object for the demand forecasting in the time series is to consider and understand the format of the data patterns, which are mentioned in the previous chapter, whether they are Horizontal, Trend, Cyclical, Seasonal and Irregular. This stage can be done by plotting the graph as seen in the Figure 3.2

3.5 Selecting Forecasting Methods

In accordance with a Figure 3.2 the pattern of demand for the target product proves not only the steadiness but also elucidates a trend component. Thus, the suitable forecasting methods are Sample Moving Average, Weight Moving Average, Exponential Smoothing, and Trend-Adjust Exponential Smoothing Method.

3.6 Performing the Forecast

After choosing the correct techniques like Simple Moving Average, Weighted Moving Average, Exponential smoothing and Trend Adjusted Exponential Smoothing this paper also exploits those selected approaches to do the forecast in the past which are from the year 2008 and 2009 to check whether the methods and results are accurate. Then the company can apply these methods for the year 2010, which is the result of the past experiment corrected. All of the samples and outcomes in this chapter will be only from the years 2008 and 2009 only to show and explain the calculations of those methods.

3.6.1 Simple Moving Average

A sample of Simple Moving Average method in the Table 3.2 explains that the number of terms in the moving average (n) is determined from n = 3 to The Forecasting periods and from January 2008 to December 2009. Table 3.2 illustrates the Simple Moving Average approach when the calculation was performed.

Table 3.2 sample of 3-point Simple Moving Average

year	period	Demand	forecast	error	abs error	squared error	squared error (%)
Jan-08	1	113					
Feb-08	2	104					
Mar-08	3	136					
Apr-08	4	128	(118)	10.33	10.33	106.78	8%
May-08	5	122	123	-0.67	0.67	**0.44**	1%
Jun-08	6	134	129	5.33	5.33	28.44	4%
Jul-08	7	135	128	7.00	7.00	49.00	5%
Aug-08	8	123	130	-7.33	7.33	53.78	6%
Sep-08	9	102	131	-28.67	28.67	821.78	28%
Oct-08	10	123	120	3.00	3.00	9.00	2%
Nov-08	11	109	116	-7.00	7.00	49.00	6%
Dec-08	12	133	111	21.67	21.67	469.44	16%
Jan-09	13	144	122	22.33	22.33	498.78	16%
Feb-09	14	115	129	-13.67	13.67	186.78	12%
Mar-09	15	143	131	12.33	12.33	152.11	9%
Apr-09	16	124	(134)	-10.00	10.00	100.00	8%
May-09	17	145	127	17.67	17.67	312.11	12%
Jun-09	18	141	137	3.67	3.67	13.44	3%
Jul-09	19	111	137	-25.67	25.67	658.78	23%
Aug-09	20	125	132	-7.33	7.33	53.78	6%
Sep-09	21	120	126	-5.67	5.67	32.11	5%
Oct-09	22	155	119	36.33	36.33	1320.11	23%
Nov-09	23	149	133	15.67	15.67	245.44	11%
Dec-09	24	147	141	5.67	5.67	32.11	4%

From the table 3.2

$$F_{t+1} = \frac{D_i + D_{,-1} + D_{12} + \bullet\bullet\bullet + D_{l-,+1}}{n}$$

Where

A = actual demand in period t

n = total number of periods in the average

F_{t+1} = forecast for period t+1

The simple moving average for April, 2008 is

$$F_{April\,2008} = \frac{113 + 104 + 136}{3} = 118$$

The simple moving average for April, 2009 is

$$F_{April\,2009} = \frac{114 + 115 + 143}{3} = 134$$

3.6.2 Weight Moving Average

In the Simple Moving Average method, each demand has the same weight in the average namely, 1/n. in the Weight Moving Average method each historical demand in the average can have its own weight. The sum of the weights must be equal to 1. The outcome of the Weight Moving Average method is shown in the Table 3.4. The number of terms in the moving average (n) is determined from n = 2 to n = 6. The sample forecasting outcome will use the period of January 2008 to December 2009 forecasted. In a three period weight moving average model the average is obtained by multiplying the weight of each period by the value for that period and adding the products together. Table 3.3 demonstrates the calculation of the Weighted Moving Average Method.

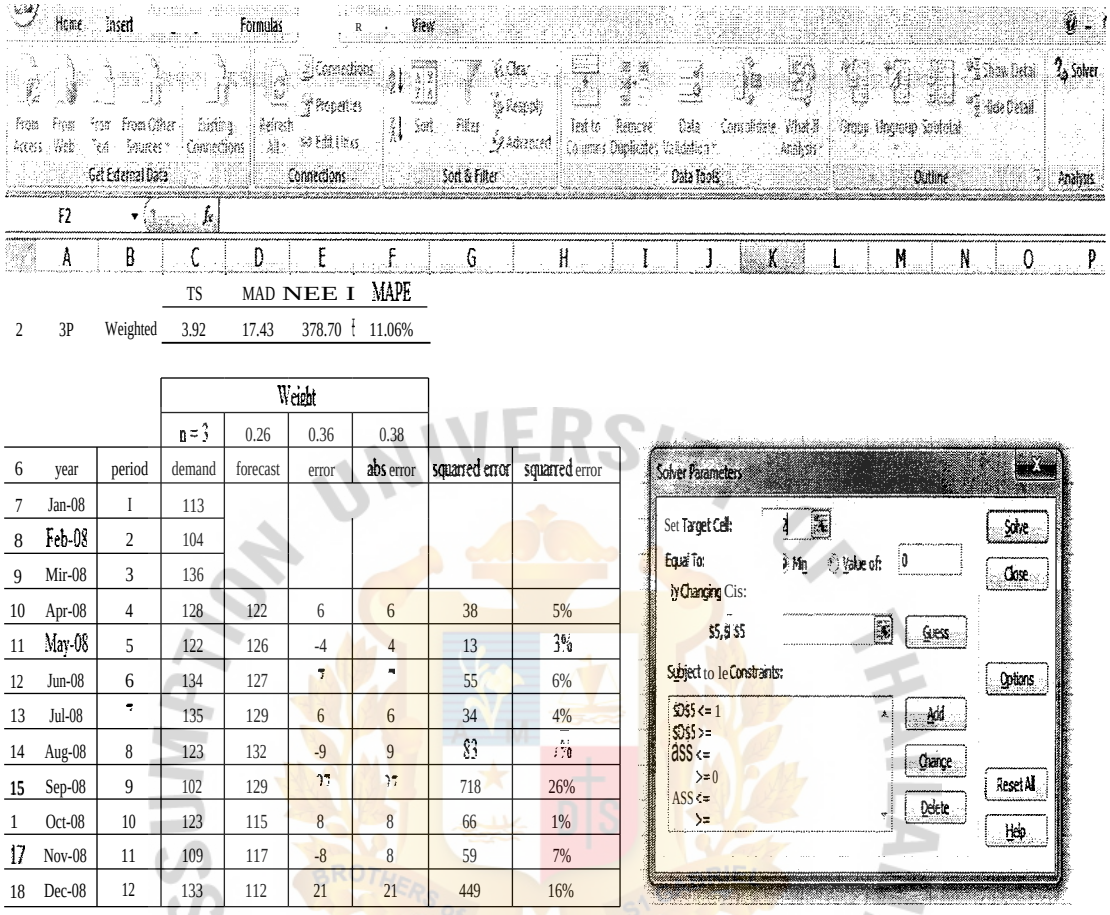
Table 3.3 sample of 3-point weighted moving average

year	period	Demand	forecast	Error	abs error	squared error	squared error
Jan-08	1	113					
Feb-08	2	104					
Mar-08	3	136					
Apr-08	4	128	119	9.50	9.50	90.25	7%
May-08	5	122	125	-2.64	2.64	6.97	2%
Jun-08	6	134	128	6.20	6.20	38.44	5%
Jul-08	7	135	128	6.88	6.88	47.33	5%
Aug-08	8	123	131	-8.26	8.26	68.23	7%
Sep-08	9	102	130	-28.18	28.18	794.11	28%
Oct-08	10	123	118	4.86	4.86	23.62	4%
Nov-08	11	109	115	-6.44	6.44	41.47	6%
Dec-08	12	133	112	20.78	20.78	431.81	16%
Jan-09	13	144	122	22.24	22.24	494.62	15%
Feb-09	14	115	131	-15.94	15.94	254.08	14%
Mar-09	15	143	130	12.88	12.88	165.89	9%
Apr-09	16	124	133	-9.18	9.18	84.27	7%
May-09	17	145	129	16.50	16.50	272.25	11%
Jun-09	18	141	137	4.08	4.08	16.65	3%
Jul-09	19	111	138	-27.02	27.02	730.08	24%
Aug-09	20	125	131	-5.64	5.64	31.81	5%
Sep-09	21	120	124	-4.12	4.12	16.97	3%
Oct-09	22	155	119	35.54	35.54	1263.09	23%
Nov-09	23	149	135	14.40	14.40	207.36	10%
Dec-09	24	147	144	3.38	3.38	11.42	2%

Weight
n = 3 0.26 0.36 0.38

Remark* the value of weights in every (n) in each period is calculated by a solve function in Microsoft Excel Program and by heuristics.

Figure 3.3 weights calculation for Weighted Moving Average



Home Insert Formulas R View

Get External Data | Connections | Sort & Filter | Data Tools | Outline | Analysis

F2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
			TS	MAD	NEE I	MAPE										
2	3P	Weighted	3.92	17.43	378.70	11.06%										

			Weight					
			n = 3	0.26	0.36	0.38		
6	year	period	demand	forecast	error	abs error	squarred error	squarred error
7	Jan-08	I	113					
8	Feb-08	2	104					
9	Mir-08	3	136					
10	Apr-08	4	128	122	6	6	38	5%
11	May-08	5	122	126	-4	4	13	3%
12	Jun-08	6	134	127	7	7	55	6%
13	Jul-08	7	135	129	6	6	34	4%
14	Aug-08	8	123	132	-9	9	83	7%
15	Sep-08	9	102	129	27	27	718	26%
1	Oct-08	10	123	115	8	8	66	1%
17	Nov-08	11	109	117	-8	8	59	7%
18	Dec-08	12	133	112	21	21	449	16%

Figure 3.3 shows the weights calculation in the Weighted moving Average Method. Firstly, the data function is opened in the Microsoft Excel then the 'Solver' is selected. Since, the main idea is to receive the minimum value of the MAPE, the Title `Set Target Cell' is selecting the cell in which the MAPE Value will appear in this paper is F2. Then in the 'Equal to:' the title is selecting is ‘Min’ since the minimum MAPE is desired. Then, in the 'Subject to the Constraints:' determining cells D5, E5, and F5 to be more or equal 0 and to be less or equal to 1 is selected.

From the table 3.3

Weight Moving Average = Y (Weight in Period i) (Actual Value in Period)
X (Weights)

$$F_{t+1} = \text{Weight}_1 (D_i) + \text{Weight}_2 (D_{i-1}) + \text{Weight}_3 (D_{t-2}) + \cdots + \text{Weight}_n (D_{t-n+1})$$

Where

D_t = actual demand in the period t

Weight, = weight for ith observation

F_{t+1} = forecast for the period $t+1$

Weighted Moving Average for September, 2008

$$[(0.26*134) + (0.36*135) + (.0.38*123)] = 130$$

Weighted Moving Average for June, 2009

$$[(0.26*143) + (0.36*124) + (.0.38*145)] = 137$$

3.6.3 Exponential Smoothing Method

The Exponential Smoothing Method is a sophisticated weighted moving average method that calculates the average of a time series by giving recent demands more weight than earlier demands. As mentioned in the previous chapter, this method is the most used by managers because of its simplicity and the small amount of data needed to support it. Only three items are required by this Exponential Smoothing; the Alpha (a), which is the smoothing parameter, normally (a) value is between 0 and 1, the current demand, and the forecasted demand from the last period. An outcome of the Exponential Smoothing method is demonstrated in the Table 3.4. The sample of the forecast will be used from the period of January 2008 to December 2009.

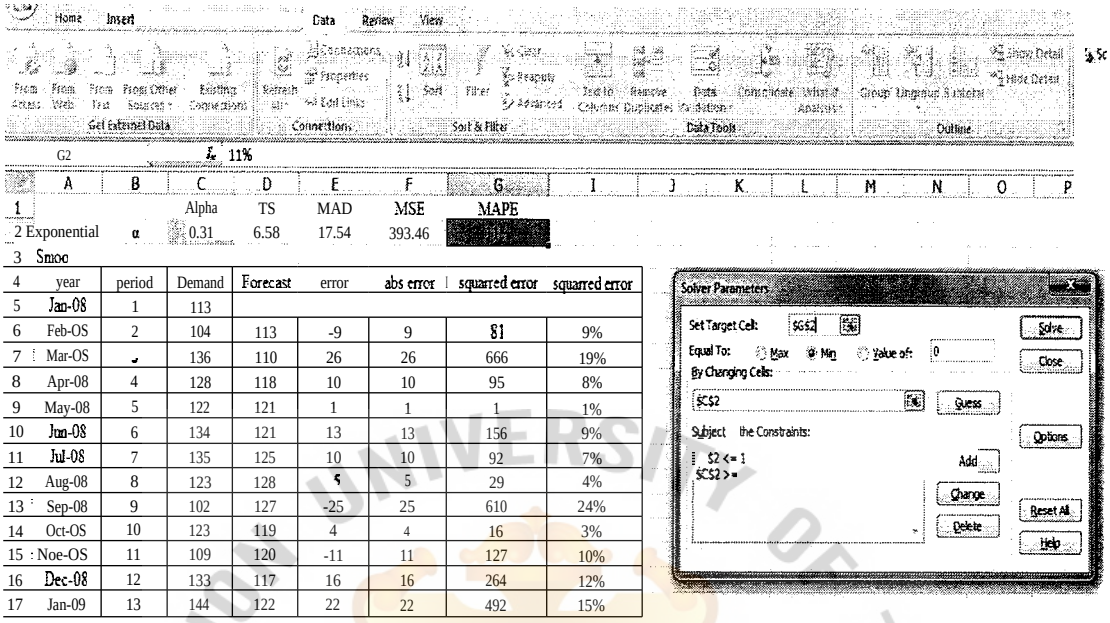
Table 3.4 Sample of Exponential smoothing

Year	period	demand	Forecast	error	abs error	squared error	squared error
Jan-2008	1	113					
Feb-2008	2	104	113	-9	9	81	9%
Mar-2008	3	136	110	26	26	666	19%
Apr-2008	4	128	118	10	10	95	8%
May-2008	5	122	121	1	1	1	1%
Jun-2008	6	134	121	13	13	156	9%
Jul-2008	7	135	125	10	10	92	7%
Aug-2008	8	123	128	-5	5	29	4%
Sep-2008	9	102	127	-25	25	610	24%
Oct-2008	10	123	119	4	4	16	3%
Nov-2008	11	109	120	-11	11	127	10%
Dec-2008	12	133	117	16	16	264	12%
Jan-2009	13	144	122	22	22	492	15%
Feb-2009	14	115	129	-14	14	188	12%
Mar-2009	15	143	124	19	19	344	13%
Apr-2009	16	124	130	-6	6	39	5%
May-2009	17	145	128	17	17	279	12%
Jun-2009	18	141	133	8	8	56	5%
Jul-2009	19	111	136	-25	25	616	22%
Aug-2009	20	125	128	-3	3	10	2%
Sep-2009	21	120	127	-7	7	51	6%
Oct-2009	22	155	125	30	30	905	19%
Nov-2009	23	149	134	15	15	217	10%
Dec-2009	24	147	13	8	8	66	6%

Smoothing Parameter a	0.31

Remark * The Smoothing Parameter is calculated by Solve function in the Microsoft Excel.

Figure 3.4 the Smoothing Parameter calculations for Smoothing Exponential



	A	B	C	D	E	F	G
1			Alpha	TS	MAD	MSE	MAPE
2	Exponential	α	0.31	6.58	17.54	393.46	11%
3	Smoo						

4	year	period	Demand	Forecast	error	abs error	squarred error	squarred error
5	Jan-08	1	113					
6	Feb-OS	2	104	113	-9	9	81	9%
7	Mar-OS	3	136	110	26	26	666	19%
8	Apr-08	4	128	118	10	10	95	8%
9	May-08	5	122	121	1	1	1	1%
10	Jun-08	6	134	121	13	13	156	9%
11	Jul-08	7	135	125	10	10	92	7%
12	Aug-08	8	123	128	-5	5	29	4%
13	Sep-08	9	102	127	-25	25	610	24%
14	Oct-OS	10	123	119	4	4	16	3%
15	Noe-OS	11	109	120	-11	11	127	10%
16	Dec-08	12	133	117	16	16	264	12%
17	Jan-09	13	144	122	22	22	492	15%

Figure 3.4 illustrates that the best alpha value for the Exponential Smoothing Forecasting Method is calculated by using Solve function in the Microsoft Excel. Select 'Data' in the Microsoft Excel then select the 'Solver'. To get the minimum of MAPE select 'Set Target Cell', "G2" is selected, because it is the outcome of the MAPE. Then pick the 'Min', since the minimum MAPE is required. In the 'By Changing Cell', "C2" is selected because the alpha value needs to be calculated. In the 'Subject to the Constraints' C2" is selected because it is less or equal to 1 and "C2" is more than or equal to 0.

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

Where

F_{t+1} = Forecast for period t+1

F = Forecast for period t

D_t = Actual demand for period t

a = Smoothing constant ($0 < a < 1$)

Exponential Smoothing for October, 2008

$$F_{Octoer\,2008} = 0.31 * 102 + (1 - 0.31) * 127$$

$$= 119$$

Exponential Smoothing for December, 2009

$$F_{December\,2009} = 0.31949 + (1 - 0.31) * 134$$

$$= 139$$

3.6.4 Trend-Adjust Exponential Smoothing Method

A trend is a rational decrease or increase, in the habitually over time. When a considerable style is presented, the adaption of the exponential smoothing is done. Otherwise, the forecast is likely to be above or below the real customer demand. With this method, the estimates for both average and trend are smoothed, requiring two smoothing constants, which are Alpha (a) and Beta ((3). The value of (a) and (β) can be something between 0 and 1, which do not have to be summed up. An outcome of the Trend-Adjust Exponential Smoothing technique is demonstrated in the Table 3.6. The Forecast outcome will be used for the period of January 2008 to December 2009.

Figure 3.5 Smoothing Parameters calculations for Trend Adjusted Exponential

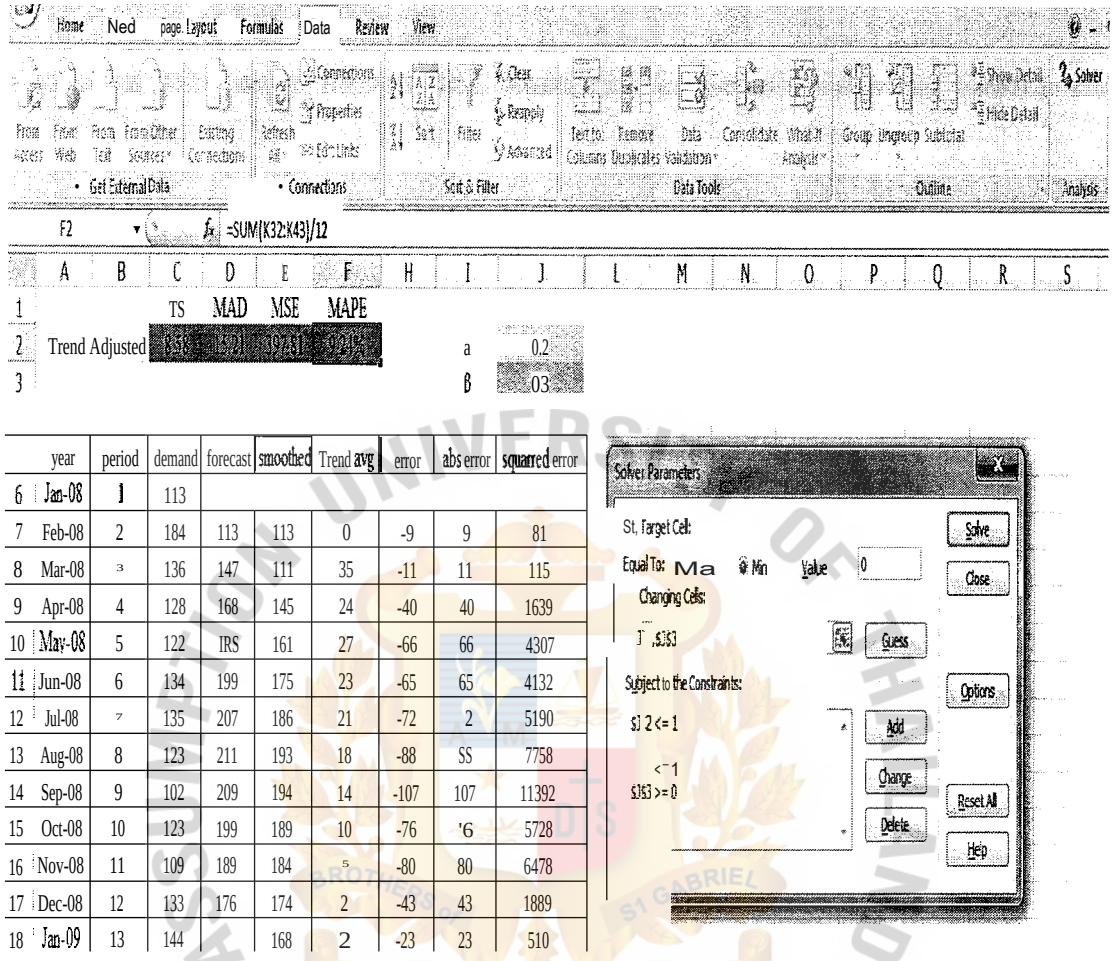


Figure 3.5 shows the calculations for the smoothing parameters of Trend Adjusted Exponential Smoothing. Instead of finding only alpha (a) as in the Exponential Smoothing, there is another smoothing parameter in this forecasting method which is Beta (β). Starting off at the 'Data' in the Microsoft Excel, then selecting the 'Solver'. To get the lowest MAPE in the 'Set Target Cell', in this sample is cell F2. Then, selecting 'Min' in the 'By Changing Cell'. In the changing cell's space entering cells for both (a) and ((3), which in this sample are cells J2 and J3 respectively. In 'The Subject to the Constraints', J2 is less than or equal to 1, and J2 is more than or equal to 0 is determined. Then, the process is repeated for the J3.

Table 3.5 Sample of Trend-Adjust Exponential Smoothing

Year	period	demand	forecast	smoothed avg	trend avg	error	abs error	squared error
Jan-2008	1	113						
Feb-2008	2	104	113	113	0.00	-9.00	9.00	81
Mar-2008	3	136	147	111	35.43	-10.73	10.73	115
Apr-2008	4	128	168	145	23.79	-40.49	40.49	1639
May-2008	5	122	188	161	26.80	-65.63	65.63	4307
Jun-2008	6	134	199	175	23.46	-64.67	64.67	4182
Jul-2008	7	135	207	186	20.61	-72.04	72.04	5190
Aug-2008	8	123	AP	193	17.67	-88.08	88.08	7758
Sep-2008	9	102	209	194	14.32	-106.74	106.74	11392
Oct-2008	10	123	199	189	10.14	-75.69	75.69	5728
Nov-2008	11	109	189	184	5.12	-80.49	80.49	6478
Dec-2008	12	133	176	174	2.21	-43.47	43.47	1889
Jan-2009	13	144	167	168	-1.66	-22.59	22.59	510
Feb-2009	14	115	159	162	-3.02	-44.29	44.29	1962
Mar-2009	15	143	147	151	-3.93	-3.98	3.98	16
Apr-2009	16	124	140	146	-6.28	-15.95	15.95	254
May-2009	17	145	131	137	-5.78	13.84	13.84	192
Jun-2009	18	141	127	134	-6.88	14.10	14.10	199
Jul-2009	19	111	124	130	-5.71	-12.85	12.85	165
Aug-2009	20	125	41P	121	-5.24	8.82	8.82	78
Sep-2009	21	120	112	118	-6.15	8.30	8.30	69
Oct-2009	22	155	108	113	-5.34	47.08	47.08	2216
Nov-2009	23	149	112	117	-5.10	37.27	37.27	1389
Dec-2009	24	147	116	119	-2.39	30.61	30.61	937

Smoothing Parameter	a	=	0.20
	β	=	0.30

$$A_t = \alpha D_t + (1 - a)(4\_,$$
$$T_t = \beta(A_t \quad A_{t-1}) + (1 - \beta)T_{t-1}$$
$$= A_t + T,$$

Where

A_t = Exponentially smoothed average of the series in period t

T_t = Exponentially smoothed average of the trend in period t

$D,$ = Actual demand for period t

a = Smoothing parameter for the average, with a value between 0 and 1

β = Smoothing parameter for the trend, with a value between 0 and 1

$F_{+,}$ = Forecast for period t + 1

Trend Adjusted Exponential Smoothing for August, 2008

$$A, = 0.20*(135) + 0.8*(186 + 20.61) = 193$$

$$T_1 = 0.3*(186 - 175) + 0.7*(23) = 18$$

$$F_{August2008} = 193 + 18 = 211$$

Trend Adjusted Exponential Smoothing for August, 2009

$$A, = 0.20*(111) + 0.8*(130 - 5.71) = 121$$

$$T_1 = 0.3*(130 - 134) + 0.7*(-5.7) = -5.24$$

$$F_{August2009} = 121 - 5 = 116$$

3.7 Measuring Forecast Error

According to this research related literature review, the vital objective of the forecasting is to have a precise and unprejudiced forecast. Anyway, the forecast error means the gap or the differences of the actual demand and the forecasted demand. There are three widespread exercises that are employed to examine if the forecasting demand is not excessively diverse from the real demand.

I. Mean Absolute Deviation (MAD): is to take the absolute value of the errors and average it over the n period to get alternative of the forecast picture.
2. Mean Squared Error (MSE): as the name implies this measurement is acquired by obtaining the mean of the square of the error terms. Squaring of the error terms serves the important purpose of amplifying the forecast errors. Therefore, in situations demanding low tolerance for forecast errors it is desirable to make use of this measure.
3. Mean Absolute Percentage Error (MAPE) is an option to embody the deviation in relative terms rather than absolute terms. It works by converting the absolute error into a percentage.

In this paper will use only the MAPE as a tool to measure the forecast error. Since, there are more than one forecasting methods MAPE is used because it is common and widely used to compare the results between different forecasting methods.

CHAPTER IV

PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

According to previous chapters vinyl tubes are the best seller of the company and this trend is increasing in each year. Thus, the vinyl tube is chosen as the model to conduct the demand forecasting. As mentioned in the previous chapter, the forecasting methods that will be used in this paper are Simple Moving Average, Weighted Moving Average, Smoothing Exponential, and Trend Adjusted Smoothing Exponential. In this chapter there will be a presentation of the demand forecasting results and the details of the selected item in those four methods for the year 2010 to discover and to select the best suited the time series forecasting method. All the results in this chapter are from the year 2010 only.

4.1 Simple Moving Average Result

The Simple Moving Average is the simplest form of the moving average. It is utilized to calculate the average of the past sales to smoothen short-term unstable demand. Table 4.1 shows the Simple Moving Average's calculation for the vinyl. The number of terms (n) is decided from n=2 to n=6 and the forecast results will be used for forecasting demand for January 2010 to December 2010.

Table 4.1 the Result of Simple Moving Average

Period	Demand	SMA n = 2	SMA n=3	SMA n = 4	SMA n = 5	SMA n = 6
Jan-10	166	148	150	143	139	135
Feb-10	130	157	154	154	147	144
Mar-10	153	148	148	148	149	145
Apr-10	125	142	150	149	149	150
May-10	162	139	136	144	144	145
Jun-10	176	144	147	143	147	147
Jul-10	152	169	154	154	149	152
Aug-10	151	164	163	154	154	150
Sep-10	169	152	160	160	153	153
Oct-10	167	160	157	162	162	156
Nov-10	195	168	162	160	163	163
Dec-10	190	181	177	171	167	168
MAD		17.67	17.03	16.81	16.65	17.22
MSE		377.67	380.75	410.84	383.98	406.5
MAPE		11.11%	10.70%	10.44%	10.25%	10.56%

Table 4.1 shows the results of the first forecasting method which is the Simple Moving Average. With the (n) terms from n=2 to n=6. Table 4.1 shows that The Simple Moving Average with n=5 provides the best result. Since, it produces the minimum MAPE which is 10.25%. The MAPE is Mean Absolute Percentage Error. For the error measurement the less MAPE is more preferable, because the forecast demand is not very different from the actual demand. In this case, there is only a 10.25% different from the real demand.

4.2 Weighted Moving Average Result

The Weighted Moving Average puts more significance on the recent progress. Therefore, the Weighted Moving Average responds more rapidly to the changes of the demand than the Simple Moving Average. Table 4.2 below presentw the sample and the result of the Weighted Moving Average method. The number of terms (n) is decided from n=2 to n=6 and the forecast results are used for forecasting demand for January 2010 to December 2010.

Table 4.2 the result of Weight Moving Average

Period	Demand	WMA n = 2	WMA n=3	WMA n = 4	WMA n = 5	WMA n = 6
Jan-10	166	148	150	143	139	135
Feb-10	130	157	154	154	147	144
Mar-10	153	148	148	148	149	145
Apr-10	125	142	150	149	149	150
May-10	162	139	136	**144**	144	145
Jun-10	176	144	147	143	147	147
Jul-10	152	169	154	154	149	152
Aug-10	151	164	163	154	154	150
Sep-10	169	152	160	160	153	153
Oct-10	167	160	157	162	162	156
Nov-10	195	168	162	160	163	163
Dec-10	190	181	177	171	167	168

Weight						
n = 2	0.45	0.55				
n = 3	0.26	0.36	0.38			
n = 4	0.10	0.20	0.30	0.40		
n = 5	0.02	0.10	0.27	0.29	0.32	
n = 6	0.04	0.15	0.16	0.17	0.18	0.30

MAD	17.85	17.43	17.21	17.02	16.73
MSE	383.78	378.70	380.51	384.36	376.55
MAPE	11.25%	11.06%	10.82%	10.63%	10.38%

Remark* the value of weights in every (n) in each period is calculated by a solve function in Microsoft Excel Program and by heuristics.

Table 4.2 shows the results of the second forecasting technique, which is Weighted Moving Average where n=2 to n=6, which is similar to the Simple Moving Average. The results shows that the Weighted Moving Average with n=6 presents the best value of MAPE, which is 10.38%.

4.3 Exponential Smoothing Method Result

The Exponential Smoothing method is a more sophisticate version of the weighted moving average forecasting technique. The forecast for the subsequently period's demand is the existing period's forecast corrected by a small part of the differentiation between the existing period's actual demand and forecast. The forecast result will be used for forecasting demand for January 2010 to December 2010.

Table 4.3 the Result of Exponential Smoothing

Year	period	demand	forecast	error	abs error	squared error	squared error
Jan-10	25	166	141	25	25	605	15%
Feb-10	26	130	149	-19	19	363	15%
Mar-10	27	153	143	10	10	98	6%
Apr-10	28	125	146	-21	21	449	17%
May-10	29	162	140	22	22	502	14%
Jun-10	30	176	147	29	29	866	17%
Jul-10	31	152	156	-4	4	14	2%
Aug-10	32	151	155	-4	4	13	2%
Sep-10	33	169	153	16	16	241	9%
Oct-10	34	167	158	9	9	76	5%
Nov-10	35	195	161	34	34	1155	17%
Dec-10	36	190	172	18	18	339	10%

MAD	17.54
MSE	393.46
MAPE	11.00%

Smoothing Parameter	a	0.31

Remark* The Smoothing Parameter (a) discovered by a Solve function in Microsoft Excel Program.

The method requires a precise amount of (a) and the calculation is from (a) = 0.1 to (a) = 0.9. In order to to save time and discover the best (a) value simultaneously. Instead of testing (a) from 0.1 to 0.9, the alpha number is determined by the "solve function" in Microsoft Excel. The (a) value that is calculated by the solve function equals to 0.31 which is the best suited for this data.

Table 4.3 presents the results of the next forecasting method, which is the Exponential Smoothing. As a matter of fact this forecasting method requires more time to execute, because this forecasting technique needs to have a precise of an (a) value to get the best results. So, to find the best value of the smoothing parameter (a), testing must be attempted since the alpha value equals to 0.1 until it reaches 0.9, then a selection of the best number of alpha value that constructs the smallest value of the MAPE can be done. The minimum MAPE is 11% with the alpha value of 0.31.

4.4 Trend Adjust Exponential Smoothing Result

With this method not only the average is smoothed but also the trend. But in this method two smooth constants for each period will be required which are alpha (a) for an average, and beta (β) for a trend. The forecast results are used for forecasting demand for January 2010 to December 2010.

Table 4.4 the Result of Trend-Adjusted Exponential Smoothing

Year	period	demand	forecast	smoothed avg	trend avg	error	abs error	squared error	squared error
Jan-10	25	166	121	122	-1	45	45	2011	27%
Feb-10	26	130	130	130	0	0	0	0	0%
Mar-10	27	153	133	130	3	20	20	417	13%
Apr-10	28	125	138	136	2	-13	13	178	11%
May-10	29	162	139	136	3	23	23	523	14%
Jun-10	30	176	146	143	2	30	30	928	17%
Jul-10	31	152	155	151	4	-3	3	10	2%
Aug-10	32	151	160	155	5	-9	9	74	6%
Sep-10	33	169	162	158	5	7	7	42	4%
Oct-10	34	167	168	164	4	-1	1	1	1%
Nov-10	35	195	172	168	5	23	23	511	12%
Dec-10	36	190	181	177	4	9	9	79	5%

MAD	15.21
MSE	397.81
MAPE	9.24%

Smoothing Parameter	a	=	0.20
	β	=	0.30

Remark* The Smoothing Parameter (a) and (β) values discovered by a Solve function in Microsoft Excel Program.

The Trend Adjusted Exponential Smoothing Method has to discover the appropriate number of the alpha (a) and beta (β) which consumes more time than the previous forecasting method. The method requires the exact amount of both (a), and (β) value for the precise forecasting results. The calculation must start by (a) = 0.1 to (a) = 0.9, and (β) =0.1 (β) = 0.9. Then the testing of those (a), and ((3) also has to be trial and error, starting from (a) = 0.1 with (13) =0.1, until (a) = 0.9 with (β) = 0.9. Due to the limited time available, to solve such a problem the alpha and beta values are determined by a "solve function" in Microsoft Excel. The (a) and (β) value are

calculated by the solve function equals to 0.20 and 0.30 respectively, which are best suited for this data.

Table 4.4 demonstrates results of the Trend Adjusted Exponential Smoothing forecasting method, in which the MAPE value equals to 9.24%.

4.5 Measuring the error

In the final step, the best results of each forecasting method must be selected in order make comparing with the other methods' results. This is then compared again with the as-is model situation that the company uses at the moment. After many trials and errors, this stage will present the outcomes of all attempts. Adding with the tables the MAPE will be utilized to measure the results of forecasting, because it is simple to recognize. There are several forecasting methods that been attempted, but MAPE is the best indicator that is used to compare the results between those forecasting methods. The amount of the MAPE will decide which forecasting methods gives the best results. Then the company will apply it to be a standard in the future.

Table 4.5 Comparing of Time Series Forecasting Methods

	SMA n=5	WMA n=6	Exponential Smoothing	Trend Adjust Exponential
MAD	16.65	16.73	17.54	15.21
MSE	383.98	376.55	393.46	397.81
MAPE	10.25%	10.38%	11.00%	9.24%

After comparing MAPE of all forecasting methods as shown in table 4.5 it was found that the Trend Adjusted Exponential Smoothing method produces the lowest amount of the MAPE value, which means that it is the most appropriate forecasting method to be exploited.

4.6 Comparing the result of the forecast with the current process.

Table 4.6 the Current situation of the Company's inventories (as-is)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Begin Inv	0	0	100	177	152	150	194	192	181	182	295	350
Procure	150	230	230	100	160	220	150	140	170	250	250	200
Demand	166	130	153	125	162	176	152	151	169	167	195	190
Delivered	150	130	153	125	162	176	152	151	169	167	195	190
Loss sales	16	0	0	0	0	0	0	0	0	0	0	0
Ending stock	0	100	177	152	150	194	192	181	182	265	350	360

Table 4.7 the Result of the simulation of a Forecast Improvement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Begin Inv	0	0	100	0	13	0	0	3	12	5	6	0
Procure	121	130	133	138	139	146	155	160	162	168	172	181
Demand	166	130	153	125	162	176	152	151	169	167	195	190
Deliver	121	130	133	125	152	146	152	151	169	167	178	181
Loss sales	45	0	20	0	30	30	0	12	0	0	17	9
Ending stock	0	0	0	13	0	0	3	0	5	6	0	0

Table 4.6 and table 4.7 show the improved results of the company's inventory. The simulation is done by setting the beginning inventories at zero. The results of the simulation is to examine the straight effect of the forecasting demand on the inventories level. The company has less of the inventories. This causes the storage cost and defection risks of holding large amount of inventories which also decrease. The results of that improvement are in Table 4.7. It shows that even the inventories level is significantly decreases, but there is some loss of sale opportunity that occurs in January, March, May, June, August, September November and December. Even though, this loss in sales opportunities is not that high in each period, it does with agree with the company policy which is to keep customers' satisfaction at the highest level. So, to improve and secure those loss sales opportunities the 10% purchasing buffer has been created to solve such the problem.

Table 4.8 Result of the simulation of a Forecast Improvement with 10% purchasing buffer

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Begin Inv	0	0	13	6	19	10	0	19	44	53	71	68
Procure	133	143	146	152	153	161	171	176	178	185	189	199
Demand	166	130	153	125	162	176	152	151	169	167	195	190
Deliver	133	130	153	125	162	171	152	151	169	167	195	190
Loss sales	33	0	0	0	0	5	0	0	0	0	0	0
Ending Inv	0	13	6	19	10	0	19	44	53	71	65	77

Table 4.8 states that if the company implements this 10% purchasing buffer, the company can solve the problem of the surplus inventories and loss of sales opportunity simultaneously. In table 4.6 – 4.8 the definitions of terms of each row are as follows:

- **Begin Inv -** the beginning Inventories of each month.
- **Procure** - manufactured goods that are acquired from the suppliers. This row utilizes the data from the outcomes of demand forecasting. Consistent with the simulation, the procurement officer will procure the same amount as the outcomes of the forecasting. Except for the Table 4.8 that the 10% of the forecasting demand will be added to solve the inventories surplus and loss of sale opportunity.
- **Demand -** the real demand for the products that occurs in each period.
- **Delivered –** the quantity of products delivered to customers.
- **Ending Inv –** the ending inventories at the end of each month.

Figure 4.1 Comparison between As-Is, Forecasted Demand, and Actual Sales.

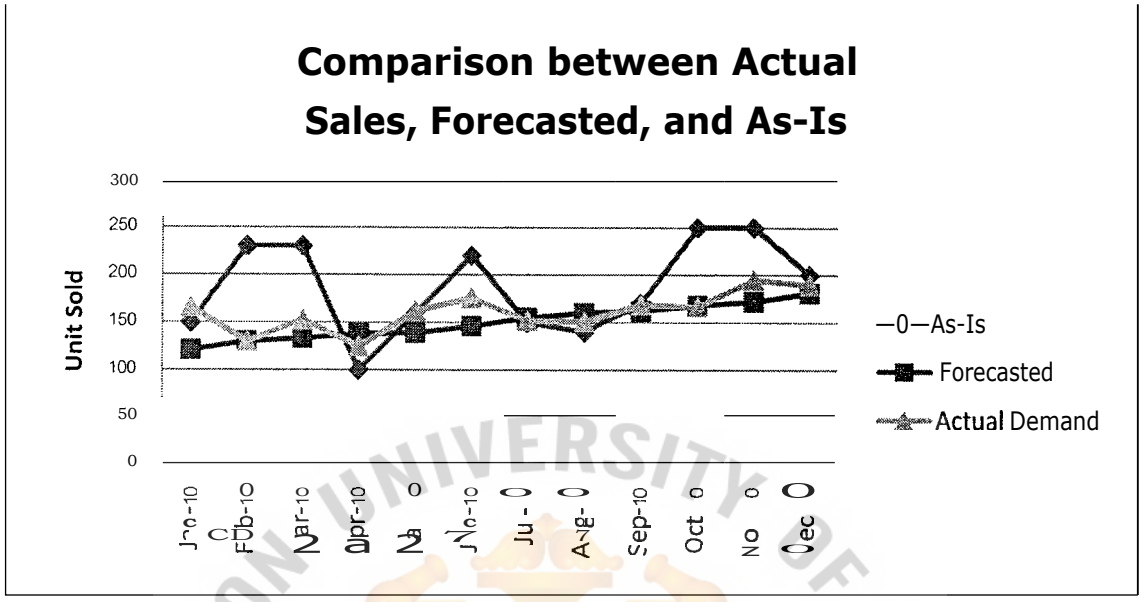


Figure 4.1 displays the results of the comparison of the graphs between the Actual Sales, Time Series Trend Adjusted Smoothing Exponential, and the As-is method that the company is now using.

The result notifies the large differences between the As-is method of the company and the forecasted compared to the actual demand. It proves that the company is now holding a great amount of the inventories cost, especially in February, March, June, October and November.

As a result of the Time Series Trend Adjusted Exponential Smoothing technique, the forecasting demand has improved. The outcome of the forecasting demand is not so dissimilar from the actual demand. This is the main objective of this paper. The Quantitative Time Series Trend Adjusted Exponential Smoothing method facilitates the situation of the company by lowering the inventories level.

4.7 Managerial implications of the result

After all the trials and errors, and implement affords of the forecasting approaches in the actual business situation with General Manager and other procurement department employees, the best method for the BPS United turns out to be a Simple Moving Average Method. There is couple of reasons why this method is chosen by staff.

The first reason is its simplicity of utilization. The method does not require much effort but gives an impressive result. Only the summation of the historical actual demand is then divided by the amount of the period of demand. Compared to the Method that gives the best result such as a Trend Adjusted Exponential Smoothing method, which has to find both of smoothing parameters (a) and (β) before a forecasting the Simple Moving Average is better. The second reason that convinces the staff of BPS United is the result of the forecast. In this paper, referring back to the Table 4.5 the best demand forecasting for the Simple Moving Average is (n) = 5, and the MAPE is 10.25%. Table 4.1 confirms that even in the worst MAPE value produced such as Simple Moving Average (n) = 2, MAPE equals to 11.11%.

The comparison of those two MAPE shows a difference of less than one percent. Then comparing the worst MAPE 11.11% of Simple Moving Average with the best MAPE value of Trend Adjusted Exponential Smoothing, which is 9.24%. The difference is only 1.87%, which is not incredibly different.

From an academic point of view the best solution for the inventory surplus problem solving in this paper is the Trended Adjust Exponential Smoothing Forecasting Method, but in the Business owner and employees managerial implications the best answer will be the Simple Moving Average Forecasting Method due to its simplicity and amount of effort required.

CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the Findings and Conclusion

The main purpose of this research is to study and experiment how to develop the accuracy of the forecasting demand so the outcomes are able to aid BPS United to lower the inventories costs and to remain competitive advantage in the industry.

The project begins with the company's analyzing the problem. Then the inventories surplus is chosen as a vital problem of the company. Since, the company is holding surplus inventories. It costs a lot of money. Without an excellent inventories control system some defects occur with the products. Finally, the firm fails to spot the chance to invest in other segments, because the inventory of the vinyl section has not been transferred to a liquidity asset of the company on time. So the company strives to eliminate these problems by lowering the inventories cost yet to keeping a customer satisfaction at the high level. Then the company starts by selecting the product segment that is the cash cow (best seller) and facing the situation.

The next step, there is gathering the historical data of the selected product. The pattern of the demand of the product which is called data pattern analysis is studied. This process can be done by putting the data into the Microsoft Excel and plotting graphs to determine the demand pattern. The graph illustrates that the pattern of the demand of the selected item is holds the trend fashion.

After knowing the type and pattern of the demand of product, the next step is to decide on the suitable forecasting method to cure the inventories surplus problem. This segment contains the process of choosing forecasting techniques. The forecasting techniques that are used for this project are Simple Moving Average, Weighted Moving Average, Exponential Smoothing, and Trend Adjusted Exponential Smoothing.

All the above motioned forecasting methods have been attempted. The results of each forecasting method are measured by the Mean Absolute Percentage Error (MAPE). The MAPE has been chosen to be a measurement of an outcome, because of several reasons. Firstly, it is the simplest measurement technique to understand. Secondly, since there is more than one method exercised in this paper, because of its simplicity the approach that is widely used to compare the result between them is the MAPE. Then the company notices to a decision as to which of those forecasting methods produces the lower MAPE value with the same Data of demand. The Trend Adjusted Exponential Smoothing forecasting method produces the lowest value of the MAPE which is only 9.24%, which means, the forecasted demand performed by this Method is only 9.24% different from the real demand. The results of the forecasting demand simulation implies that if the company implements the time series Trend Adjusted Exponential Smoothing demand forecasting method, the company can save numerous amount of money for the inventories holding.

5.2 Limitations and Recommendations for Future Research

The Time Series Trend Adjusted Exponential smoothing demand forecasting technique that is adopted within this research can be regarded as an improvement of the demand forecasting for the company. Nonetheless, there are several of limitations in this research. The limitations and the recommendations for the future research are presented below:

- This paper utilizes the past statistics data of the BPS United Co., LTD. merely. Also, the data that is used for the experiment is observed and is to perception of the procurement department point of view.
- The other related factors that might have some affects on this research such as suppliers' point of view, and freight forwarders' attitude are not included in this research.
- The product's historical data merely came from only one brand and one type of the product. In fact, there are several more brands and kinds of products. For better forecasting demand, the company ought to do the forecasting demand for every product that company acquires.
- To improve the inventory management the company should also focus on the Economics Order Quantity (EOQ), and Minimum Order Quantity (MOQ). Nowadays, both EOQ, and MOQ are one of the key tools for purchasers to use to attain further accurateness in the forecasting demand process.
- To improve the forecasting demand technique the company is supposed to adopt a Tracking Signal (TS) as an indicator for procurement staff, in order to allow those to have ability to plan for the next purchase to also monitor the current situation of the inventories.
- In the real world, the outer aspects, for instance the life cycle of products, the acts of the opponents, the market, industry, and economics situation are all important. These aspects always have a straight affect on the demand. Each of these aspects generates an unusual magnitude on demand. To study of these aspects is required for the company, in order to increase and develop the demand forecasting progression.

After all is said and done, this paper is written to be the instruction for the company to concentrate on the historical data. Also, to mount up the profit of the company it is not always necessary to rely on increasing the sales volume by piling up the inventories to impress customers, but the company can focus preventable cost and better management of the inventories also. For these reasons, for the further study, Company may go through these forecasting processes once again but should forecast the demand not only of the vinyl tubes, but also the rest of the products of the company in order to achieve a better result and to keep customers satisfaction at the height level by keeping the company's expenditures as low as possible.

BIBLIOGRAPHY

Caruana. A. (2001). Steps in forecasting with seasonal regression: a case study from the carbonated soft drink market. *Journal of Product & Brand Management, 10(2),* 94-102

Hanke, J. E. & Wichern, D. W. (2009). *Business Forecasting.* Upper Saddle River, NJ: Pearson Prentice Hall. 9th edition.

Krajewski, L., Ritzman, L., Malhotra. (2007). *Operation Management.* Upper Saddle River NJ: Pearson Prentice Hall. 8th edition.

Nanako. M. (2008). Collaborative Forecasting and Planning in Supply Chain. *The Impact on performance in Japanese manufacturers.* pp. 84-104

Render, B., Stair, R. M., Hanna, M. E. (2009). *Quantitative Analysis for Management.* Upper Saddle River, NJ: Pearson Prentice Hall. 10th edition.

Simchi-Levi. D., Kaminsky. P., Simchi-Levi. E. (2008). *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies.* NY: McGraw-Hill. 3rd edition.

Smith III. H. C., Herbig. P., Milewicz J., and Golden J. E. (1996). Differences in Forecasting Behaviour between large and small firms. *2,* 35-51

Waddel. D., Sohal. A. S. (1994). Forecasting: The key to Managirial Decision Making. *Management Decision, 32,* 41-49

Wisner, D. J., Tan, C. K. & Leong, K. G. (2005). *Principles of Supply Chain Management – A Balanced Approach.* South-Western, OH: South-Western Thomson.

Wisner, D. J., Tan, C. K. & Leong, K. G. (2008). *Principles of Supply Chain Management – A Balanced Approach.* South-Western, OH: South-Western Cengage Learning. 2nd edition.