COMPARING THE PERFORMANCE OF TOP-DOWN AND BOTTOM-UP DEMAND FORECASTING

By
NATTHAPON TANGMATIKUL

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

ABAC School of Management
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ABAC School of Management, Assumption University has approved this 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.

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Abstract

This research is a case study of making an improvement in demand planning. As an overview of the stationery business presents the need to manage with various SKU and groups of products; this can be the reason for barely managing demand forecasting. The interesting point of running a business with many SKU and brands is to fulfill the customers' demand as much as possible. Therefore, the methodology or the process which can improve demand planning or reduce forecasting error is an important finding for this research.

The methodology process is set up by using historical sales data and simulated with some forecasting techniques under the Top down and Bottom up approaches. The results between those two approaches are compared until the better one emerges. That suitable technique is then applied to the current year or a particular situation, to see how the forecasting accuracy has been improved or not.

In this case, the simulation has been run with two situations which are High growth and Stable growth. These two groups are selected because their demand variations have been different. Moreover, the testing proves which approach, Top down or Bottom up, is suited to which one of these two groups. The result shows that both high and stable growth items had rather use the Top down approach. The reason behind is that monthly share of sales is not quite at variance, and so the sales pattern is not too dynamic.

Finally, the most suitably technique chosen can be used to generate sales forecasting with the coming new year, and it also can affect other aspects, such as inventory level, safety stock, and service rate.. Those kinds of effects can be converted to a monetary value of contribution to the organization by having a better demand planning process.

Acknowledgements

I need to say thank you to the stationery company which supplied the data for use in the case study. And this research is due to the inspiration from the marketing department where I am working. As demand planning was always a crucial problem, I would like to initiate the new methodology to make an improvement for this organization.

Moreover, the advisor (Assistant Prof. Dr. Sompong Sirisoponsilp) gave me the knowledge of how to process this case study, including with the right guiding from the beginning to the end. I need to say thank you to the advisor, which needed the sacrifice of his time to advise me.

TABLE OF CONTENTS

Page

Page

List of Figures

Page

Page

Chapter I: Introduction

1.1 Background of the Study

The stationery business in Thailand is worth 5,000 million baht a year and there are presently three major companies earning more than a billion baht in annual sales, including D Stationery *(an alias name),* Nanmee, and Sanford.

The company which is the focus for this study, is the D Stationery Company which operates mostly a make-to-stock business. The company is faced with a challenge of demand planning and stock planning so that the right amount of inventory will be always available to accommodate the uncertainty of customer demand. The sales of the company are in the range of 1,000 to 2,000 million baht a year generated from a thousand stock keeping units (SKUs). The company serves traditional stores who act as resellers for the company. These stores require timely product replenishment and if there is any shortage the stores may immediately switch to other manufacturers. In some years, sales dropped because of poor demand and stock planning, despite the launching of an expensive marketing promotion campaigned. The company has suffered from the fact that customers' demand cannot be adequately served during many high-selling seasons.

Sometime, the customized products, or high involvement category, will not be much affected by time spent waiting for goods to arrive, compared with mass items. Due to the reason of making-to-order, the consumer will perceive that the lead time is longer and the degree of availability is lower. The nature of the stationery business is that it is a mass production business with low involvement. Every time that backorders have been occurring in the process, it forced the company to search for some direction for improvement, and it is hard to implement a flexible plan in both the production line and in buying raw materials.

More than 50% of sales which are lower than expected is not caused by competitors' actions, such as price cutting, new product launching, and attractive promotion, which match our main selling items or leading items. D Stationery Company is one of the biggest stationery companies and has a very strong channel strategy with traditional trade. It is that uniqueness which supports the company in pushing its products in the stores, and the relationship with many stores has existed for more than 50 years. The reasons behind low sales arise from no stock preparation for demand or for production capacity. However, the demand forecasting management improvement is expected to be value for money worth 10 million baht a year at an aggregated level.

Back Order Value: Office Products Group
At the end of Dec 07

NO	Group	Group Name	Value BackOrder	Value Pending For Sale	Total Value BackOrder
1	512	Lever Arch Ale	5,064,341	831,658	5,895,999
2	502	File	4,458,010	297,892	4,755,902
3	521	Sticker Label	1,431,080	16,031	1,447,111
4	534	Education File	1,060,003	129,690	1,189,693
5	516	Note BOOK	457,300	79,377	536,677
6	535	Education Books & Pad	328,947	91,211	420,158
7	302	Pen (Ball piont, Gel Ball)	389,924	29,609	414,533
	322	ton ection-Fluid-F en-Tape	239,497	1,023	240,520
9	538	Cash Receipt & Delivery Bill	190,054	23,192	213,246
10	531	Staplers-Punches-Staples	174,688	35,458	210,146

Figure 1.1 Back order value of stationery items (Source from D Stationery Company)

Figure 1.1 shows the total value of products for which people have had to wait. (The figures are tracked over a period of time). The red highlight shows the

back order value of the sticker label group at 1.4 million baht at that time. Furthermore, not only the management needs to improve forecasting but also need to focus on inventory management in term of safety stock and contingency planning which can react to the demand variables.

Therefore, the company does have chance to improve the gap of demand forecasting errors and inventory problems, which are the main weaknesses. That would create a possible growth rate in the sales volume and reach the target set. Nevertheless, the company obviously needs to realize the cause of the problems before moving on to implement strategic improvement and trying to develop a better forecasting process.

1.1.1 Company background

D Stationery Company is a local company which is a manufacturer and distributor of well-known stationery products such as "ELEPHANT" file and sticker labels. The company also imports products, such as pens and pencils from Germany, water colors (color set) from America, and stencil paper from Japan, from the original manufacturers, and some products from the Original Equipment Manufactures (OEMs).

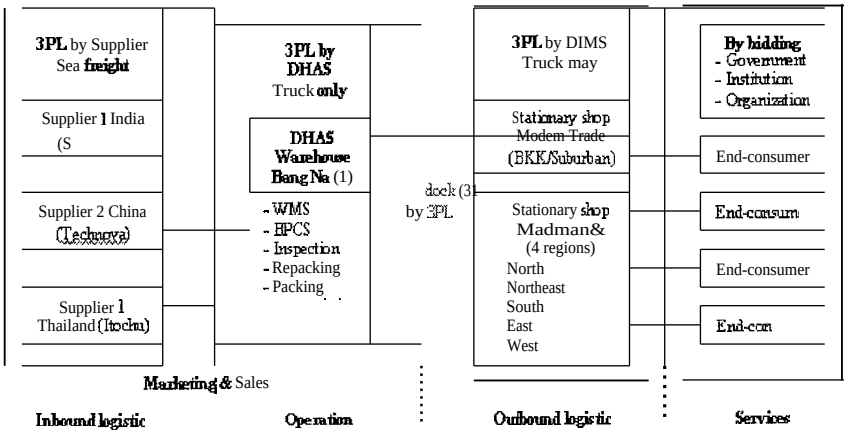


Figure 1.2 Illustrates the D Stationery Co.'s Supply chain

At present, the company sells 2,000 – 3,000 SKUs and has more than a thousand outlets throughout the country.

D Stationery Co. procures the resources and raw materials from many countries which are transported by the third party logistics. After the arrival of goods at the company's warehouse, they will pass through the process of receiving, inspection, and packing. The management of these operations is controlled by counting and management by an Enterprise Resource Planning System named "BPCS" and "WMS". Finished goods would be kept in stock (make to stock) and distributed by a local 3PL service provider through various sale channels such as traditional stores and modern trade, IT stores, and direct users.

The company is facing the challenge of preparing the right level of finished goods in inventory to serve fluctuating customers demand. The stock planning begins with demand planning to forecast customer demand. As demand forecasts serve as the basis for the planning of almost all aspects of the company's operation, the quality of demand forecasts certainly affects the capability of the company to accommodate the customers' demands in the most effective and efficient fashion.

1.2 Statement of the Problem

First of all, the main focus of this problem comes from the demand process in the organization. The nature of estimated committed sales would come from the meeting of the sales director, demand planner, marketer, sale manager, and production team. Normally, the demand planner will analyze and show the proposed sales figure from their calculation using software support which is called Point of Forecast. It seems that the method of generating the figure is from the judgment of the demand

planner. The inventory and back orders of the goods at that time would be proposed with the new sales figure which is expected to cover the demand in future.

The sales director would analyze the sale figure from the demand planner with support information from the marketing team, production, and sales team, to see whether it is possible to approach the market with this estimate or not. After that, the sales director will finalize the sales figure based on his experience and judgment. If all parties have agreed on that figure, demand planning would have finished for that group of products or that item, and would then start with the next group.

The mistaken did not happen immediately, but happened after the sales had been running for some time. The sales director and the other team involved, would monitor their sale forecasting through the COGNOS on web program. This program will conclude the actual sales which can be compared with the sales forecast. The effective planning would be shown at that stage.

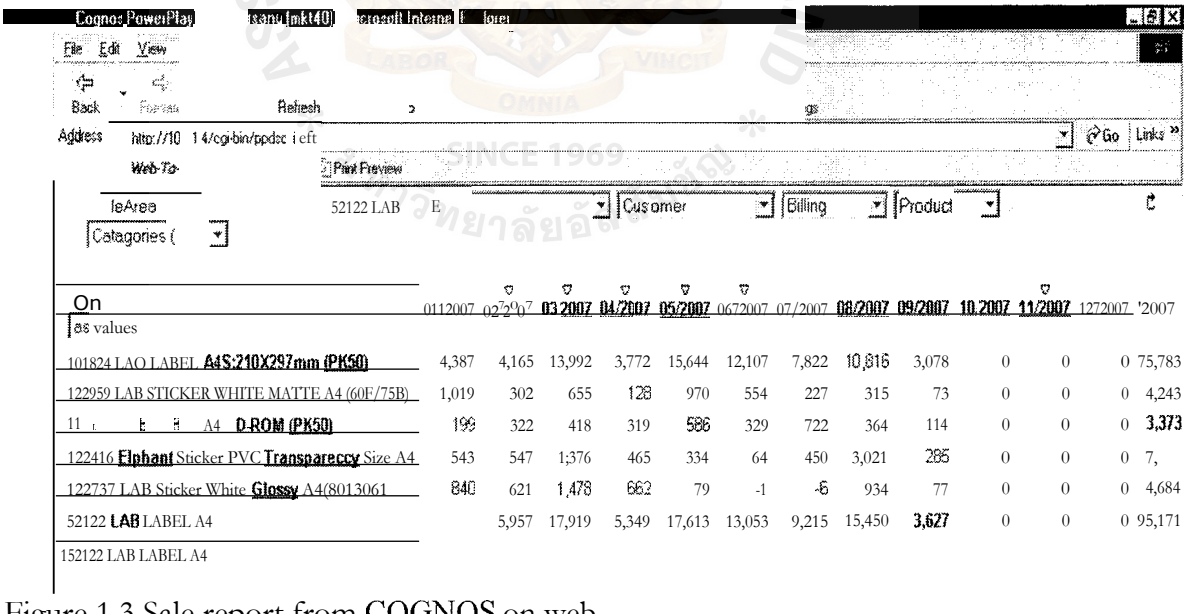


Figure 1.3 Sale report from COGNOS on web

Figure 1.3 shows the data from the sale report of "sticker label" products for the Year 2007. The data clearly illustrate a good example of the fluctuation in monthly demand faced by the company. The data also display a drop in the sales in

the 4th and 7th month of the Year 2007 caused by product shortages. It should be noted that all the best selling items contributing to more than 80% of the company's revenue have all experienced frequent product shortages. The persistence of these shortages problems signals the need to improve the demand planning process of the company so as to reduce or eliminate the shortage problems.

Although the demand planning can be improved in many aspects, the area that has received attention from both academia and practitioners is the investigation of the relative advantages/disadvantages between the top-down and bottom-up approaches in forecasting, which is the main focus of this study.

1.3 Research Objectives

The objectives of the study are two-fold.

1. To investigate and compare the relative performance of the top-down and bottom-up approaches in forecasting the customers' demand in the case company.
2. To identify any factors that may affect the relative performance of the two approaches

1.4 Scope of the Research

As **D** Stationery Company has been managing various product items, the scope of this research focuses on the group of product which has had some different selling pattern within those categories. The group of products which has been selected is "Sticker label". It can be called a direct mail or postal segment, or sticker label. This group of products consists of two main categories which are Label A4 and Computer label. The Label A4 has been newly launched to the market, with a high growth

pattern. The reason for selecting this group of products is because the sale volumes of these products have grown by 40%-60% a year which is at the high growth at expansion stage in the product life cycle. Another reason is a category (Computer label) which has been introduced into the market for a significant time and has experienced relatively stable sales. The findings are explored: whether the difference in sale patterns would affect the relative performance of the two approaches of Top-down and Bottom-up or not.

Furthermore, in the last two to three years, the company has always been faced with the stock-out problem which made it necessary to outsource others suppliers to run the production (normally, this group of product has been manufactured by our plant). This missing stock is due to forecasting error over whether the company can have under- or over- demand expectations. Therefore, this research uses simulation testing by using the sales in the past three years, evaluated for each of the two categories.

The idea of top-down and bottom-up approach could cope with a forecasting technique, which can find a better approach to match the stationery business of D Stationery Co. by evaluating the value of forecasting error.

1.5 Limitations of the Research

Even though the study focuses on the customers' demand, the records kept by the company reflect only the actual sales. It should also be noted that the results of the study may not be generalized to other businesses or products due to the uniqueness of the demand patterns of the product researched in this study.

1.6 Significance of the Study

- To identify the direction of using evaluation in forecasting which can enhance the ability to improve forecasting accuracy in an organization.
- Helping to develop the forecasting process and management which can fit with the companies' product type.
- To be an information support for the company which acts as a distributer or manufacturer of the goods from the customer demand forecasting perspective.

Chapter II: Review of Related Literature and Studies

2.1 Forecasting Definition

According to Mentzer & Bienstock (1997) sale forecasting is a projection into the future of expected demand given a stated set of environmental conditions. Cox (1995) says that the process of predicting future demand for products or services as a means to schedule production is called demand forecasting. Even before a company receives an order for a product or service, the linkage between operations and the customer is established through demand management via forecasting.

2.2 Significant of forecasting in "Supply Chain Management"

Trunick (1996) says that a company's supply chain encompasses all of the facilities, functions, and activities involved in producing a product or service from suppliers to customers. Supply chain functions include purchasing, inventory, production, scheduling facility location, transportation, and distribution. All these functions are affected in the short run by product demand and in the long run by new products and processes, technology advance, and changing markets.

Forecasts of product demand determine how much inventory is needed, how much product to make, and how much material to purchase from suppliers to meet forecasted customer needs. It determines the kind of transportation that will be needed and where plants, warehouses, and distribution centers will be located so that products and services can be delivered on time.

Without accurate forecasts large stocks of costly inventory must be kept at each stage of the supply chain to compensate for the uncertainties of customer demand. If there are insufficient inventories, customer service suffers because of late deliveries and stock outs. This is especially hurtful in today's competitive global

business environment where customer service and on-time delivery are critical factors.

2.3 Sale forecasting management process

Mentzer & Bienstock (1997) say that the sale forecasting management process consists of four main things, which are management, systems, techniques, and users. For management, it concentrates on many approaches that can drive the forecasting process to move on effectively. Normally, it would be top down and bottom up approaches that are selected as the management perspective. For techniques, these can be divided into two mains parts, which are quantitative (e.g. time-series, regression) and qualitative. For sale forecasting system, this is about the analysis and communications template that is laid over the sales forecasting management processes. The circle diagram below shows the overview of the sales forecasting management process.

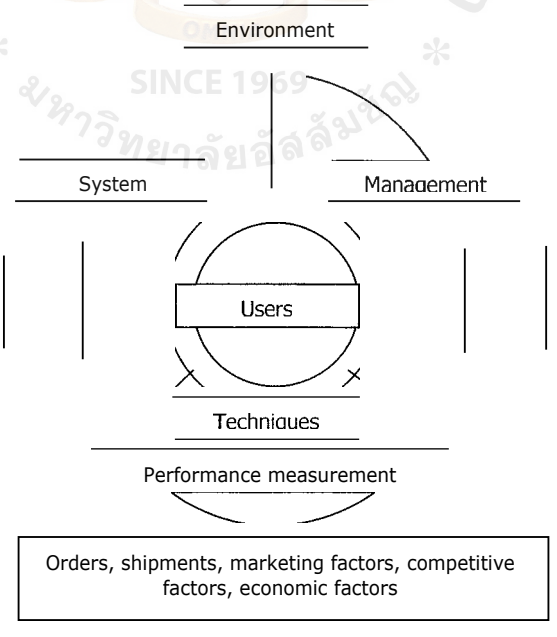


Figure 2.1 Sale forecasting management process

In the outer ring, the environment would encompass the availability of a history of orders, shipments, or demand that is the data that can be used to help in determining sales forecasts. The state of the economy and the level of competition in the industry and the supply chain as well as possible competitive response to company marketing policies e.g. advertising, also are factors that affect the sales forecasting process.

2.3.1 Management:

Overview of Top-down and Bottom-up

There exists great consensus amongst authors about the conceptualization and operational of the Top-Down (TD) and Bottom-Up (BU) sales forecasting approaches. For example, according to Lapide (1998), under the TD approach, sales forecasting is done first by aggregating all individual items, and then by disaggregating these aggregate data into individual items again, generally based on the historical percentage of the item within the total group. In this sense, Schwarzkopf *et al.* (1988) point out that in the TD approach is primarily forecasting the aggregate total and the subsequent disaggregation is done based on the historical proportions of each individual item. As regards the BU approach, each one of the individual items is forecasted separately and then all the forecasts are summed up in case an aggregate forecast for the group is deemed necessary (Lapide, 1998). In other words, under the BU approach, the forecaster prepares first the forecasts for each individual item, aggregating them thereafter under the interest level of the analysis (Jain, 1995).

2.3.1.1 Top-Down Approach

According to Tomkin (2005), Top Down entails demand planning at a summary level and a subsequent allocation or 'pushing down' of demand to products and stores to support replenishing and purchasing activity. The Bottom Up methodology involves the generation of forecasts at the lowest possible level (e.g. product by location) to support execution activity and the aggregation of these forecast to support higher level demand planning requirements.

Mentzer & Bienstock (1997) say that, in detail, top-down management would be an approach driven by the business / profit plan. They concentrate primarily on the profit plan with little recognition of the impact of economic factors, marketing efforts, or stage in the product life cycle of their product mix. Forecasting is seen principally as a tactical function i.e. "How do we obtain the sales this month to meet the plan?" with little impact on the development of their business plan. Moreover, it can be stated that this approach ignores what actually was demanded.

In the case of bottom up, the concept would take data from the SKU level to incorporate that forecast into forecasting demand. Furthermore, this approach would focus on real demand or captured demand that cannot be fulfilled. Or it can be concluded that the bottom up approach would be a forecasting level which is started at the SKU/item level before seeing on overview of the figures. The top down approach considers forecasting at a higher level (product group) before separating the proportions to the SKU level.

Tomkin (2005) shows in the picture below how top down and bottom up approaches can be operated. They can be adjusted with forecasting at product group level as top down and at SKU level as bottom up by noticing the line of forecasting. The step

would show forecasting at DC (distribution center level) which can be indicated as aggregated level or product group level. On the other hand, the forecasting process at store level can be interpreted as the SKU level.

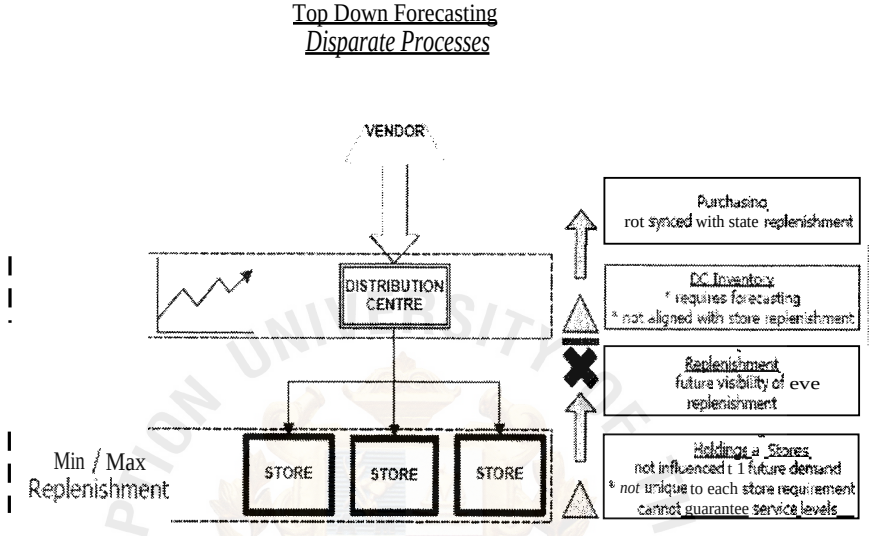


Figure 2.2 Top down Forecasting flow

A “Min / Max" approach is typically relied upon in absence of a store level forecast. The Min / Max approach simply looks at available stock to determine a replenishment requirement. What is going to be sold tomorrow, or even later that day, is not considered. By forecasting at a store level, both stock position *and* future customer demand can be used to determine replenishment requirements. Having future visibility of demand and replenishment requirements by week or day into the future is essential for maximizing sales potential and avoiding lost sales, especially for promotional or seasonal lines where sales from one week to the next can vary dramatically. An effective store level or Bottom Up forecasting approach:

- Reduces missed sales by pre-positioning stock prior to customer demand, and
- Is essential for seasonal and promotional sales, noting that Min / Max techniques do not recognize weekly or daily sales variations into the future.

However, the top down approach also can contribute some good points, as follow:

- Time has been saved in making decisions
- It suits the data of sales patterns which have been low on variation and have no seasonality. Once the company applies this approach to such a kind of product, it will help to improve the accuracy.

2.3.1.2 Bottom-Up Approach

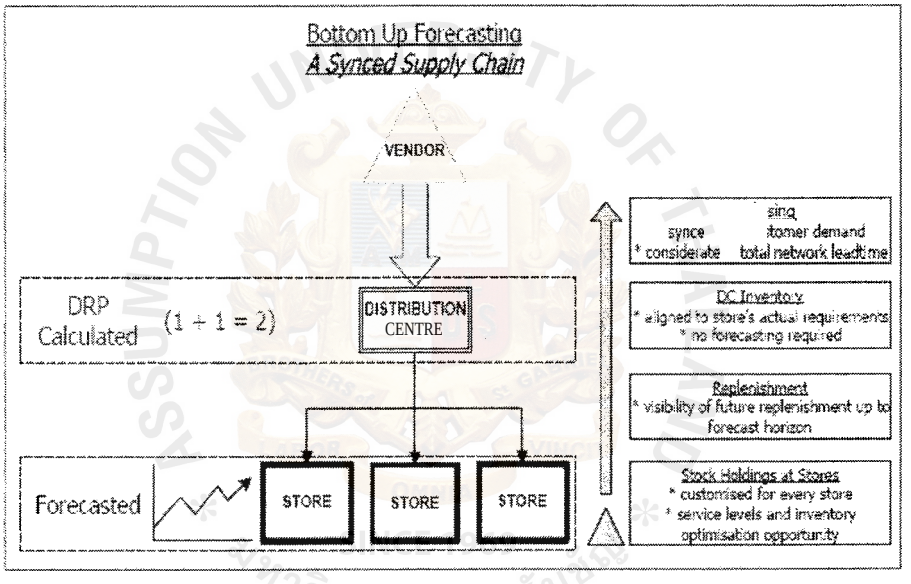


Figure 2.3 Bottom up forecasting flow

By planning demand at a store/SKU level, there is no need to forecast at distribution centers, nor estimate purchase order requirements. Distribution Replenishment Planning (DRP) can be used to roll up store level replenishment requirements to the distribution centre or warehouse level, thereby removing assumptions and aligning stocking, replenishment and purchasing through an integrated planning methodology. Error associated with translating a sales forecast at an aggregate level to store replenishment requirements is eliminated. Importantly, alignment of supply chain processes delivers a 'single set of numbers' for sales,

finance and supply chain functions. An effective store level or Bottom Up forecasting approach:

- Supports full Distribution Replenishment Planning
- Integrates replenishment, purchasing and forecasting processes
- Reduces error at each node in the supply chain, and
- Coordinates management control with greater precision and less effort.

2.3.2 Techniques:

For Stevenson (1999) the forecasting technique can be divided into two approaches which are "quantitative" and "qualitative". Qualitative techniques would allow for the use of opinion or information that is often difficult to quantity, including executive opinion, sales force estimates, consumer or market research, outside opinion, and Delphi method. In the quantitative approach, a time series analysis is useful in short-term and medium-term forecasting and forms the basis for short and medium term plans. And this model generally uses the historical data to predict the demand, which contrary to causal models. Causal models are used for medium term plans and identify the underlying relationships or causes that affect demand.

Figure 2.4 below shows a summary of forecasting techniques;

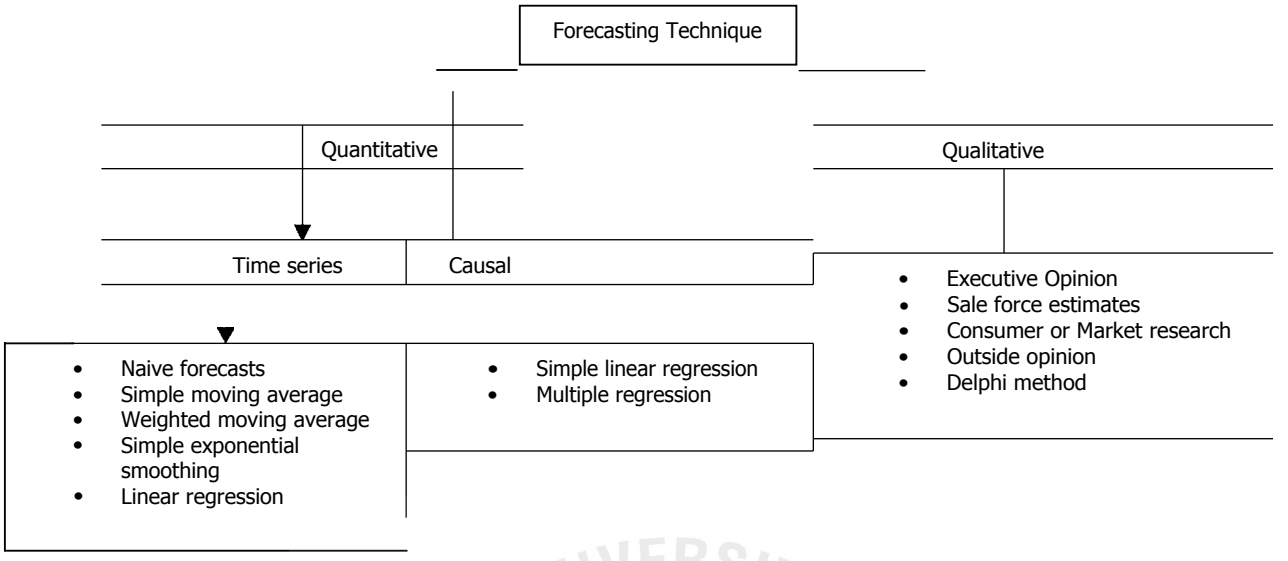


Figure 2.4 The Chart of Forecasting techniques

2.3.2.1 Simple Exponential Smoothing

According to Gijbels *et al.* (1999), Simple Exponential Smoothing (SES) is the most commonly used model in sales forecasting. Its main advantages are related to the fact that it is a non-parametric model based on a simple algebraic formula that quickly enables the updating of the local level estimation of the sales data. In the last twenty years, some researches were carried out to better comprehend and describe the SES and its extensions from a statistical perspective. For example, Chatfield *et al.*, (2001) compare a variety of potential Exponential Smoothing models derived from autoregressive moving averages, structural models and non-linear dynamical spaces and conclude why SES and its extensions are robust even despite changes in the variance of the historical data. Blackburn *et al.*, (1995) show that the SES may introduce spurious autocorrelations in series, that the trend component may have been removed, and that these autocorrelations would depend upon the average age of the data and of the smoothing constant value. Finally, Gijbels *et al.*, (1999) compare the SES with the Kernel Regression enabling a better understanding of the equivalence

and best adequacy between both approaches. The SES and its extensions were developed in the late 1950s by Brown, Winters, and Holt, amongst other authors Chatfield *et al.,* 2001). Among its main premises and limitations, it is worth highlighting that in the SES, eventual growth or decrease trends, seasonal fluctuations and cyclical variations are not considered. For example, the sales forecast for a random variable *X* with SES is as follows:

=

Where Ft is the forecast of *X* for period *t* , *X*t–1 is the actual sales of *X* in period t-1, Ft-1 is the forecast of *X* in period t-1, and a is the smoothing constant, which ranges from 0 and **1.**

2.3.2.2 Moving average

The demand for most items changes over time, so that a certain amount of historical data is irrelevant to the forecasts. One way is to ignore old data and only use the most recent values in forecasts. This is the principle of the moving average method.

Formula:

$$MA_n = \frac{\sum_{i=1}^{n} D_i}{n}$$

Where i = "age" of the data **(I** = 1,2,3,...)

n = number of periods in the moving average

Di = demand in period i

This method responds to changing demand, with a high demand moving the forecast upwards. The rate at which a method responds to changing demand can be adjusted by using an appropriate value of N (Waters, 1999).

However, a large value of N takes the average of many observations, and the forecast is unresponsive. The forecast will smooth out random variations, but will be slow to follow genuine changes in demand. Also, a small value for N gives a responsive forecast, which quickly follows genuine changes in demand, but may be too sensitive to random fluctuations (Waters, 1999).

2.3.2.3 Simple Linear regression

This method is a useful tool for modeling when there is an increasing or decreasing trend in the data. The procedure involves the development of a linear relationship between a dependent variable of interest, such as sales revenues, profits, and the time period or the independent variable.

Formulas:

$$Y = a + bx$$

Where a is a constant, the intercept on the y axis

b is a constant, the slope of the line

X is the time, or the independent variable

And Y is the predicted value of the dependent variable

Mathematical models are premised on the assumption that past events are reasonable predictors of future activity. The models assume that the historical sales environment is representative of the future sale climate. If factor such as advertising, competitors behavior, product design, technology or needs of customers have changed, the developed model may not be representative of the future (Water, 1999).

2.3.2.4 Weighted moving average

Stevenson (1999) offers a refinement of the moving average approach, which is to weight the older or, more commonly, the newer data more heavily, rather than use equal weights. The moving average method can be adjusted to more closely reflect fluctuations in the data. In the weighted moving average method, weights are assigned to the most recent data according to the following;

Formulas:

$$WMA_n = \sum_{i=1}^{n} WiDi$$

Where Wi = the weight for period i, between

$Wi = 1.00$

Determining the precise weights to use for each period of data usually requires some trial-and-error experimentation, as does determining the number of periods to include in the moving average. The advantage of a weighted moving average over a simple moving average is that the weighted moving average is more reflective of the most recent occurrences. If the most recent periods are weighted too heavily, the

forecast might overreact to a random fluctuation in demand. If they are weighted too lightly, the forecast might under-react to actual changes in demand behavior.

2.3.3 Performance measurement:

Finch and Luebbe (1995) say that the forecasting evaluation can indicate the performance accuracy of figure which the teams can successfully propose. On the other hand, forecast accuracy is defined as how close the forecast of demand matches actual demand and it is usually quantified using measures of forecast error. The forecast error of different forecasting techniques can be measured and compared, making it possible to identify the best technique for a specific situation. Forecast error is determined by calculating the difference between the actual demand and the forecast demand for a given period using the following formula;

$$E_t = At - Ft$$

Where Et is the error for time period t, At is the actual demand for period t, and Ft is the forecast of the demand for period t. Forecast error will be positive when the forecast is too small and negative when the forecast is too large. By using the forecast error, several procedures for measuring forecast can be defined.

There are different measures of forecasting error. Therefore, the popular models selected are MFE (Mean forecast error), MAD/MAE (Mean absolute deviation or Mean absolute error), MSE (Mean square error), and MAPE (Mean absolute percent error).

2.3.3.1 Mean Forecast Error

The mean forecast error (MFE) is a common approach to measuring forecast bias. The MFE is the average error over time, and the formula for MFE is:

Formula:

$$MFE = \frac{\sum_{t-1}^{n} (At - Ft)}{n}$$

Where n = the number of periods under consideration

t = the period number

At = actual demand in period t

Ft = the forecast for period t

Et = the forecast error for period t

RSFE= running sum of forecast error

The running sum of forecast error (RSFE) is also sometimes used as a measure of forecast bias. It is obtained by summing the errors for all the periods in which forecasts were determined. Obviously, the closer the RSFE is to zero, the better.

The bias that exists in the forecasting approach is represented by a positive or a negative MFE, so the MFE is sometimes called the "bias". Thus, if the MFE is negative, forecasts are, on average, too large; if the MFE is positive, forecasts are, on average, too small. Because the errors in an

unbiased forecast sum to zero, the closer the MFE is to zero, the better the forecast.

2.3.3.2 Mean Absolute Deviation or Mean Absolute Error

The MAD or MAE is a common measure of the magnitude of the forecast error. The MAD provides a measure of the size r magnitude of the error, without considering whether the error is positive or negative. To compute the MAD, we determine the absolute value of each error, |At – Ft|, and then we calculate the average of the absolute errors. The smaller the average magnitude of the error, the smaller the MAD value. The formula for MAD is:

Formula:

$$MAD = \frac{\sum_{t-1}^{n} |At - Ft|}{n}$$

Where I I = absolute value

2.3.3.3 Mean Squared Error

An alternative measure of the magnitude of the forecast error is the mean squared error (MSE). To calculate the MSE, we first determine the error for each period, square those values, and sum them. Then we divide by the number of values (n) minus 1. The formula for MSE is:

Formula:

$$MSE = \frac{\sum_{t-1}^{n} (At - Ft)'}{n}$$

2.3.3.4 Mean Absolute Percent Error

The next measure of forecast accuracy uses calculations of the percent error, the absolute error divided by the actual demand for each time period. This measure, the mean absolute percent error (MAPE), does not measure the bias or the average magnitude of the error, but instead, computes an average of the absolute values of the errors as a percent of the demand. This is quite useful because often the size of the error relative to the size of the demand is more important than the size of the error alone.

The MAPE is calculated by dividing the absolute error for each period by the demand for each period. The formula for computing the MAPE is;

Formula:

$$MAPE = \frac{100}{n} \sum_{t-1}^{n} \left| \frac{Ft}{At} \right|$$

Other consideration with Safety Stock

(Chockalingam, 2003)

The forecast accuracy also has been linked with aspects as follow;

Safety stock is defined as the component of total inventory needed to cover unanticipated fluctuation in demand or supply or both.

As the inventory needed to defend against a forecast error.

Hence Forecast error is a key driver of safety stock strategies.

2.4 Best Practices:

1st Topic: REVISITING TOP-DOWN VERSUS BOTTOM-UP FORECASTING

What is the best approach to sales forecasting'? Is it a top-down approach? Is it where national brands are proportioned down to individual product items per location forecasts? Or is it a bottom-up approach, where item per location forecasts are aggregated to create a national brand forecast. Various opinions support either approach. Proponents of top-down forecasting favor smoothing lower level data by aggregating it so that one can develop a better fitting model (the top level model will reflect a better R= value than lower level models). It is also felt that top-down models often reflect better accuracy for top-level forecasting. The problem is top-down models typically do a poor job of forecasting at lower forecast levels (e.g. at the item per location level). The reason: aggregated data at the top level is an artificial representation of the true nature of the business because such data does not typically reflect sales low level "peaks and valleys," which are canceled by aggregation.

Proponents of bottom-up forecasting point to the fact that one can achieve forecasts better mean absolute percent error (MAPE) value at the lower level (see Gordon, Morris, and Dangerfield, 1997). This is due in part to the fact that the lower level models reflect the actual nature of the business. A bias also has been documented in regression coefficients when aggregated data is used. While this supports a bottom-up approach, bottom-up forecasting often has very poor accuracy at higher forecast levels. This may he a result of forecast error at intermediate (middle) levels accumulating as data moves up to higher levels.

The case study in this research is based on a small sample data set comprising real data that represents three forecast levels: 7locations, 2 items, and 1 brand. Four of the locations correspond to one item, and the remaining three locations correspond to the other item. Both items correspond to the same brand, and the result is shown as follows:

TABLE 2
COMP. RISONS OF MAPE ACROSS::FOREC AST LEVELS

Brand Item: Location									
Individual ES Model [2] w/o Seasonal Indices (a =.2)	20'		67			53	25	j	42
Individual ES Model with Seasonal Iodizes (a = .2	10			na	48	na	15	5	25
Bottom Up Model (Sum *Of* Individual ES Models with Seasonal Indices).	10		x,	na	na		na	no	no
Top-Down Modal (Proportion Breakup of Top-Level Mode: w/o Seasonal Indices)			84			'62	25	24	
Top-Down Mode: (Proportion Breakup of Top-Leval Model w/ Seasonal Indices)	no		21		48	50'	13`		
Top-Down Model (Proportion Breakup of Top-evel Model w/o Seasonal dices Modified by Low Level a c al Indices)	na	IL	18		42			-	21
Top-Down Medal ;Proportion Breakup of Top-Level Model w/ Seasonal Iodises Adjusted by Low Level Seasonal Indices Ratio) .	na		24	na	43		23		

Note: L MAPE = Mean absol te percent; error 2 ES 'Exponential smoothing

Best mode

best model = lowest MAPE

Figure 2.5 Comparison of MAPE across Forecast levels

Conclusion: Proposal to apply a hybrid approach

As the result from table 2 above shows, this case is using "exponential smoothing technique" to run the forecast, and Top-down fits with this kind of product, and the model concentrates on low seasonal factors. As this group of product has been showing a low value for seasonal variability, the forecasting at a high level

should possibly create more accuracy. In turn, the result shows the MAPE value at the lowest for applying this model. However, the bottom up approach can be suited to the situation of uniqueness in seasonality of each item/sku. The lower level forecasting might have been used instead, with bottom up to separate the forecasting at individual level. Finally, the main decision for selecting which approach would be selected depended on the "Company objective".

If the company uses forecasts to develop strategic plans and budgets, then top-down forecasting would be preferable. Conversely, if production and distribution schedules (tactical side of the business) are driven by forecasts, then bottom-up forecasting would probably be a preferred choice. There are, of course, many companies that generate one forecast by reconciling top-down and bottom-up forecasts.

Based on research conducted in a major consumer products company, a hybrid approach may be preferable. That is, a top-down model can he created and forecasts proportioned down to lower forecast levels by lower level models (lower level analyses). The purpose of this paper is to provide an overview of such an approach.

2nd Topic: THE JOURNAL OF BUSINESS FORECASTING, SUMMER 2006 (Lapide, 1998)

Top-down forecasting is extremely useful for improving the accuracy of detailed forecasts. As depicted in Figure 2.6, aggregated demand is less volatile than its individual components; so on a relative basis a forecast of the aggregate is more accurate than the forecasts of its individual components. This is due to the phenomenon of compensating errors where random errors and variations tend to cancel each other out. This is the principle behind the concept of Top-Down

forecasting where, rather than forecasting each component separately, it is better to first forecast the aggregated group and then disaggregate the resulting forecast to derive the forecasts of the individual components. The good news is that this principle can be leveraged for any type of aggregation, such as aggregations across products, sales channels (e.g., stores), geographies, and even time itself. However, as discussed in my summer 1998 JBF column, one of the things to be careful about is that Top-Down forecasting only makes sense when a top-level aggregated group is made up of components that have similar patterns of variation. That is because component forecasts are frequently derived by breaking down the top-level forecast using the proportions that the individual components represent of the total. When this is done, the pattern of variation of the aggregated group would be assumed for the individual components—and this may not always hold.

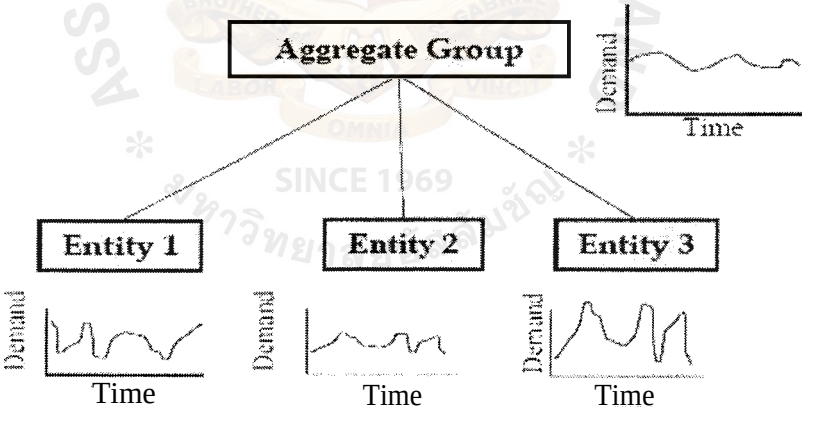


Figure 2.6 Sum up the demand from the lower level

The use of Bottom-Up forecasting is better for situations where the individual components have different patterns of variation. Under the concept of Bottom-Up forecasting, one forecasts the individual components separately and then adds the forecasts up to get the forecast for the aggregated group.

Conclusion:

Generally, Top-Down or Bottom-Up when used on an exclusive basis is not the best way to forecast. Often the aggregate group's Bottom-Up forecast can be improved by replacing it with a Top-Down forecast. The individual Bottom-Up component forecasts can be then improved by adjusting each, using correction factors derived from looking at the aggregated group's Bottom-Up versus its Top-Down forecast. (For example, if the Bottom-Up forecast predicts aggregate sales to remain flat, while the Top-Down forecast predicts it to grow by 10%, then the correction factor to apply to the bottom level forecasts would be 1.1). Thus, Top- Down in conjunction with Bottom-Up, and even Middle-Out is recommended.

Chapter III: Research Methodology

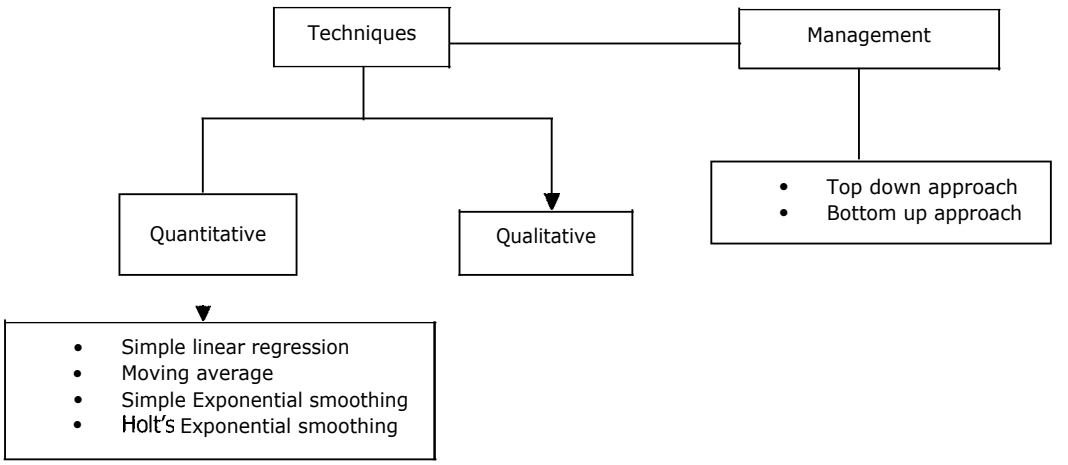


Figure 3.1 Chart of relationships between forecasting technique and management

From this chart, the research scope is to select an approach between top down and bottom up by testing the forecasting technique (quantitative approaches) by different methods and seeing the results with least errors.

3.1 Flow of Methodology Process:

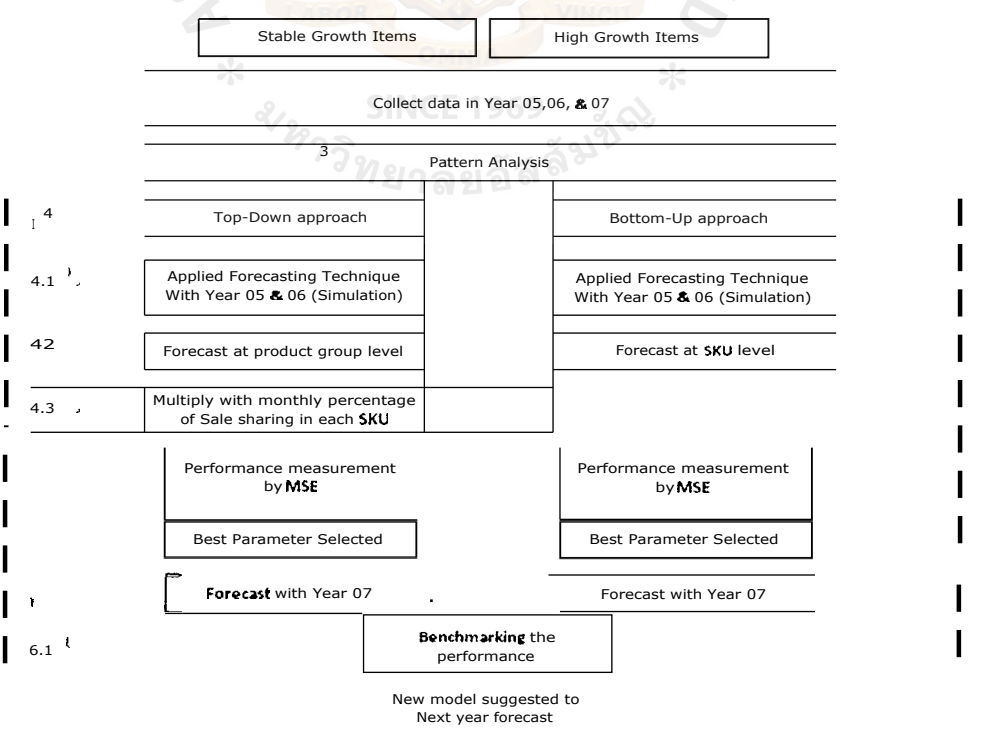


Figure 3.2 the flow of methodology process

Table 3.2 shows the process of methodology. Firstly, it starts with the product group selected. For this simulation, the testing has two groups of products which are new items with high growth, and an existing one with stable growth. Each group of products consist of 5 items or SKU. Secondly, the past sales record for each is collected for three years 2005-7. After that, all sales record data are analyzed for the patterns in term of "TREND" and "SEASONALITY". Regression analysis is used to detect the existence of the "TREND" pattern in sales while "SEASONALITY" is identified by manually visualizing the graphical plots of the sales against time.

In th graphical technique, the historical sales data in each year is analyzed, one by one, to see whether the movement has signals of seasonality or not. Fourthly, before the data is subject to Top-down and Bottom-up approaches, a suitable "forecasting technique" is selected along with pattern analysis (check with the quantitative model chart). For example, the data that has been showing the trend but does not have a seasonality pattern. It is subjected to "Holt's Exponential Smoothing" and the data which have neither trend nor seasonality uses simple exponential smoothing and moving average. Essentially, the range of data which has been used in this testing would be limited to two years, 2005-6.

Fifthly, the forecasting program is run and finds out the new forecasting figure with various types of degree of alpha, beta, and time series of moving average. To find out the best parameter, MAPE, MAD, and MSE are used to decide the best accuracy performance. Sixthly, after getting the best parameter, that parameter would be applied to the year 2007 to discover the best forecasting technique between Top-down and Bottom-up. The forecast measurement is then compared between the old forecasting model and the new model to see the difference or improvement

Chapter IV: Data Analysis

A. Existing Items: Stable Growth

4.1.1 Pattern Analysis:

The process starts with "Pattern analysis". The graph below is the way how to find seasonality patterns of computer label product which is item 42-342. The selling record in packs would be arranged for three years, 2005, 2006, and 2007.

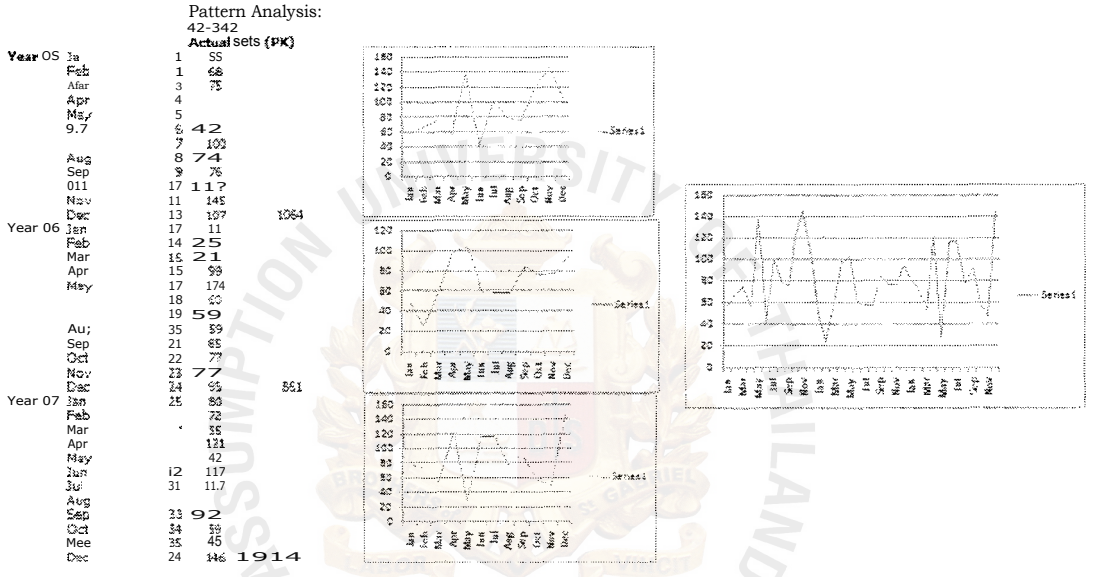


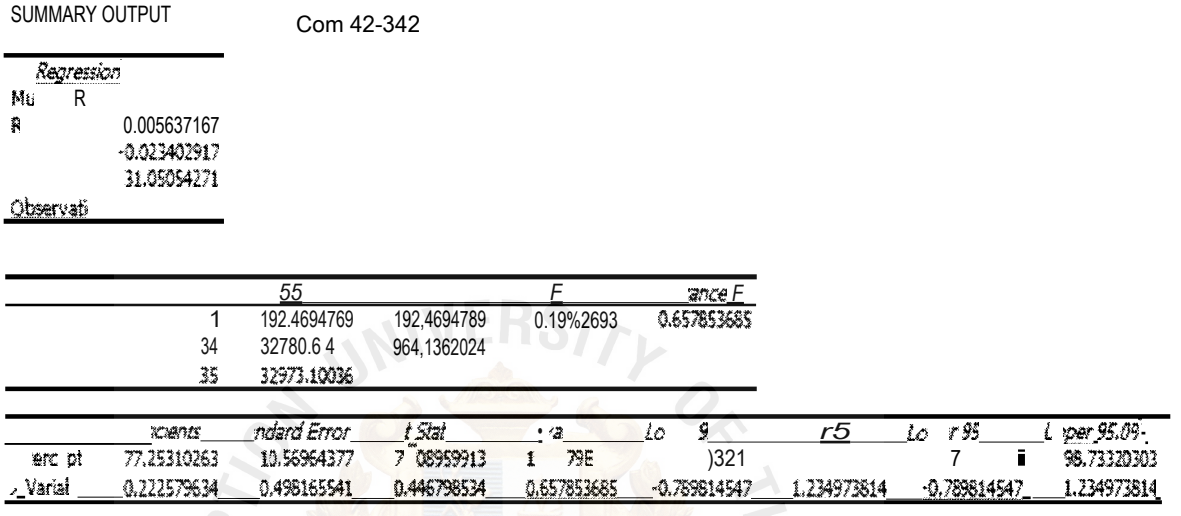
Figure 4.1 Pattern analysis of corn label 42-342

For seasonality proving, the graphical method is selected. The past three year records would be listed and generate the graph pattern one by one to see the difference. The result shows that in the May period sales have been increasing for year 05 and 06 but in year 07, the sales have been decreasing which is conveying a negative relationship. Moreover, the sales record during November is a totally different pattern in those three years. Therefore, it can be concluded that this product item does not have a "Seasonality Pattern".

After the data has been analyzed with the graphics then it is run with regression statistics to find the trend possibility. This one is data of an existing product which is "Computer label" and this item is 42-342. The yellow highlight

showed 0.446 of T-stat value. This means that there is little trend effect in the data pattern and the standard for comparing would be 1.96. If the T-stat value reaches 1.96 or over, it can be seen that those data have a trend.

The chart below shows the sample of Com 42-342 in Regression statistic.


SUMMARY OUTPUT

Com 42-342

Regression

Mu R	
R	0.005637167
	-0.023402917
	31.05054271
Observati	

	55		F	ance F
1	192.4694769	192,4694789	0.19%2693	0.657853685
34	32780.6 4	964,1362024		
35	32973.10036			

	icients	ndard Error	t Stat	: a	Lo 9	r5	Lo r 95	L iper 95.09
erc pt	77.25310263	10.56964377	7 08959913	1 79E	)321		7 i	98.73320303
,_Varial	0.222579634	0.498165541	0.446798534	0.657853685	-0.789814547	1.234973814	-0.789814547	1.234973814

Computer Label	T-Stat Value
Com 42-342	0,447
Com 42-632	-0.046
Com 42-132	1,373
Com 42-332	0.750
Com 42-812	-2.333

Figure 4.2 T-Stat value output of com label 42-342

The T-Stat value of "Computer Label" is shown on the summarized table above. The value shows that most of them are less than 1.96, from which it can be concluded that the trend possibility is very low, especially the main selling item Com 42-332 (whose value is just 0.75). (All regression tables are described in the APPENDIX).

The next step is that those five items are brought to test with a suitable forecasting technique. Stevenson (1999) classified the forecasting method structure into two types, which are time series and causal. In this case, the data pattern is time

series and does not have any effect from trend or seasonality. Therefore, the data is suitable for simulation in four ways which are Naive, Moving average, weighted moving average and simple exponential smoothing. For this testing, moving average and simple exponential smoothing are the forecasting techniques, applied.

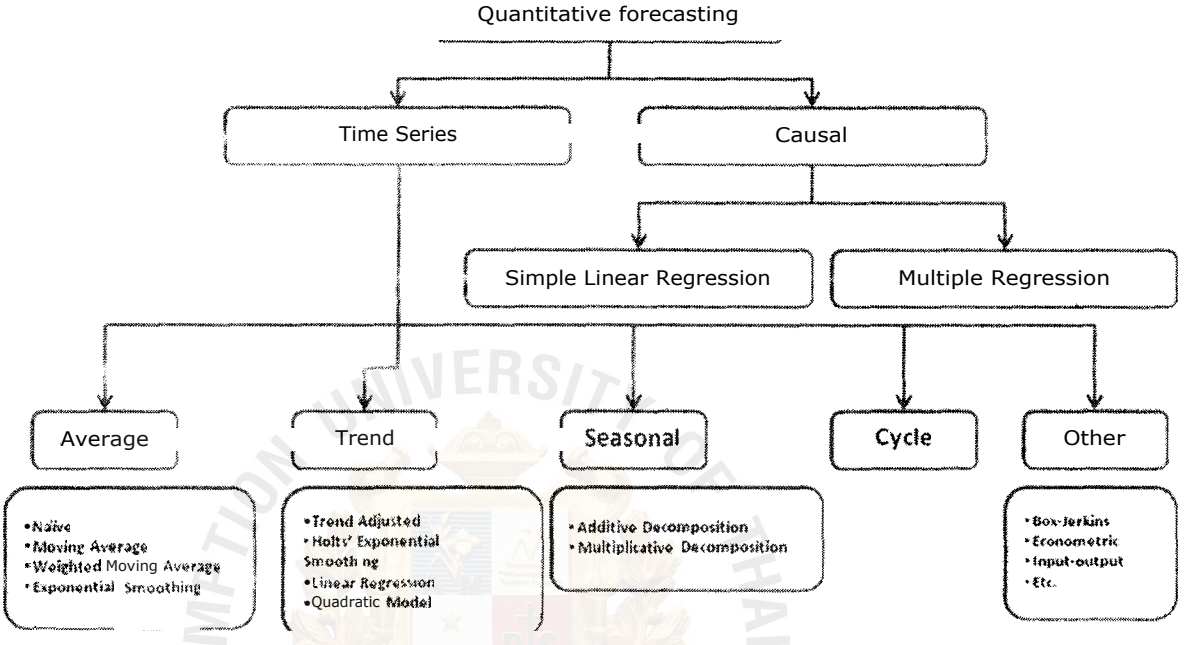


Figure 4.3 Classifying forecast methods

TOP-DOWN

4.1.2 Top-Down Approach applied: Simple Exponential Smoothing,:

The sales record of year 2007 is cut off which leaves only the data of years 2005 and 06. Then the formula is created by Excel program. The sheet is separated into simple exponential and moving average. For simple exponential, the level of alpha is running from *0.1 to 1.0* due to the testing for the data which has different variations.

Formula:

$$F_t = a \cdot X_{t-1} + (1- a) \cdot F_{t-1}$$

Existing it ms

Top-DOWN

Exponential Smoothing Testing:

Computer Label

			New Forecast degree alpha									
	No,	Actual (PK)	0.1	0.2	0.3	0.4	0.5	0.6	0,7	0.8		1
year 05	1 Jan	520	520	520	520	520	520	520	520	520	520	520
	2 Feb	472	520	520	520	520	520	520	520	520	520	520
	3 Mar	755	515	510	505	501	496	491	486	431	476	472
	4 Apr	742	539	559	580	602	625	649	674	700	727	755
	5 May	529	559	596	629	558	684	705	722	734	740	742
	6 Jun	802	556	582	599	606	606	599	586	570	550	529
	7 Jul	619	531	626	660	635	704	721	737	755	777	802
	8 Aug	995	585	625	647	658	661	659	654	646	634	619
	9 Sep	583	626	699	752	793	828	861	893	926	959	995
	10 Oct	574	631	696	731	749	756	754	746	732	711	683
	11 Nov	1,369	626	671	684	679	665	646	626	606	588	574
	12 Dec	991	700	811	889	955	1,017	1,080	1,146	1,216	1,291	1,369
Year 06	13 Jan	539	729	647	920	969	1,004	1,027	1,038	1,036	1,021	991
	14 Feb	324	710	785	806	797	771	734	689	638	587	539
	15 Mar	797	671	693	661	608	548	468	433	387	350	324
	16 Apr	705	684	714	702	684	672	673	668	715	752	797
	17 May	534	636	712	703	692	689	693	700	707	710	705
	18 Jun	748	671	676	652	629	611	597	584	569	552	534
	19 Jul	493	679	691	681	677	680	688	699	712	729	748
	20 Aug	699	660	651	625	603	586	571	555	537	516	493
	21 Sep	806	664	661	647	641	643	648	656	666	681	699
	22 Oct	552	673	690	694	707	724	742	761	778	793	306
	23 Nov	783	666	662	652	645	638	628	615	597	576	552
	24 Dec	1,124	677	686	691	700	711	721	733	746	763	783
	Total	17,155										

Figure 4.4 Top-down forecasting with exponential smoothing at group level

Due to the top-down approach applied to this data; the level of forecasting is set at "Product Group Level". This table shows that the new forecasting figure has been generated from the aggregate level. At the first period of simple exponential smoothing, it is assumed the forecast value is equal to the first period of actual demand. Therefore, the value shows as 520 packs to all levels of alpha.

After that, the new forecasting value at aggregate level is separated into SKU level by using two months proportions (percentage of sharing). The first month of both years at aggregate level is combined and divided by the sum amount of the first month sales of both years at SKU level. This calculation generates a percentage proportion for multiplying with the forecast value and finding the top-down forecasting value. For example; *58 packs of Jan 05 plus with 51 packs of Jan 06 and divided with the sum between 520 packs and 539 pack of Jan 05 and 06 respectively.* Finally, the percentage outcome is *10.29%* and this value is the proportion which is multiplied with the forecasting value. Moreover, each SKU level will get different

proportions because it depends on past sales records which item can possibly be generated.

Top-Down
Simple Exponential Smoothing
sku 1st
Com 42 342

					Forrest New									
			Actual (PK)	2mth Sharing	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0,9	
Year 05			58	10.29%	53	53	53	53	53	53	53	53	53	53
	2	b	68	11.7533	61	61	61	61	61	61	41	61	61	61
	3	Mar	75	8.74%	45	45	44	44	43	43	42	42	42	41
	4	Apr	57	10.7	56	60	62	65	67	22	73	75	78	65
	5	May	137	22.69%	127	125	143	549	155	163	164	165	166	168
	6	16n	42	6.58%	17	38	39	40	40	39	39	37	36	35
	7	Jul	103	11. %	43	69	94	95	101	103	103	105	111	514
	S	Aug	79	5.15%	45	Si	53	54	54	54	5.3	53	52	50
	9	Sep	76	10.83%	68	76	61	86	90	91	97	103	134	108
	10	Obi	119	17.43%	110	121	127	131	132	131	130	128	124	119
	11	Nov	145	10.33%	65	69	71	70	69	47	65	63	61	39
	12	Dec	107	9.54%	67	77	85	91	97	103	109	1.1.6	123	131
Year 06	13	Jan	31		73	57	91	300	103	106	107	107	135	102
	14	Fab	ZS		53	92	95	94	91	86	81	75	69	63
	13	Mar	65		59	61	SS	53	46	43	36	34	31	26
	16	Apr	99		74	77	76	74	72	72.	74	7.1	81	56
	17	May	141		158	162	160	157	155	157	159	161	16.1	163
	IS	Jun	82		44	44	43	41	44)	39	38	37	36	35
	19	Jul	59		57	93	97	97	97	96	100	502	104	107
	20	Aug	59		54	53	31	49	4a	47	43	44	42	40
	21	Sep	55		72	72	73	69	73	70	71	72	74	76
	12	Oct	77		116	120	121	121	126	129	133	1.36	136	140
	23	Nov	77		69	68	67	67	66	65	64	62	60	57
	24	Dec	95		65	65	56	67	66	69	73	71	73	75
			1,915	11%										

Figure 4.5 Separated Top-down forecasting with exponential smoothing into SKU level

4.1.3 Performance Measurement: Top-down Exponential Smoothing:

Formula:

$$MAPE = \frac{100}{n} \sum_{t-1}^{n} \left| \frac{At - Ft}{At} \right|$$

Top-Down

Forecast Accuracy Sy Simple Exponential Smoothing

Cons 42-342

	No.		0.1 NAPE	0.2 NAPE	03 NAPE	0,4 NAPE	0.5 NAPE	0.6 NAPE	0.7 NAPE	0.8 NAPE	0.9 NAPE	1 NAPE
Year 05	1	Jan										
	2	Feb	0.11	0.11	8.106	0,106	0,106	0.106	0.106	0.106	0,106	0,106
	3	Mar	0.40	0.40	0.409	0,415	0.421	0.426	0,432	0.438	0.443	0.449
	4	Apr	0.02	0.06	0.099	0.140	0.184	0.229	0,277	0.326	0.376	0.429
	5	May	0.07	0.01	0.041	0.090	0.132	0.167	0.195	0,215	0.226	0.229
	6	Jun	0.13	0.09	0,061	0.049	0.050	0.061	0.081	0.107	0.138	0.171
	7	Jul	0.17	0.10	0.056	0.021	0,007	0.031	0.055	0.081	0.111	0.147
	8	Aug	0.40	0.36	0.334	0.323	0,320	0.322	0.327	0.336	0.348	0.364
	9	Sep	0.11	0.00	0.071	0.129	0.180	0.226	0.272	0.318	0,366	0,418
	10	Oct	0.03	0,02	0.067	0.093	0,103	0.101	0.039	0.068	0,038	0,003
	11	Nov	0.55	0.52	0.513	0.517	0.527	0.540	0.555	0.569	0.582	0.591
	12	Dec	0.38	0.28	0,209	0.151	0.096	0.040	0,019	0.082	0.148	0.217
Year 06	13	Jan	0,483	0.722	0.871	0.971	1.041	1.087	1,110	1.107	1.076	1.015
	1-1	Feb	2,317	2,668	2.763	2.724	2.603	2,428	2,216	1.982	1.742	1.517
	15	Mar	0,035	0,004	0,050	0,127	0.213	0,299	0.377	0.444	0,497	0.535
	16	Apr	0.256	0.223	0.236	0.256	0,268	0.267	0.252	0,222	0,181	0.133
	17	May	0.496	0.552	0.532	0.509	0,502	0.510	0.526	0.542	0.548	0.538
	13	Jun	0.265	0,259	0.285	0.311	0,330	0.345	0.360	0,377	0.395	0.415
	19	Jul	0.646	0.676	0.652	0.642	0,649	0.669	0.696	0,728	0,768	0.815
	20	Aug	0.086	0,093	0,135	0.165	0.188	0.209	0,232	0.257	0.285	8.317
	21	Sep	0.156	0.160	0,178	0.184	0.183	0.177	0,166	0.153	0.135	0.111
	22	Oct	0,537	0.563	0,574	0.603	0.641	0.683	0,724	0,763	0.798	0.826
	23	Nov	0,110	0.114	0,128	0,137	8.116	0.160	0,178	0.201	0.229'	0,261
	24	Dec	0.317	0,307	0.303	0.293	0.283	0.272	0.261	0.247	0.230	0.210
		Total	35.28%		37.71	4%			41,32%	42		42,69%

Figure 4.6 Top down performance with exponential smoothing of computer label by MAPE

The table above shows the MAPE value which indicates the error percentage in each alpha value. In this case, the best alpha value which gave the lowest MAPE is 0.1. The formula of MAPE is from actual sale minus the forecasting value and divided by actual sale. Moreover, the report also adds other methods for comparing the accuracy, which are MAD (Mean Absolute Deviation) and MSE (Mean Square Error). The purpose of using these two methods, is concerned with the swing of sale data and error. This reason is the direct effect on inventory management. Therefore, the best selected parameter would be relatively relying on the MSE value.

Formula:

$$MSE = \frac{\sum_{t-1}^{n} (At - Ft)^2}{n}$$

Top-Down

Forecast Accuracy By Simple Exponential Smoothing

Corn 42-342

	No.		0.1 tiSE	0.2 MSE	0.3 MSE	0.4 MSE	03 MSE	0.6 MSE	0.7 MSE	0.8 NSF	0.9 MSE	1 MSE
Year 05	1	Jan										
	2	Feb	23,55	23,55	23.55	23.55	23.55	23,55	23.55	23.55	23,55	23.55
	3	Mar	52.16	52.16	52.16	52.16	52.16	52.16	52.16	52.16	52.16	52.16
	4	Apr	886.41	911.75	937.45	963.51	989.92	1,016.69	1,043.81	1,071.30	1,099, 11	1, 127,33
	S	May	1,37	11.13	31.42	63.64	109.29	169.90	247.10	342,55	458.00	595,26
	6	Jun	101,34	3,30	32.22	152.35	322.29	526.16	714.75	866.91	960,84	981.67
	7	Jill	28.78	13.35	6.64	4.31	4.37	6.51	11.43	20.19	33.60	51.69
	8	Aug	285.18	108.37	31.77	4.34	0.46	9,54	29,66	64.63	122.64	215.36
	9	Sep	998.14	802.50	701.38	655.46	642,51	650,12	672,23	707.53	758.57	831.26
	10	Oct	68.50	0.13	28.85	96.90	186.72	295,97	427.28	585.04	775.47	1,008.52
	11	Nov	87.21	3.45	64.65	124.62	151.84	145,67	113.26	65.86	20.06	0.11
	12	Dec	6,478.60	5,741.48	5,544.91	5,621.57	5,843.44	6,143,41	6,479.65	6,818.45	7,126. 33	7,366.82
Year 06	13	Jan	1,635.94	892.82	501.14	260.56	104.91	18.04	4.23	76.70	251.68	543.41
	14	Feb	596,29	1,334,76	1,940.32	2,414.49	2,776.49	3,026.74	3,152.28	3,136.01	2,965, 10	2,639,07
	15	Mar	3,394,01	4,501,00	4,827.17	4,690.66	1,285.26	3,728.47	3,104.84	2,483. 24	1,919.86	1,455,69
	16	Apr	4,61	0.07	9.33	59.37	168.15	330.80	527.31	730,39	913,32	1,057.64
	17	May	639.37	487,60	545.99	642.19	704.74	698,86	618.76	482.34	321,92	172,53
	18	Jun	2,663.59	3,306.26		2,808.40	2,726.95	2,815.85	3,000.82	3,181,70	3,253,38	3,133,18
	19	Jul	252,08	240.64	292.68	347.44	391.77	429.07	466.91	511.07	563.05	619,37
	20	Aug	1,447.56	1,582.80	1,473.46	1,425.96	1,460.34	1,549.96	1,676.24	1,836. 74	2,041,17	2,302.91
	21	Sep	25.49	33.30	63.10	93,91	122,33	151.81	136.10	228.11	230.91	349.03
	22	Oct	175.93	185.26	228.50	246,66	242.70	225,92	200.83	168.97	131.42	90.03
	23		1,705.75	1,876.70	1,949,01	2,147,76	2,431,06	2,756,09	3,098.56	3,440.46	3,760.99	4,032.78
	24	Dec	71.69	77.62	97,79	111,89	127.70	151.77	188.29	210.89	313.03	407.29
		Total		964.78	976.26	1,000.51	1,013.04	1,083.61	1,132,18	1,179,77	1,223.75	1,263.33

Figure 4.7 Top down performance with exponential smoothing of computer label by MSE

The data result above shows the MSE value which can be derived from Corn 42-342 which is in the computer label group and has the lowest score indicated at alpha 0.1. The value is 940.15, which is the best.

4.1.4 Top-Down Approach applied: Moving Average:

For moving average, the moving time decided is *2 months to 12 months.* The reason behind this method is that the period of forecasting is 24 months. As a Top-down approach, this technique is applied at product group level.

Formula:

Where i = "age" of the data (I = 1,2,3,...)

n = number of periods in the moving average

Di = demand in period i

Existing Items:
Top-DOWN
Moving Average Testing:
Computer Label

				breast New										
	No.		Actual (PK)	2 mth	3 mth	4 mth	5 mth	6 mth	7 mth	8 mth	9 mth	113 mth	11 mth	2 mth
Year 05	1	Jan	520	-										
	2	Feb	472											
	3	Mar	755	496	-									
	4	Apr	742	613	532									
	5	May	529	748	656	622								
	6	Jun	802	635	675	624	603							
	7	Jul	619	665	691	707	660	536						
	8	Aug	995	710	650	673	689	653	634		-			
	9	Sep	633	807	805	736	737	740	702	679	-			
	10	Oct	574	839	766	775	726	728	732	700	680			
	11	Nov	1,359	629	751	715	735	700	706	712	666	669		
	12	Dec	99 1	971	875	905	848	840	796	789	785	754	733	-
Year 06	13	Jan	539	1,180	978	904	922	872	862	620	811	806	775	754
	14	Feb	324	765	966	868	631	859	824	321	789	784	782	756
	15	Mar	797	431	618	806	759	747	782	762	766	742	742	743
	16	Apr	705	560	553	663	804	756	754	734	766	769	747	747
	17	May	534	751	609	591	671	783	757	746	775	760	763	744
	18	Jun	748	620	679	590	580	648	751	729	724	751	739	744
	19	Jul	493	641	663	696	622	608	663	751	731	726	751	740
	20	Aug	699	621	592	620	655	600	591	641	722	707	705	729
	21	Sep	806	596	647	613	636	663	614	605	648	720	707	705
	22	Oct	552	752	666	686	656	66-4	6683	638	627	664	728	715
	23	Nov	783	679	686	637	660	639	643	657	629	620	653	713
	24	Dec	1,124	668	714	710	667	580	659	665	680	644	635	664
			17,155											

Figure 4.8 Top-down forecasting with moving average at group level

Finally, the results showed that the selling units in March are 496 packs which are found from the summing of 520 and 472 and divided by 2, as an example.

Then each month of forecasting value is multiplied by the percentage proportion (as mentioned in simple exponential) to find the forecasting value at down level. For example, the forecasting value of March at 2 months period would be 43 packs which are calculated from 8.74% multiplied by 496 packs at aggregate level.

Existing Items:
Top-DOWN
Moving Average Testing:
Corn 42-342

sku 1st			Actual (PK)	2mth Sharing	Forcast New 2 mth	3 mth	4 mth	5 mth	6 mth	7 mth	8 mth	9 mth	10 mth	11 mth	12 mth
	No.														
Year 05	1	Jan	58	10.29%	-	-	-	-	-	-	-	-	-	-	-
	2	Feb	68	11.75%	-										
	3	Mar	75	8.74%	43	-									
	4	Apr	57	10.76%	66	63									
	S	May	137	22.69%	170	149	141								
	6	Jun	42	6.58%	42	44	41	40		-					
	7	Jul	100	14.28%	95	99	101	94	91						
	8	Aug	79	3.15%	58	53	55	56	53	52					
	9	Sep	76	10.83%	87	87	80	80	30	76	74	-			
	10	Oct	119	17.43%	146	133	135	178	127	128	122	118			
	11	Nov	145	10.33%	65	73	74	76	72	73	74	71	69		
	12	Dec.	107	9.54%	93	83	86	81	80	76	75	75	72	70	
Year 06	13	Jan	51		121	101	93	95	90	89	34	83	83	80	73
	14	Feb	25		90	113	102	98	101	97	96	93	92	92	69
	15	Mar	61		38	54	70	66	65	63	67	67	65	65	65
	16	Apr	99		60	60	71	87	82	81	84	82	83	80	80
	17	May	104		170	138	134	152	179	172	170	176	172	173	169
	18	Jun	60		41	45	39	33	43	49	48	48	49	49	49
	19	Jul	59		92	95	99	89	87	95	107	104	104	107	106
	20	Aug	59		51	48	51	53	49	48	52	59	58	57	59
	21	Sep	35		65	70	67	69	72	67	65	70	73	77	76
	22	Oct	77		131	116	120	114	116	119	111	109	116	127	125
	23	Nov	77		70	71	66	68	66	67	59	65	64	68	74
	24	Dec	95		64	68	68	64	65	63	63	65	61	61"	63
			1,915												

Figure 4.9 Separated Top-down forecasting with moving average into SKU level

4.1.5 Performance Measurement: Top-Down Moving Average:

In the case of moving average, three methods also have been applied, which are MAPE, MAD, and MSE. The following table shows the results of accuracy: the best value of moving average under Top-down approach would be 40.84% at five months moving average.

Top-Down
Forecast Accuracy By Moving Average
Corn 42-342

	No,		2 mth MAPE	3 mth MAPE	4 mth NAPE	5 mth MAPE	6 mth MAPS	7 mth MAPE	8 mth MAPE	9 mth MAPS	10 mth MAPS	11 mth MAPE	12 mth MAPS
Year 05	I	Jan											
	2	Feb	-										
	3	Mar	0.42										
	4	Apr	0.16	0.10	-								
	S	May	0,24	0.09	0.03								
	6	Jun	0.00	0.06	0.02	0.05							
	7	Jul	0.05	0,01	0.01	0.06	0.09						
	8	Aug	0.27	0.33	0.31	0.29	0.33	0.35		-			
	9	Sep	0.15	0.15	0.05	0.05	0.05	0.00	0.03				
	10	Oct	0.23	0,12	0.13	0.06	0.06	0.07	0.02	0.01			
	11	Nov	0.55	0.47	0,49	0,48	0,50	0,50	0,49	0,51	0,52		
	12	Dec	0.14	0.22	0.19	0.25	0.25	0.29	0.30	0.30	0.33	0.35	
Year 06	13	Jan	1.40	0.99	0.84	0.88	0.77	0.75	0.67	0.65	0.6-4	0.58	0.53
	14	Feb	2.57	3.5.1	3.05	2.88	3.01	2.85	2.84	2.68	2.66	2.65	2.53
	15	Mar	0.38	0,11	0.16	0.09	0,07	0.12	0.09	0,10	0,07	0.07	0,07
	16	Apr	0.39	0.40	0.28	0.13	0.17	0,18	0.15	0.17	0.16	0.19	0.19
	17	May	0.64	0.33	0.29	0.46	0.72	0.55	0.63	0.69	0,66	0.66	0.62
	18	Jun	0.32	0.26	0.35	0.36	0.29	0.18	0.20	0.21	0.18	0.19	0.18
	19	Jul	0.56	0.61	0.69	0.51	0,47	0,61	0.82	0.77	0,76	0,32	0.79
	20	Aug	0.14	0.18	0.14	0.09	0.17	0.18	0.11	0.00	0.02	0.02	0.01
	21	Sep	0.24	0.13	0.21	0.19	0.15	0.72	0.23	0.18	0.08	0.10	0.10
	22	Oct	0.71	0.51	0.55	0.49	0.51	0.55	0.45	0.42	0.50	0.65	0.62
	23	Nov	0.09	0.03	0.15	0.12	0.15	0,13	0.11	.3.16	0,17	0,13	8.05
	24	Dec	0.33	0.28	0.23	0.33	0.31	0.33	0.33	0,31	0.35	0.36	0.33
		Total	45.31	42,74	41.15	40.84	44,91	46,34	46.69	7			50,25

Figure 4.10 Top down performance with moving average of computer label by MAPE

Top-Down
Forecast Accuracy By Moving Average
Con? 42-342

	No.		2 mth MSE	3 mth 115E	4 mth MSE	5 mth 1.158	6 mth 145E	7 mth MSE	8 mth 1.158	9 mth 1158	10 mth 1158	11 mth 1158	12 mth
Year 05	1	Jan											
		Feb											
		Mar	989.92										
	4	Apr	83.78	3171									
	5	May	1,077,19	141,27	17.32								
	6	Jun	0.03	5.99	0,80	5.15							
	7	Jul	23.43	1.43	1,20	31.60	80.07						
	8	Aug	456.11	691.30	596,09	532.42	677.53	760,50					
	9	Sep	128.84	124.73	13,52	14.44	16,97	0.00	6.23				
	10	Oct	722.74	197.63	244.53	49.78	56,69	67.14	6.35	0.91			-
	11	Nov	6,431.18	4,564.04	5,037,68	4,793.81	5,297,81	5,208.89	5,118.41	5,521.43	5,778.62		
	12	Dec	212.40	563.37	435,56	693.77	732.83	980.77	1,021.45	1,044.65	1,246,39	1,394.18	-
Year 06	13	Jan	5,011,72	2,501.69	1,800.65	1,963.50	1,5 ,78	1,449.53	1,141.54	1,081.82	1,043,91	851.71	728.67
	14	Feb	1,187.13	7,804.21	5,902,11	5,253.03	5,729.57	5,136.08	5,089.23	4,558.43	4,184,04	4,442.29	4,047,12
	15	Mar	534.85	46.56	91,73	30.57	19.53	56.63	32.92	37.56	16,42.	16.38	17.13
	16	Apr	1,488.90	1,549.02	760,56	153.38	272.50	315.98	210.98	272.38	259.64	341,07	342.92
	17	May	4,403.74	1,153.98	904,95	2,325.88	5,565.71	4,581.09	4,301.76	5,160.02	4,661.60	4,781.61	4,187.01
	18	Jun	370.53	236.03	449,30	478.26	701.42	112,24	145.24	153.45	112.41	129.55	122.12
	19	Jul	1,068.29	1,277.62	1,643,54	394.73	780.78	1,278.65	2,333.50	2,075.01	2,012,87	2,338.38	2,188,55
	20	Aug	68,40	112.83	69,01	29.43	98,53			0.00	1,42	1,38	0.36
	21	Sep	426.06	229.16	330,35	265.92	179,57	347.47	33.6.54	225.43	51,97	74,74	78,45
	22	Oct	2,938.45	1,531.96	1,826,60	1,400.63	1,510.35	1,778.28	1,179.56	1,051.19	1,502,70	2,493.63	2,275.75
	23	Nov	50.29	41.00	129.51	82.57	126.55	105,34	69.58	150.74	174,36	94.39	12.65
	24	Dec	950.47	699.76	713.65	957.36	379,13	1.001,24	966.77	881.83	1,094,82	1,156,01	971.39
		Total	1.437.48	119.64	1,1048,72			1,370,18	1,378.64	1,430.99	1,602,93	1,393.55	1,247.69

Figure 4.11 Top down performance with moving average of computer label by MSE

Next step, after *the performance of moving average and simple exponential* under Top-down approach has been concluded; those values would be compared to discover the most accurate. Below is the chart that shows the result in term of MAPE, MAD, and MSE

4.1.6 Comparison Chart:

(This accuracy comparison is given, the MSE value is the best indicators)

As a Top-down method, only the alpha value needs to be selected as the forecasting would be done at product group level. Therefore, the MSE value would be summarized at each alpha value and the decision takes the best one. In this case, the alpha of 0.2 has been chosen because the highlighted items, which are Com 42-332. 42-132, and 42-632, are contributing a high percentage of sale at 32%, 23%, and 18% respectively. The MSE value showed the best lowest at alpha 0.2.

Simple Exponential Smoothing
MSE

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Com 42-342	940.15	964.78	976.26	1,000.51	1,038.04	1,083.61	1,132.18	1,179.77	1,223.75	1,263.33
Corn 42-632										
Com 42-132										
Corn 42-332										
Com 42-812	3,024.69	3,153.61	3,282.26	3,408.77	3,531.01	3,639.85	3,724.71	3,777.05	3,792.08	3,770.08

Figure 4.12 Comparison chart of MSE in each degree of alpha

Figure 4.13 summarizes the MSE value of moving average. And the selected one is 12 months moving average which shows the MSE of Corn 42-332, 42-132, and 42-632 at 7,184.72, 3,391.16, and 3,663.20 respectively.

Moving Average
MSE

	2 mth	3 mth	4 mth	5 mth	6 mth	7 mth	8 mth	9 mth	10 mth	11 mth	12 mth
Com 42-342	1,437.48	1,119.64	1,048.71	1,050.35	1,325.24	1,370.18	1,378.64	1,480.99	1,602.98	1,393.55	1,247.68
Com 42-632	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Corn 42-132	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Com 42-332	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cons 42-812	4,776.73	3,736.02	3,491.16	3,602.93	3,693.67	3,940.86	3,607.60	3,837.29	3,933.41	2,388.79	1,670.53

Figure 4.13 Comparison chart of MSE in each moving time

BOTTOM UP

4.1.7 Bottom-up Approach applied: Simple Exponential Smoothing:

For the bottom up approach, the main calculation is totally the same as the top down method. There are some different points which are that the forecasting technique is applied at SKU level and then the forecasting value in each SKU is summed all up to the aggregate level. Therefore, the formula of calculation would be fixed into each item to run the forecasting. In this case, the result shows that the new forecasting values of March, April, and June are 59, 61, and 60 packs respective at 0.1 degree of alpha.

Existing Items:
Bottom UP
Simple Exponential
Corn 42-342

	No.		Actual (PK)	Forcast New degree alpha 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0,9	1
Year 05	1	Jan	55	58	56	55	SE			58	58	56	55
	2	Feb	<ti	5S	55	56	SS	58	58		58	59	55
	3	Mar	75	59	60	61	62	63	54	65	66	67	69
	4	Apr	57	51	63	65.	67		71	72	73	74	75
	5	Slay	137	60	62	53	53	S3	62	Si		59	57
	6	Jun	42		77	55	93	'CO	107	114	122	129	137
		Jul			70	72	72	71	68	64	58	51.	42
	8		79	69	76	62	63	SS		89	91	95	100
	9	Sep	76		77	80	82	82	82	52	82	61	79
	10	Oct	119	71	76	73	73	79	79	7$	77	77	76
	11	Nov	145	75	SS	91	'95	99	103	107	111	115	119
	12	Dec	107	82	37	107	115	122	126	134	126	142	145
Year 06	13	Jan	51	85	93	107	112	115	116	115	113	111	107
	14	Fab	25	S1	89	90	57	63	77	70	63	57	51
	15	Mar	61	76	77	71	63	54	46	35			25
	15	Apr		74	73	SS	62	57	SS	54	SS	55	61
	17	May	104	77	79	77	77	78	61	65	80	95	s'9
	18	Jun		80	64	55	56	51	55	99	101	103	104
	19	Jul		76	73	72	77	75	74	72	68	64	60
		Aug	59		75	72	69	67	SS	63	'61	59	59
	21	Sep	95	74	72	68	65	63	61	60	59	59	59
	22	Oct		75	74	73	73	74	76	78	60	53	65
	2a	Nov			75	74	75	75	76	77	7$	77	77
	24		95		75	75	76	76	77	77	77		77
			1,915										

Figure 4.14 Bottom up forecasting of computer label with exponential smoothing at SKU level

The chart below shows the sum level of all forecasting values in each SKU.

Existing items
Bottom-UP
Simple Exponential Smoothing Testin
Computer Label

	No,		Actual (P/C.)	New Forecast degree alpha 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Year 05	1	Jan	520	-	-	-	-	-		-		-	
	2	Feb	472	520	520	520	520	520	520	520	520	520	520
	3	Mar	755	515	510	505	501	496	491	486	481	476	472
	4	Apr	742	539	559	530	602	625	649	674	700	727	755
	5	May	529	559	596	629	658	684	705	722	734	740	742
	6	Jun	802	556	582	599	606	606	599	585	570	550	529
	7	Jul	619	531	626	660	685	704	721	737	755	777	802
	8	Aug	995	585	625	647	658	661	659	654	646	634	$19
	9	Sep	683	626	699	752	793	828	861	893	926	959	995
	10	Oct	574	631	696	731	749	756	754	746	732	711	683
	11	Nov	1,369	626	671	634	679	665	646	626	606	588	574
	12	Dec	991	700	811	889	955	1,017	1,080	1,146	1.216	1,291	1,369
Year 06	13	Jan	539	729	847	920	969	1,004	1,1127	1,038	1,036	1,021	991
	14	Feb	334	710	785	$06	797	771.	734	689	638	587	539
	15	Mar	797	671	693	661	608	548		-433	387	350	324
	16	Apr	705	684	714	702	684	672	673	688	715	752	797
	17	May	534	686	712	703	692	689	693	700	707	710	705
	18	Jun	7-48	871	676	652	629	611	597	584	569	552	534
	19	Jul	493	679	691	681.	677	680	688	699	712	729	748
	20	Aug	699	660	651	625	603	536	571	555	537	516	493
	21	Sep	306	664	661	647	641	643	648	656	666	681	699
	22	Oct	552	673	890	694	707	724	742	761	778	793	806
	23	Nov	7S3	666	662	652	645	638	628	615	597	576	552
	24	Dec	1,124	677	686	691	700	711	721	733	746	763	783
			17,155										

Figure 4.15 the aggregate forecasting value from each SKU

4.1.8 Bottom-up Approach applied: Moving Average:

The moving average forecasting also has been applied in each SKU level.

Existing Items
Bottom-UP
Moving Average Testing:
Com 42-342

sku 1st		Actual (PK)	Forcast New 2 nth	3 mth	4 mth	5 mth	6 mth	7 mth	8 mth	9 mth	10 mth	11 mth	12 mth
Year 05	7 33n	58											
	2 Feb	68											
	Mar	75	63										
	4 Apr	57	72	67									
	S May	137	66	67	65								
		42	97	90	84	79							
	7 Ju	100	59	79	75	76	73						
	5 Aug	79	71	93	E4	52	50	77					
		76	90	74	90	&3	62	60					
	10 Oct	119	76	59	74	57	52	81	79	77			
		145	95	92	94	63	92	87	86	EA	81		
	12 Dec	107	132	114	105	104	94	100	94	92	90	67	
		51	126	124	112	105	104	96	101	96	94	91	89
	14 Feb	25	79	101	106	100	96	97	90	95	91	50	65
	IS Mar	61	38	61	82	59	87	86	88	83	88	SS	84
	16 Apr	99	43	45	61	75	es	33	83	85	46		53
	17 May	104	60	62	59	69	SI	87	65	SS	SS	E2	87
	16	60	101	85	73	88	74	SS	89	87	87	E&	84
	19 Jul	59	52	SS	61	70	67	72.	61	66	85	84	56
	20 Aug	59	59	74	so	77	68	65	71	79	83	62	52
	21 Sep	SS	59	SS	70	76	74	67	55	69	7	51	80
	22 Oct	77	72	68	66	73	76	75	69	67	71	75	51
	23 Nov	77	Si	74	70	63	74	76	75	70	66	72	75
	24 Dec	95	77	80	75	71	69	74	,,	76	71	69	72
		1,915											

Figure 4.16 Bottom up forecasting of computer label with moving average at SKU level

As the previous step, after the figure has been calculated at SKUs level, then all are summed up to the aggregate level. The table below shows the forecasting value at product group level.

Existing Items
Bottom-UP
Moving Average Testing:.
Computer Label

	No.		Actual (PK)	Forcast New 2 Wrath	3 mth	4 mth	5 mth	6 mth	7 mth	8 mth	9 oath	10 mth	11 mth	12 mth
Year 05	1	Jan	520											
	2	Feb	472											
	3	Mar	755	496										
	4	Apr	742	613	53									
	S	May	529	748	656	622								
	6	Jun	802	635	675	624	603							
	7	Jul	619	665	691	707	660	636						
	S	Aug	995	710	650	673	689	653	634					
	9	Sep	683	807	805	736	737	740	702	679				
	10	Oct	574	339	766	775	726	728	732	700	680			
	11	Nov	1,369	62.9	751	718	735	700	706	712	686	669		
	12	Dec	991.	971	375	905	848	340	796	739	785	754	733	
Year 06	13	Jan	539	1,180	978	904	922	872	862	820	811	806	775	75-4
	14	Feb	324	765	966	868	831	859	824	821	789	754	782	756
	15	Mar	797	431	618	806	759	747	732	762	766	742	742	743
	16	Apr	705	560	553	663	804	766	754	734	766	769	747	747
	17	May	534	751	609	591	671	788	757	7-16	775	760	743	744
	18	Jun	743	620	679	590	580	648	751	729	724	751	739	744
	19	Jul	493	641	663	696	622	608	663	751	731	726	751	740
	20	Aug	699	621	592	620	655	600	591	641	722	707	705	729
	21	Sep	806	596	647	618	636	663	614	605	643	720	707	705
	22	Oct	552	752	664	666	656	664	633	633	627	664	728	715
	23	Nov	783	679	686	637	660	639	648	667	629	620	653	713
	24	Dec.	1, 124	648	714	710	667	680	659	665	680	644	635	664
			1 7,155											

Figure 4.17 the aggregate forecasting value from each SKU

4.1.9 Performance Measurement: Bottom-Up Moving Average:

Bottom-UP
forecast Accuracy By Moving Average
Com 42-342

	No.		2 mth MSE	3 mth MSE	4 mth MSE	5 mth MSE	6 mth MSE	7 mth MSE	8 mth MSE	9 mth MS/	10 mth MSE	11 mth MSE	12 mth MSE
Year 05	1	Jan											
	2	Feb											
	3	Mar	131.57										
	4	Apr	216.05	106.09									
	5	May	5,067.37	4,951.00	5,247,19								
	6	Jun	3,022.58	2,265.76	1,736.17	1,377,10							
	7	Jul	105.97	450.30	491.61	578.06	726.19						
	3	Aug	69.89	187.16	21.72	8.05	0,29	6.36					
	9	Sep	182.43	5,55	181.69	48,26	31.13	13.55	1.02				
	10	Oct	1,743.73	1,180.32	2,037.04	1,061,72	1,412.11	1,488.52	1,611.70	1,803.54			
	11	Nov	2,250.12	2,871.94	2,654,73	3,826.49	2,798,95	3,359.54	3,541.50	3,774.52	4,092.56		
	12	Dec	628,72	40.03	5,03	10.69	184,92	54.72	162.97	223,44	300.79	408,33	
Year 06	13	Jan	5,711.90	5,375,56	3,763.45	3,003,91	2,902.82	2,020.15	2,512.98	2,047.95	1,861,82	1,667.54	1,449.99
	14	Feb	2,888.87	5,750.48	6,469.92	5,553,93	5,053.11	5,130.60	4,195.79	9,900.95	4,379,27	4,182.64	3,953.86
	15	Mar	527.21	0.02	448.98	321.62	697,98	638,86	728.46	979,30	716.96	599,04	556.92
	16	Apr	3,125.73	2,846.75	1,440.64	445.84	201.06	237.82	254-41	198.11	337.10	175.00	244.31
	17	May	587.34	1,804.08	2,045,96	1.264,98	519.74	301,23	399.53	375.58	319,33	479.40	300,27
	13	Jun	1,722,10	780.78	149,90	62.52	209,10	603.11	835.95	755.20	710.61	775.85	577.37
	19	Jul	533.18	830.28	488.67	119.77	59.96	183.43	512,46	720.86	669.87	644,29	711.92
	20	Aug	0.33	239,19	467.03	312.75	83.17	44.05	140,44	404.40	583,91	553.51	541.39
	21	Sep	691.92	671,91	216.24	81.28	133.30	341.78	420.11	248.70	67,15	13.31	22.43
	22	Oct	23,87	85,92	124.86	12.23	0.57	2.71	62.56	99.05	35.12	0.67	18.42
	23	Nov	14.33	13.00	53,29	36.26	10.64	0.09	3.20	54.45	86.59	32.90	0.16
	24	Dec	304.37	217,52	399.04	534.18	625.59	402.75	289.39	355.82	571,39	662.11	507,60
		Total	1,343.46	1,460.77	1,424.76	1.011 04	869.79	872.31	976.40	1,096.16	1.054,46	784.63	740.39

Figure 4.18 Bottom up performance of computer label with moving average by MSE

The MSE values above show that the best moving time for the Bottom-Up approach is 12 months, which contributed a value of 740.39.

Next step: after the performance of moving average and simple exponential under the Bottom up approach has been concluded, those values are compared for discovering the most accuracy one. Below is the chart that shows the result in term of MAPE, MAD, and MSE

4.1.10 Comparison Chart:

Simple Exponential Smoothing

	Alpha	MAPE	AI ha	MAD	Aloha	MSE
Corn 42.342	0,1	35.93%	0,2	24,54	0,2	1,020 70
Corn 42.632	0,1	95.80%	0.1	65,23	0,2	7,352,21
Corn 42-132	0,1	39.99%	0,1	5 2		4,688.51
Corn 42-332	0,1	41.83%				11,805,97
Corn 42-812	0.4	44.51%	0.4	41.90		

Moving Average

		RAPE	Moviaq	MAD	Ilevi	
42.342		3712	7 Oh	21.77	12 mth	740,39
Corn 42-632	2 HI	102,37	713th	63,45	7 mth	6,437,54
Coln 42-132	12 mt	41,91	12 mth	52,45	12 mth	3,69044
Corn 42.332	9	39,78	12 mth	75.76	12 mth	9,369,12
Com 42-812		42,21	12 th	37.48	a m	2,087.70

Figure 4.19 Comparison chart between exponential smoothing and moving average Of Bottom up forecasting

In the Bottom-Up approach, the accuracy values need to be analyzed at each SKU level to try to find the best value of each one. In the results, there are comparisons between the exponential and moving average which show the lowest MSE value at each degree of alpha and the level of moving time. Finally, the outcome discovers that the total MSE value of moving average is the lowest one. Thus this bottom up approach for "Existing Item" with stable growth, is the best with moving average.

4.1.11 Forecasting 07:

Finally, the best performance value in term of accuracy of each approach is applied to Year 2007

As for the Top-Down approach, the 12 months moving average has been used for forecasting the demand in Year 07. Therefore the following table shows the existing item's forecasts at product group level. The Figure shows that January 07 is 675 packs for total computer labels.

Existing **Items:**
Top-DOWN
Moving Average **Testing:**
Computer Label

	No.		Actual (PK)	12 **mth**
Year 06	1	Jan	539	
	2	Feb	324	
	3	Mar	797	
	4	Apr	705	
	S	May	534	
	6	Jun	748	
	7	Jul	493	
	8	Aug	699	
	9	Sep	806	
	10	Oct	552	
	11	Nov	783	
	12	Dec	1,124	
Year 07		Jan	331	675
	14	Feb	541	658
	15	Mar	1,047	676
	16	Apr	516	
	17	May	39-4	
	16	Jun	,028	
	19	Ju	722	
	20	Aug	645	
	21	Sep	553	
	2	Oct	673	
	23	Jov	642	697
		Dec	152	435
			16,354	

Figure 4.20 Top down forecasting for Year 07

Nevertheless, the Bottom-Up approach would be forecasting at SKUs level and being selected on the best moving time gotten. There are four SKUs which are needed to use the 12 months moving average and another one which is corn 42-132, is suitably with 7 months moving from the result of figure 4.21.

		Bottom-Up Moving Average				
		Com 42-342 Corn 42- 2		42-132 Co -		-
		12 mth	7 mth	12 mth	.12 mth	12 mth
Year 06	1					
	2	-		-		
	4					
	5			-	-	
	6					
	7					
	9		97			-
	9		97			
	10		105			
	11					-
	12					
Year 07	13	71	127	.169	239	94
	14	73	102	162	225	93
	15	77	105	163	233	96
	16	77	112	173	245	97
	17	79	108	168	229	92
	18	72	111	171	212	97
	19	77	137	179	216	104
	20	82	117	173	238	105
	21	84	128	171	233	103
	22	84	121	163	224	98
	23	83	123	169	234	89
	24	80		161	225	88

Figure 4.21 Bottom up forecasting with Year 07

4.1.12 Evaluation 07:

After the new sales forecast is identified, all figures are run through the process of evaluation and the main error measurement is MSE. The table below shows the outcome.

Top-Down		Bottom-tip	
Moving	MSE	Moving	MSE
12 mth	1,170.20	12 mth	1,225.33
12 mth	2,005,62	7 mth	3,560.14
12 mth	7,086.90	12 mth	11,076.78
12 mth	10,936.03	12 mth	13,942.17
12 mth	1,352.45	12 mth	1,183.90

Figure 4.22 Comparing the MSE between Top down and Bottom up of Year 07

Lastly, in this research it can be concluded that the best technique for "Stable growth" items is the Top-Down approach. The demand planner can use the twelve months moving average to forecast the sales and break them down into the SKU level which gives a better performance.

B. New Items: High Growth

4.2.1 Pattern Analysis:

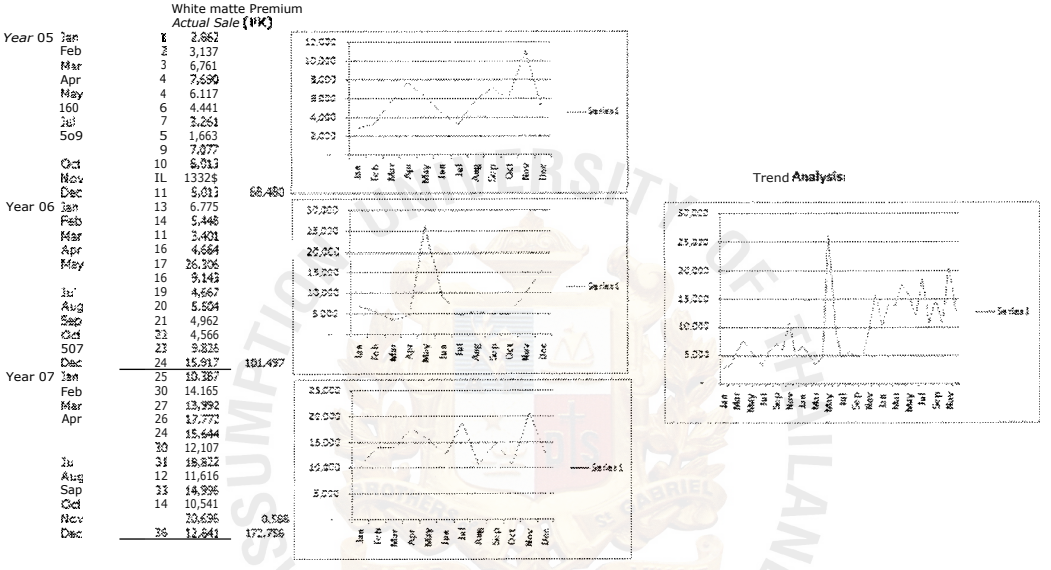


Figure 4.23 Pattern analysis of sticker label A4

In the methodology step, this research needs to compare the Top-Down and Bottom-Up approaches between High growth items and Stable growth items. Therefore, the next section shows the three years sales record (05, 06, and 07) of "Sticker Label A4" group. The first step started with pattern analysis, and after noticing the graph series, there will be some movement and swing not in the same direction. Fo\rom this, it can be concluded that there is no seasonlity for this kind of products. The graph table above shows the result of product "White matte premium 50 sheets per packs". This item generates the most sales volume at more than 85% compared to the other four SKUs.

SUMMARY OUTPUT White Matte premium

Regression Statistics	
Multiple R	0,648163
R Square	0420116
Adjusted R Square	0.40306
Standard Error	4393.782
Observations	36

ANOVA

	df	SS	MS	F	Significance F
Regression	1	475536324,4	475536324,4	24.63239283	1,91762E-05
Residual	34	656361015,9	19305324		
Total	35				

	Coefficient	Standard Error	t Stat	P-value	LOWEY 95%	Upper 95%	Lowe 9	tipper 950%
intercept	3047.921	1495,649061	2.03 54	0,049405122	8.396059723	6087.44521		6087.44521
X Variable 1	349 46	70.49251933	4,9.63103145	1,91762E-05	206.6036116	493.1196531		493.1196631

Sticker Label A4	T-Stat Value
White Matte Premium	4.963
CD-Rom	3.508
PVC	3.459
White Matte Standard	0.449
White Glossy	3.010

Figure 4.24 Summary of T-Stat value of sticker label A4 by Regression analysis

Then the regression statistics are applied for "Trend analysis" testing. The value of T-stat of white matte premium is 4.96, which is somewhat more than 1.96. This value indicates that the data pattern is showing a aggressive trend. Thus the items of this sticker label A4 group have a trend pattern but do not have seasonality. If the pattern is set at these criteria, the forecasting technique would be suitable with "Holt's Exponential Smoothing".

The summary table above also indicates the T-stat value for each item in high growth products. Mostly, they are getting a value more than 3. From this it can be concluded that the trend possibility is substantially high.

TOP-DOWN

4.2.2 Top-Down: Holt's Exponential Smoothing:

After the Holt's exponential technique has been applied to high growth items, the forecasting value needs to be classified by the factors of degree of alpha and beta. The degree of alpha would be the weighting scale for "Level forecasting" in monitoring the forecasting value from past sales records. If the variation of the data is high, the degree of alpha need to be less. Whereas the beta value will support the value with a trend calculation. The degree of beta value will illustrate the data, whether it has high fluctuation of trend movmement or not. After the level forecasting value and trend value have been specified, these two values are combined and represent the forecasting value in the following period

Thus this forecasting simulation is classified into 32 sets, in which the range of the degree alpha and beta value is frome 0.1 and 0.1 to 0.8 and 0.8 and trying to find the best one.

Formula:

Level Forecasting $= L_t = a.S_t + (1- a).(L + T_{t-1})$

Trend $= /3 (L_t - L_{t-1}) + (1 - /3) T_{t-1}$

New forecasting $= L_t + Tr$

Where L = Level, T = Trend, 0<a<1, and 0<13<1.

In this technique, the starting point is very crucial. For example, the first period which is January 05 would be used to get the level forecasting at 3,529 packs, which is the same as past sales. And the trend value is calculated by substracting February and January 05 (4,095 – 3,529 packs). The result is 566 packs at trend with

January 05 period. Next, the second step of calculation will be along the formula mentioned above .

High Growth Items:
Top-Down
Holt's Exponential
Sticker Label A4

	N.		Actual [Pk]	α Level 0.2	β Trend 0.2	New Forecast	a Level 02	Trend 0,4	New Forecast	a Level 0.2	Trend 06	New Forecast	a Level 08	Trend 0,5	New Forecast	a Level 3,4	β Trend 0.2	New Forecast	a Level 3.4	R Trend 0.4	New Forecast
Year 05	1	:an	3.529	3.529	586	-	3,525	566		3.525	556	-	3.519	584	-	3,529	566		3.529	555	
	2	Feb	4.095	4.955	566	-	4595	556		49.55	566	-	4.095	566	-	4,095	566	-	4.095	566	-
		Mar	7.219	5.172	668	4603	5,172	770		5.172	873	44 3	5.172	976	4,660	5,684	770	4.660	5.684	975	4,660
		Apr	8.331	6.338	755	5441	6,420	961	5.942	6.502	1.147	6,344	6.584	1,324	6.147	7,205	920	6,454	7,328	1,243	6.659
		May	6.493	6.983	743	7.105	7.204	5%	7,311	7.418	1.008	7,649	7,625	1,096	7,905	7,472	790	8.125	7,739	910	5,570
		Jun	5.331	7 247	647	7.726	7,541	669	8.054	7.807	637	6,426	6045	555	5,723	7,089	555	8162	7,322	379	8,649
		Jul	3.666	7455	486	7.894	7,341	322	5210	7.528	88	6.444	7,653.	202	5.600	6,133	253	7,615	6.167	234	7,701
		Aug	6.634		446	7.575	7.457	239	7,663	7.419	38	7.616	7.287	- 233	7,451	6.485	273	6,356	6,213	- 122	5.933
	9	Sep	7,7%	7.827	447	7435	7.716	147		7.470	16	7389	7.123	- 196	6,954	7.173	356	6.758	6.773	152	5,091
	13	Oct	6.560	7,931	376	8,274	7.683	05	7,954	7,353	93	7.485	6451	- 257	6.924	7.141	278	7,529	6,778	52	6.923
	11	Nov	12;515	9,151	547	8.309	8.758	511		8.2 2	544	7.210	7,779	691	6,595	9.459	686	7.420	9.129	996	6.870
	11	Dec	6,731	9,894	508	9,655	9,161	465		6,799	534	5416	5,523	733	8,470	9.579	573	10,145	9,556	773	10.125
Year 06	13	Jan	7849	9.586	423	10.012	9,281	325		9.044	361	9,333	8 982	514	9.255	9.247	392	10,152	9.360	381	10,341
	14	Feb	6,875	9,384	298	10,011	9063	110	#5107	6 593	57	9.404	8.973	95	9,496	5.535	171	9639	8.896	- 77	0.741
	15	Mar	6.590	8064	174	9,582	8,657	- 97	9,174	8.483	227	8.957	8.572	- 301	9.068	7.559	2	8,706	7.747	- 1%	8318
	15	Apr	1,449	8,480	23	9,135	7.938	- 345		7,695	563	8.257	7,707	- 753	5.271	6.6%	191	7.661	6.596	- 692	7.361
	17	140y	26847	12,171	756	8,502	11,444	1,195	7,593	11.075	1.802	7,132	10933	1430	5,954	14762	1.420	6.705	14.281	2,659	5.904
	15	Jun	10.759	12.494	570	11528	12,263	1.045		2.454	1,546	12,877	13,842	2.014	13,343	14,013	9834	16.182	14.465	1.672	16.940
	19	Jul	5,597	11.650	367	13,163	11.765	428		12,321	540	14.002	13,004	532	14,8%	11,236	284	14.599	11,922	- 17	16,134
	20	Aug	7.010	11.016	167	12.017	11,156	t3	12.193	11.692	162	12862	12,231	- 512	11036	96,667	123	11,472	9,947	- 800	11.905
	21	Sep	6.206	10 157	- 32	11,162	10.177	- 364	11,169	*11,464*	801	11,528	11,616	- 1,394	11,719	8.221	392	9,565	7.971	- 1.270	9.247
	22	O	5.799	9.293	- 207	10,155	8.994	- 703	9,793	8.898	1.265	9.662	8.536	- 1,942	9.222	7,017	554	7.830	6.343	- 1.415	6.70
	23	Nov	11.201	9.502	- 122	9,077	8.873	- 471	8,291	8.340	836	7,625	7,517	- 1,205	6.596	8.358	175	6,463	7,436	- 410	4,925
	24	Sec	18.259	11,185	233	9.380	10,373	315	8.402	9.656	455	7.503	6701	707	6.312	12,214	631	5,183	11,519	1.387	7.025
			199,585																		

Figure 4.25 Top Down forecasting with sticker label A4 by Holt's exponential

Break down the forecasting:

After the new forecasting value has been found at each period, those values are divided by percentage of sharing by using a 2 months period (the same method as with existing items). In the March period, the sales forecasting at group level is 4,660 packs, multiplied by 66.36%, and the value of 3,092 packs would stand for a forecasting value of "White matte premium" item at control alpha 0.2 and beta 0.2.

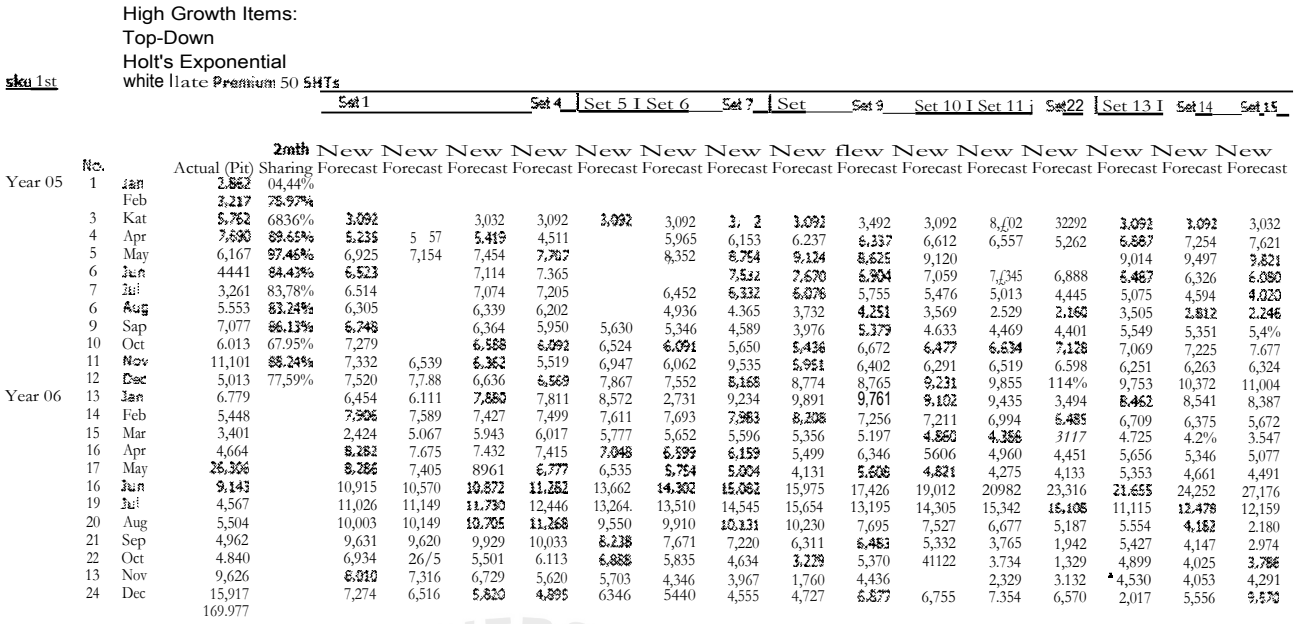


Figure 4.26 break down the forecast into SKU level

4.2.3 Performance Measurement

As the same sequence, the forecasting accuracy is set with MAPE, MAD, and MSE, whereas the MSE value is the main one for making decisions. The table below showed the MAPE value of each alpha and beta value.

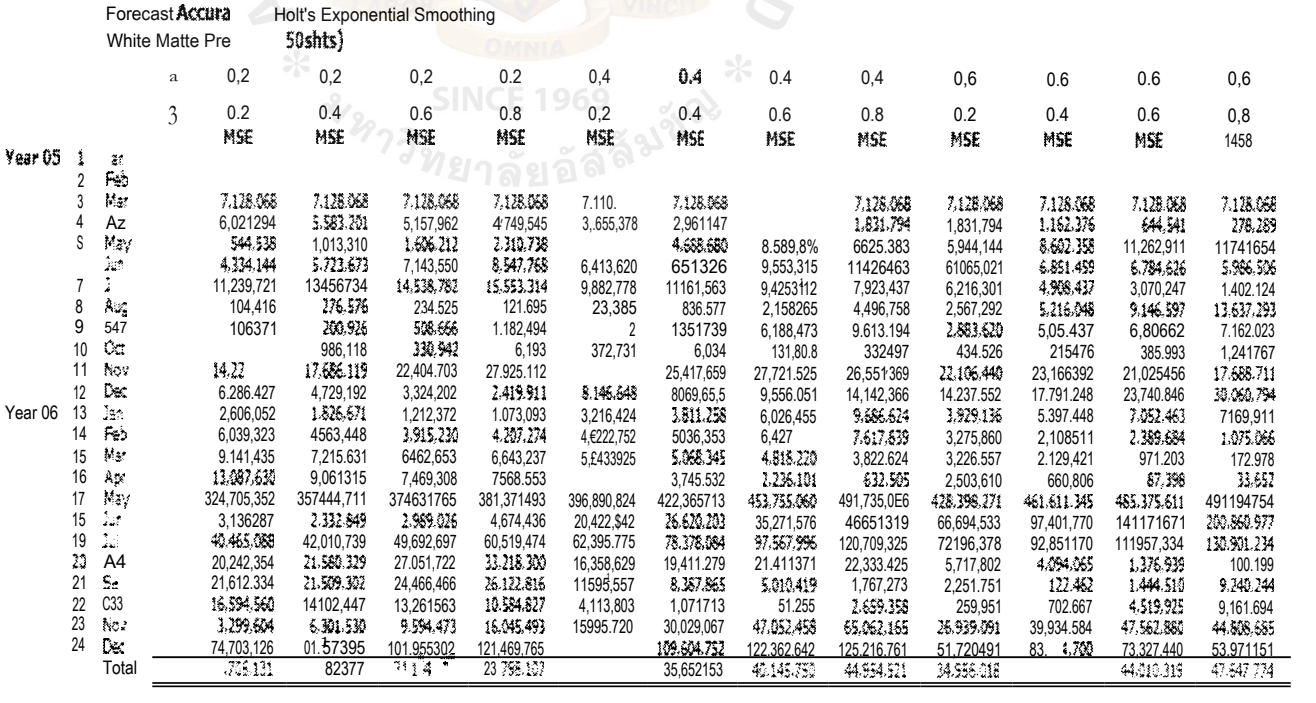


Figure 4.27 Top down performance with Holt's exponential by MSE

The table below is the summarize of MSE values in each alpha and beta value range from 0.1 & 0.1 to 0.8 to 0.8. As in the case of Top-Down management, the manager need to select only one value of alpha and beta value. As the highest selling item of this product group is White matte premium, the important weight would concentrate on its value. The best one which is selected, is at alpha 0.1 and beta value 0.5 and this set of control values are applied for Year 2007.

Mean Square Error

Alpha	0.1	9.1	0.1	0,1	0,3	0,3	0.3	0.3	0.5	0.5
Beta	0.1	0.3	0.5	0.7	0.1	0.3	0.5	0.7	0.1	0.3
White Matte Premium	24,351,217,79	24419.741.20		26,360,947.35	27410,733.44		34,274,366.04	38,058,549.78	31.2k5,764.19	35,574,191.11
CD-Rom	38.272.45	34,759,63	32.527.98	31,922.59	41,76.64	45,802 19	54,317.50	63481.82	50875.26	61,637.40
PVC	12,062.36	10.647.37	10,397.95	10491.74	10466.66	11,727.84	14,051.18	06,296.55	12,546.29	11,154.06
White Matte Standard	71,23224	61461,52		59,881.73	58.179.77	58.725.82	61,925.65	66,104.91	54,853.04	56,978.27
White Glossy	.6€)3.05	24,311,25		21,52£.47	21.021,12	26.805.33	33A53.64	40,159.35	24,939.18	

Alpha	0.5	0.5	0.7	0.7	0.7	0.7	0.2	0.2	0.2	9.2
Beta	0.5	0.7	0.1	0.3	0.5	0.7	0.2	0,4	0,6	O5
White Matte Premium	40,349,597.97	44,926,63144	33,914,571,04	38,775,359.19	43285,16614	47,296,289.33	26.706.130.80	28.762.376.	31.154,009.08	33.748,106.76
CD-Rom	75,640.85	92.835.55	58,145.12	72,316.72	88,913.93	105,995.71	37,459.50	38968,21	44,360.26	51,864.32
PVC	18,725.00	23,632.05	20,421.97	27,844.89	39,1815.57	58,324.10	10,475.17	11,462.07	543.29	16,096.36
White Matte Standard	60,205.29	64,731,11	52,899.60	55,792.89	69,987.79	69,091.83	59,524.44	59,716.36	62,364.05	66,006.02
White Glossy	39,181,13	47	2,				21.269.46	34,416,95	29,539.10	36,090,29

Alpha	0.4	0.4	9,4	0.4	0,6	O4	0.6	OS	0.8	0.8
Beta	0.2	0.4	0.6	0.8	0.2	0.4	0.6	0.8	0.2	0.4
White Matte Premium	31,537,962,92	35452.253.16	40,145,74998		34,956,017,97	39,648,747.63	44,010,318.51	47,647,774,39	37410,97535	4288134957
CD-Rom	49,550.35	59,731,46	71,732,93	85,258.12	60,713.42	71423.50	92,405.15	110,/$6.34	67,932.47	84,070.70
PVC	11.777.72	14,097.29	16,547.41	19,189.14	17,428.12	22434.64	31,137.06	44,28736	32,571.66	47,640.60
White Matte Standard	56,75560	59,553,29	63,071,22	66870,12	54,779.82	57,983.96	61.282.50	72,120,41	53,477.18	57,902.20
White Glossy	26.476.52	33.316.11	39,732.70	45,973.01	30.367.12	38,506.63	48,541.16	61,932,32	39,567,52	47027,37

Alpha	OO	04
Beta	0.6	0.8
White Matte Premium	47,672,637.90	52,839,790.73
CD-Rom	100,941.35	117,504.26
PVC	70,437.13	101,314,06
White Matte Standard	64,490.38	70,964.26
White Glossy	61,340.96	77,171.28

Figure 4.28 Summarized MSE value in each alpha and beta

BOTTOM-UP

4.2.4 Bottom-Up: Holt's Exponential Smoothing:

The data would be forecasted at SKUs level and then combined up to the aggregate leve.

High Growth
Bottom' UP
Holt's Exponential
sku 1st White Matte Premium 50 SHTs

	No.		Actual (PK)	Set 1 α Level 0.2	Set 1 β Trend 0.2	Set 1 New Forecast	Set 2 α Level 0,2	Set 2 β Trend 0,4	Set 2 New Forecast	Set 3 a Level 3,2	Set 3 β Trend 0.6	Set 3 New Forecast	Set 4 α Level 0,2	Set 4 β Trend 5,6	Set 4 New Forecast	Set 5 a Level 0,4	Set 5 β Trend 0.2	Set 5 New Forecast	Set 6 α Level 0.4	Set 6 β Trend 0.4	Set 6 New Forecast
Year 05	1	Jan	2862	2662	355	-	2%3	351	-	2562	355	-	2,662	355	-	2,562	355	-	2.662	335	-
	2	Feb	3,217	3,217	355		3,217	155	-	3,217	355	-	3,117	355	-	3,217	255	-	3,217	355	-
	3	Mar	5,762	4.010	443	3,572	4,010	530	3.572	4010	615	1,572	4,010	705	3872	4.445	537	3,572	4.444	705	3.572
	4	47	7 0	5,100	572	4,453	171	762	4,540	5,240	985	4.628	3310	1.181	4.715	9163	747	4,978	6.165	1,111	5.153
	5	May	6,187	5,775	593	5672	5,999	801	5,952	6.218	981	6.226	6,431	1,133	6.492	6,561	697	6410	6,542	536	7.275
	6	Jun	4,441	5,982	516	6,368	6.325	612	6,800	6647	650	7,1%	6,939	633	7.563	6,131	473	7,258	6,444	402	7,779
	7	Jul	3.261	5.851	386	6,498	6,255	315	6,941	6,490	165	7.297	6,710	37	7,572	5.266	205	6633	5.412	171	5.546
	8	Aug	7 851	4160	371	6,237	6,389	254	6,523	6,495	69	6,655	6,493	185	6.553	6,624	231	5.471	5.416	73	5.241
	9	Sep		6,640	393	6.531	6,738	296	6,653	6666	131	65£4	6462-	62	6,336	6,346	333	8859	6.071	193	5,412
	10	Oc	«	6629	352	7,033	6,831	216	7,036	6640	37	6,797	6.323	124	6,400	6,412	279	6,679	6.168	152	6,271
	11	Nov	11.114	7,965	509	7,181	859	541	7,048	7,562	568	5.877	7,180	661	6199	8.457	632	6.692	6,233	917	6.325
	12	Dec	5.013	7,782	370	8,474	7,722	270	8,400	7,557	194	8,130	7,276	219	7,841	7,459	308	9,099	7,4%	235	9,151
Veer 06	13	Jan	5.179	7875	315	8,152	7,750	173	7,992	7,516	83	7,701	7,343	96	7,484	7,370	227	7,765	7,362	100	7,751
	14	Feb	5.448	7,644	3%	6,193	7,418	25	7123	7,169	175	7430	7,041	223	7,439	6,72	55	7,598	9.656	223	7,462
	15	Ma	3,701	6,960	28	7450	6602	345	7,403	6276	606	6,994	6,135	769	6838	5,436	216	6,793	5221	735	6,434
	16	A3	4,4c4	6523	65	6,988	5,938	473	6,257	5,468	727	5,669	5,225	882	5385	4,996	261	5,220	4,573	(54	4,513
	17	May	26,136	10.427	729	6,458	5,634	1.195	5,456	9.054	3561	4.742	8.736	2,612	4,343	13,365	1,465	4,737	12.856	2,903	3610
	15	Jun	9 - 3	10,753	645	11.156	15,491	1760	10,828	10,561	1.648	30.915	10,903	2.276	11.366	12.555	1910	14.513	13,133	1,844	18759
	19	Jul	4,667	15,055	379	11,401	10,174	509	11,551	10,701	743	12,209	11,493	911	13,195	10.006	295	13,565	10941	191	14,957
	20	Aug	5.504	9.447	182	10,433	9,647	55	15683	10,256	30	11,444	11.024	193	12.484	5.354	86	10.304	8.825	688	11,139
	21	Sep	4,982	8.700	4	9629	8.790	286	9.742	9.225	606	15.2%	9,661	1,129	10.831	6973	351	8.298	6.875	1,192	5.137
	22	Oct	4,860	7,926	158	8,695	7,775	578	8,504	7,667	1.057	8619	7796	1,716	8633	6916.	492	6,621	5,354	1.324	5,683
	23	Nov	9.826	8.182	75	7.771	7,723	367	7,197	7,413	695	6.810	6,831	1,117	6052	7,145	145	5.424	6.348	397	4,035
	24	Dec	16917	9,666	237	5.136	9.659	319	7,356	8.555	461	6,716	7,754	515	5,713	10,594	570	7,045	9.936	1.196	5,951
			169,977																		

Figure 4.29 Bottom up forecasting with sticker label by Holt's exponential

4.2.5 Performance Measurement:

In the next step, the best alpha and beta values are selected at each SKUs level. In this case, the result of MSE value shows that the best value has different points on both degrees of alpha and beta. As such, the white matte premium is most suitable with 0.1 and 0.1 which contributed the MSE value at 26,506,633,-

NO: Sticker Lable A4
1 White Matte Premium
2 CD-Rom
3 PVC
4 White Matte Standard
5 White Glossy

Alpha	Beta	MAPE	Alpha		MAD	Alpha	Beta	
0.5	0.1	51,05	0.1	0.1	3,972.31	0.1	0,1	
0.2	0.8	93,86	0.5	0.5	161,67	0.4	0,6	
0.1	0.1	73.52	0,1	0.1	127.12	0.1	0,3	
0.1	0.1	88,78	0.5	0.1	302,15	0.7	0.1	
0.2	0.4	122.63	0.1	0.7	304.47	.1	0.9	

Figure 4.30 Bottom up performance with Holt's exponential by MSE

Finally, the best performance value in terms of accuracy of each approach is applied to Year 2007. At Holt's exponential smoothing with high growth items, the best technique from both Top-Down and Bottom-Up would be chosen and given the forecast value of 07. In this case, for the Top-Down forecasting at 07, the alpha of 0.1 and beta of 0.5 would be used. Whereas, the range of control degree at Bottom-Up, would be varied as mentioned in the above table.

4.2.6 Forecasting 07:

Next, the new forecast of year 2007 is taken. The first table shows the forecast value as Top-Down level at alpha 0.1 and beta 0.5, and the second table shows the Bottom-Up level. The degree of alpha and beta varies with the best parameter predicted at a previous time.

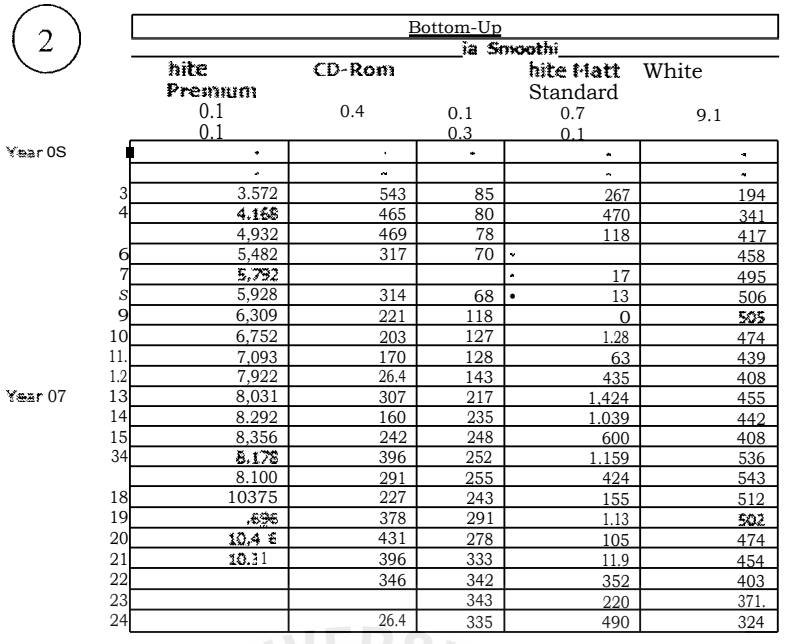
1

High Growth Items:
Top-Down
Holt's Exponential
Sticker Label A4

	No.		Actual (PK)	α Laval 0,3	Trend 0.5	New Forecast
Year 06	1	3a	7.859	7.859	1.011	
	2	Feb	6.678	6.875	1.011	
	3	Mar	6.590	5,939	975	5.867
	4	Apr	5,449	5.013	951	4.954
	5	May	26.847	6.341	199	4.062
	5	Jun	10,759	6,952	400	6,529
	7	Jul	5.597	7,177	312	7.352
	6	Aug	7,010	7.441	399	7,459
	9	Sap	5.206	7,577	312	7.730
	10	Oct	5,799	7.590	113	7,759
	11	Nov	11.201	8,053	256	7.703
	12	Dec	15.259	9.332	783	8.340
Year 07	13	Jan	12.988	10,403	97,7	10.116
	14	Fab	15,957	11,793	1,158	11,330
	15	Mar	17,919	13,448	1,407	12.951
	18	Apr	19.349	15.304	1.632	14.955
	17	May	17.613	17,004	1,665	16.935
	18	Jun	13,505	19,153	1.407	19.569
	19	Jul	20.767	19.660	1,465	19.560
	20	Aug	15,450	20,575	1.183	21.145
	21	Sep	16.407	21,225	915	21.761
	22	Oat	12.826	21.209	449	12,140
	23	Nov	33.765	21.569	555	21.659
	24	Doe	14,537	21.665	175	22,424
			319,869			

Figure 4.31 Top down forecasting with Holt's exponential in Year 07

The result of using Top-Down with Holt's Exponential shows that the trend possibility is negative during the first to four months period, and the new forecast value of March is 5,867 packs for the group level. After that, the sales figure is divided into each SKUs by using 2 months sharing.



		Bottom-Up				
				ia Smoothi		
		hite Premium	CD-Rom		hite Matt Standard	White
		0.1 0.1	0.4	0.1 0.3	0.7 0.1	9.1
Year 0S						
	3	3.572	543	85	267	194
	4	4.168	465	80	470	341
		4,932	469	78	118	417
	6	5,482	317	70		458
	7	5,792			17	495
	S	5,928	314	68	13	506
	9	6,309	221	118	0	505
	10	6,752	203	127	1.28	474
	11.	7,093	170	128	63	439
	1.2	7,922	26.4	143	435	408
Year 07	13	8,031	307	217	1.424	455
	14	8.292	160	235	1.039	442
	15	8,356	242	248	600	408
	34	8.178	396	252	1.159	536
		8.100	291	255	424	543
	18	10375	227	243	155	512
	19	,696	378	291	1.13	502
	20	10,4 ε	431	278	105	474
	21	10.31	396	333	11.9	454
	22		346	342	352	403
	23			343	220	371.
	24		26.4	335	490	324

Figure 4.32 Bottom up forecasting with Holt's exponential in Year 07

The Bottom-Up with Holt's Exponential is broken down to each suitable degree, and the forecasting value is shown in the above table. For easier understanding, the summarized table is considered showing how each one is much different in terms of MSE value.

4.2.7 Evaluation 07:

	Forecast Accuracy at Veer 2007						
	T.. Down						
	Al ha	Beta	MSE		Aloha	Beta	MM
White Matte Premium	0.1	0.5	38,344,507.93	White Matte Premium	0,1	0,1	95,736,150.02
CD-Rom	0.1	0.5	42,363.48	CD-Rom	0.4	0.6	71,025.06
PVC	0.1	0.5	77,013.43	PVC	0,1	0.3	383,841.95
White Matte Standard	0.1	0,5	80,140.09	White Matte Standard	0.7	0.1	159,396.64
White Glossy	0,1	0.5	82,180.53	White Glossy	0.1	0,5	297,711,08

Figure 4.33 Comparison of the performance between Top down and Bottom up of Year 07

The final result indicates that the Top-Down approach is still the best for high growth items in term of lowest MSE value. In this case, it showed that all SKUs have a lower MSE compared the with Bottom-Up method. For example, the best selling item, which is White matte premium, has only a 38.34 million MSE value but the Bottom-Up method gave 95.74 million.

Chapter V: Conclusion

As the purpose of this project is to compare the performance of the Top-Down and Bottom-Up approaches, the results of testing both high growth items and stable growth item found that the "TOP-DOWN" approach would be the best suitable for applying. In analyzing, the reason behind this result, it might occur from the percentage sharing of each SKUs which has rarely been different. In detail, the sale proportion of each month at each SKU level has been swinging nearly the same. The sample picture shows the percentage sharing of White matte premium (all these tables have been totally shown in the Top-Down forecasting section).

High Growth Items:
Top-Down
Holt's Exponential
White Matte Premium 50 SHTs

No.		Actual (NO	Monthly Sharing	Set 1 New Forecast	Se 2 New Forecast	Se 3 New Forecast	Set 4 New Forecast	Set 5 New Forecast	Set 6 New Forecast	Set 7 New Forecast	Set 8 New Forecast	Se 9 New Forecast	Set 10 New Forecast
1	Jan	6,779	82.22%										
2	Feb	5.448	85.69%										
3	Mar	3.401	70.97%	4.164	4,164	4,164	4,164	4,164	4,164	4,164	4,164	4,164	4,164
4	Apr	4,664	90.48%	4,465	4,479	4,492	4,505	4,609	4,649	4,656	4,727	4,753	4,819
5	May	26,306	94.35%	3,763	3,798	3,833	3,867	3,984	4,070	4,151	4,227	4,139	4,249
6	Jun	9,143	87.58%	4.620	5,270	5.718	6,164	9,379	10,670	11,944	13.202	13,815	15,859
	Jul	4,667	69,09%	4,733	5.653	6,551	7.427	3,269	11.349	13.226	14.931	11.737	14.057
S		5.504	72,66%	3,361	4.432	5,442	6,391	6,201	7,946	9,270	10.205	6,477	7653
9	Sep	4,982	88.35%	3,687	5.344	6.829	8,151	6,704	8,608	9.591	9.799	6,533	7,130
10	Oct	4,860	62.56%	3, 60	4,893	6,431	7,695	5,454	6,891	7,089	6,404	5,097	5,084
11	N v	3,626	167.29%	2,851	5,038	6,724	7,960	5,092	6,130	1.637	4,258	4,663	4,316
12	Dec	15,917	188,69%	3,032	5,505	7,247	8,363	6.125		6.343	5,065	6.881	6,932
13	Jan	10,367		3,736	6,502	6,313	3.364	8.513		9.573	9,220	10,898	11.976
14	Feb	14,165		4,338	7,684	9.731	10,789	9,589		11,436	11.831	11,403	12,872
13	Mar	13,992		4,185	7,373	9,191	10,043	9060		11,189	12..004	10,574	11,942
16	Apr	17,772		6,337	50,956	13,440	14,115	13,238	15,5 3	16,643	18,017	15,242	17,093
17	May	15,644		7,757	13.227	15,960	17,096	15.575	18,318	19.632	21.063	17,606	19,540
18	Jun	12,107		8,142	13.724	16,350	17.322	15.179	17,741	18,625	19,705	16,190	17,765
19	IL,'	18,822		8.792	14,862	17,427	18,195	14.757	16.934	17,415	17.375	14,547	15.147
20	Aug	10.816		8,151	13.399	15,357	15,806	13,318	14,873	14,927	14,422	13,822	14,210
21	Sep	14,99£		10,510	17,141	19,225	19,415	15,800	17,180	16,682	15,524	15,489	15.512
22	Oct	10518		10,513	16,737	18,279	16,067	14,708	15.474	14.559	13,226	14,207	13,924
23		20.696		11.427	17,873	18,906	18,164	14,441	14,530	13,066	11.514	13,128	12.329
24	Dec	12,641		12.697	18,986	19,485	18,370	16,641	16,595	15,361	14,521	17,256	17.090
		274,253											

Figure 5.1 Monthly sharing of Top down forecasting

The percentage of sharing shows in the same range which is around 80% every month. This reason implies that even if the product has had high growth and has much variation in the sales data, the Top-Down approach still is the best solution compared with Bottom-Up.

Top-down forecasting does appear to be most successful at low level forecasting when a non-seasonality at top-level model is proportioned down to the

low level. Whereas, Bottom-up forecasting appears to be most successful when the low level data has been very heterogeneous or has much differentiation, as stated by

To make further conclusions about whether the Top-Down approach can really improve the forecasting process in demand planning, the result shows the comparison of forecasting accuracy between the best model and the old forecasting value from the program and consensus.

Old Forecast VS New Forecast Model (Year 07)
Existing Items: Stable Growth

Computer Label	Old Forecast Performance MAPS		MSE		Moving Average' Top-Down (12 mths Moving Average) MAPS	MAD	MSE
Corn 42-342	50.72%	31.25	1,524.66	Com 42-342	37.97%	23.80	1,170.20
Corn 42-632	104.53%	55.73	4,905.89	Com 42-632	28.69%	34.71	2,005.62
Corn 42-132	52.93%	67.04	6,274.44	Com 42-132	46.78%	67.86	7,086.90
Corn 42-332	65.02%	104.82	13,463.11	Com 42-332	78.41%	90.60	10,936.03
Com 42-812	40.68%	29.13	1,424.89	Com 42-812	44.14%	30.51	1,352.45

Old Forecast VS New Forecast Model (Year 07)
New Items: High Growth

Sticker Label A4	MAPS	MAD	MSE		Holt's Exponential Smoothing Top-Down (Alpha = 0.1,Beta = 0.5) MAPE	MAD	MSE
White Matte Premium	52.46%	5,205.42	40,821,923.08	White Matte Premium	32.04%	4,116.01	38,344 507.93
CD-Rom	72.14%	143.17	32,897.67	CD-Rom	47.98%	176.18	42,363.48
PVC	96.54%	341.38	405,487.88	PVC	79.76%	225.36	77,013.43
White Matte Standard	232.94%	540.38	445,411.71	White Matte Standard	50.18%	203.79	80,140.09
White Glossy	152.88%	418.17	214,444.58	White Glossy	47.64%	220.80	82,180,53

Figure 5.2 Old forecasting versus new forecasting model in Year 07

The overall performance indicated that the new model of forecasting gave better performance in term of accuracy. In the case of stable items, the Top-Down approach has been applied with 12 months moving average. The MSE value of the main selling items, corn 42-332 and 42-632, have achieved lower scores which are 10,936.03 and 2,005.62 respectively. Additionally, the sticker label group, or the high growth items, are totally given the best outcome as the lowest values in both MAPE and MSE in each item. As such, the 85% of sales of sticker label A4 (White matte premium) has taken the MSE value of only at 38.34 million whereas the old forecast

value gave 40.82 million. Moreover, the MAPE value of the new forecast shows a 20% difference which is somewhat improving in term of accuracy.

Money value can be saved from applying the new model:

Additionally, The MSE value which can be reduced by applying the new model of forecasting can be simulated for finding some money savings from the safety stock reduction. The Lower MSE value can contribute to a lower safety stock level. The formula of safety stock would consist of three determinants which are service level, forecasting error, and lead time of production.

Safety stock = Service level x Forecasting error x √Lead time

Assumption:

Service Level is 95% confidence interval or equal to 2.57.

Forecasting error is the Root mean square error, monthly.

Lead time is the total time of production from the origin to the destination and then needs to have the token square root out.

The table below shows the money which can be saved;

Safety Stock Calculation:							
Old Forecasting model			**New Forecasting model**				
Computer Label			**Computer Label**	06f unit	Costs/pk	Money Save	
Lead time	1.5 mths						
Service Level	2.57 (95% confident interval)						
Safety Stock Level			Safety Stock Level				
Corn 42-342	10 packs/mth		9 packs/nth	1	1,250	1,586.50	Baht/mth
Corn 42-632	18 packs/mth		12 packs/mth	7	1,300	8,612.65	Baht/mth
Com 42-132	**21** packs/mth		22 packs/mth	- 1	850	- 1,108.61	Baht/mth
Corn 42-332	30 packs/mth		27 packs/mth	3	1,250	3,755.87	Baht/mth
Com 42-812	10 packs/mth		10 packs/mth	0	1,300	331.45	Baht/mth
					Total	**13,177.87**	Baht/mth

Safety Stock Calculation:							
Old Forecasting model			**New Forecasting model**				
Sticker Label A4			**Sticker Label A4**	Diff unit	Costs/pk	Money Save	
Lead time	1.5 mths						
Service Level	2.57 (95% confident interval)						
Safety Stock Level			Safety Stock Level				
White Matte Premium	1,676 packs/mth		1,624 packs/mth	52	110	5,681.42	Baht/mth
CD-Rom	48 packs/mth		54 packs/mth	- 6	121	759.48	Baht/mth
PVC	167 packs/mth		73 packs/nth	94	250	23,558.85	Baht/mth
White. Matte Standard	175 packs/Toth		74 packs/mth	101	80	8,064.17	Baht/mth
White Glossy	121 packs/mth		75 packs/mth	46	120	5,552.68	Baht/mth
					Total	**42087.62**	Baht/mth

Grand total **55,265A9** Baht/mth
Annual save **663,185.88** Baht

Figure 5.3 Money value worth from the new forecasting model

The results from the table show that the amount of money which can be saved is more than 55,000 baht per month on these two groups of products, and if it is calculated for a year, the value would be 650,000 baht approximately.

For example; the main selling sticker label a4 which is White matte premium, can be calculated as the safety stock level of 1,676 packs/month in the old model forecasting. Whereas, the new model can reduce the stock to 1,624 packs/month which is a difference of 52 packs. This amount can be multiplied by the cost/pack and will show the money value that can be saved: the value saved is 5,681.42 baht/month. On the other hand, when the forecasting has become more accurate, the sales revenue in each month would be more precise, and reduce customers' dissatisfaction in receiving goods, because the service level would be improved.

Therefore, this methodology can be applied to other group of products of stationery items, such as the group of "Elephant File" which are the highest selling value items in the company. This group is generating sales revenue of more than 600

million baht a year. If the new model improves forecasting accuracy, it will indicate that a bigger amount of investment would be saved for this group.

The other benefits from this research are concerning with many aspects. Firstly, the time wasted in discussion whether which figure would be the most suitable one, and also can help to deduct the time consumed in taking forecasting into the process. If the Top-Down had been used in this situation, it would have taken less time to compute. Secondly, the better forecasting with a suitable technique, contributes in the logical step of analyzing and computation. It can be seen that the demand planning process has good analysis of data patterns and applied techniques. Third, the result is not contributing to the numbers improvement. There are a lot of effects to the inventory, sales volume, and also market share. If the forecasting is good, those aspects would be going in a better direction. When, the inventory has been reduced, the cost of stock and unsold items would be reducing more and more. Lastly, the overall outcomes would enhance the service quality to customers. The customer's satisfaction would be developed with on-time delivery, less stock-out, and a high service level.

Even Top-Down & Bottom-Up forecasting is extremely useful to improve the accuracy of forecasts and plans when leveraged within a Sale & Operation Planning Process. The improvement is due to three underlying principles: 1) aggregated entities experience lower relative volatility than their individual components, 2) marketing intelligence can be incorporated more effectively, which improves accuracy and 3) this results in greater accountability and commitment to consensus-based plans. All these can be achieved only if all the participants in the S&OP process collaborate during the development of demand forecasts. However, much of the potential for improvement with Top-Down & Bottom-Up forecasting cannot be fully

achieved unless a formal forecast hierarchy is being leveraged to support the S&OP process (Lapide, 1981).

The outcome of this research can be useful techniques which can be applied to any kinds of products with a make-to-stock status. For the management team and demand planner, this new process of thinking can be the direction in studying the movement of products at group and SKU level, due to the nature of selling and consuming of these items which is not the same as expectation.

Teams involved in the organization cannot stick with the traditional way of thinking. The new methodology needs to be applied in coping with the company objectives.

Further Study

As the forecasting model which has been applied to this particular products, is still not used in current situations, further research will be more appreciated for collecting the real results from the current year of forecasting. The people who are involved in demand planning would notice the benefit of that, if the model is workable. On the other hand, the simulation model does not convey concrete benefits to management until the model has been proved in real situations.

Demand planning needs to be linked with other aspects, such as as inventory level, sales volume, back orders, service level, which can be translated into money value. If further study can initiate the advantage points from the aspects mentioned, it will be more preferable and be study of greater worth.

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APPENDICES

1. Sample of Top down forecasting with Simple Exponential Smoothing at aggregate level before separated into SKU level

tin items
Top-DOWN
Exponential Smoothing Testing:
Computer Lab

	N.		Actual (PK)	0.1	0.2	0.3	0.4	0,5	0.6	0.7	0.8	0.9	1
Year 05	1	Ian	520	520	520	520	520	520	520	520	520	520	520
	2	Fab	472	520	520	520	520	520	520	520	520	520	520
	3	Mar	755	515	510	505	501	496	491	486	461	476	472
	4	Apr	742	539	559	580	602	625	649	674	733	727	755
	5	May	529	559	596	629	658	684	705	722	734	740	742
	6	Jun	502	556	582	599	606	606	599	585	170	550	529
	7	Jul	619	551	526	6.6.0	685	704	721	737	755	777	802
	8	Aug	995	585	525	647	658	661	659	654	646	634	619
	9	Sep	683	626	699	752	793	828	861.	893	926	959	995
	10	Oct	574	631	696	731	749	755	754	746	732	711	683
	11	P	1,369	626	671	684	679	665	646	626	606	586	S74
	12	Dec	991	700	811	889	955	5,017	1,060	1,146	1,216	1.291	1,369
Year 06	13	in	539	77	847	920	969	1,904	1,027	1,038	1,036	1,021	991
	14	Feb	324		765	806	797	771	734	689	638	567	539
	15	Mar	797		693	661	508	538	468	433	367	350	324
	16	Apr	705		714	702	684	672	673	688	715	752	797
	17	May	534	686	712	703	692	689	693	730	707	710	705
	18	Jun	748	6.71	676	652	629	611	597	584	569	552	534
	19	Jul	493	679	591	681	677	680	688	699	712	729	748
	20	Aug	699	660	651	625	603	586	571	555	537	516	493
	21.	Sep	906	664	661	647	641	643	648	655	666	681	899
	22	Oct	552	678	690	694	707	724	742	761.	778	793	806
	23	Nov	783	666	662	652	645	638	628	615	597	576	552
	24	Dec	1,124	677	6E6	691	700	711	721	733	746	763	763
		Total	17,155										

2. Sample of multiplying with monthly sharing percentage in separating the sale forecast to each SKU

Existing items
Top-Down
Simple Exponential Smooth's;
sku 1st Com 42-342

			Actual (PK)	Monthly Sharing	Forcast New 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Year 05	1	Ian	55	10.29%	53	53	53	Si	53	53	53	53	53	53
	2	Feb	65	11,21%	61	61	61	41	61	61	61	41	61	61.
	3	Slur	75	5.74%	45	45	44	44	43	43	42	42	42	41
	4	Apr	57	10.76%	55	60	62	65	67	70	73	76	75	81
	5	Slay	137	22.69%	127	135	143	149	155	160	164	166	158	161
	6	Jan	42	6.56%	37	36	39	40	40	39	39	37	36	35
	7	Jul	1%	14.24%	Si	53	54	38	101	103	105	106	111	114
	8	Aug	73	S. IS%	46	51	53	54	54	64	53	53	52	50
	9	Sap	76	10.53%	68	76	81	86	90	33	'37	100	104	1%
	10	Oct	119	17.43%	110	121	127	131	132	331	133	126	124	119
	11	Nov	145	10.33%	65	69	71	70	69	67	65	63	51	59
	12	Dec	137	9,54%	67	77	65	91	97	103	103	116	123	131
Year 06	13	Ier	SI		75	87	95	100	113	106	107	107	105	102
	14	%b	25		83	92	95	94	91	86	Si	75	69	63
	15	Mar	61		19	61	58	53	45	43	35	34	31	28
	15	Apr	99		74	77	76	74	72	72	74	77	81	86
	12	May	134		156	162	160	157	156	157	139	161	161	160
	15	Jun	60		44	44	43	41	40	39	35	37	36	35
	13	Jul	59		97	99	57	97	97	96	103	102	104	107
	20	Au;	59		54	53	11	49	45	47	45	44	42	40
	31	Sep	55		72	72	33	69	73	70	73	72	74	76
	22	Oct	77		118	120	121	123	126	129	133	135	138	140
	23	Nov	77		63	61	67	67	66	65	£4	62	60	57
	24	Dec	95		65	65	66	67	68	69	70	71	73	75
		Total	1,915											

3. Sample of Bottom up forecasting with Moving Average which forecasting at SKU level before sum up to aggregate level.

Existing Items
Bottom UP
Mo.ing Average Testing:
sku 1st Corn 41-342

			Forcast *New*										
	N.	Actual (PK)	2 mth	3 loth	4 mth	5 mth	6 mth	7 mth	8 mth	9 mth	10 mth	11 mth	12 mth
Year 05	1 Jan	58											
	2 Feb	68											
	3 Mar	75	63										
	4 Apr	57	72	67									
	5 May	137	66	67	65								
	6 Jun	42	97	90	84	79							
	7 Jul	108)	89	79	78	76	73						
	Aug	79	71	93	84	82	80	77					
	9 Sep	76	90	74	93	83	82	887	77				
	10 Oct	119	78	85	*74*	87	82	81	79	77			
	11 Nov	145	96	92	94	83	32	87	86	84	81		
	12 Dec	107	132	114	105	104	94	100	94	92	90	87	
Year 06	13 len	51	126	124	112	105	104	96	101	96	94	91	89
	14 Feb	25	79	101	106	103	96	97	90	95	91	90	68
	15 Mar	61	*38*	*61*	82	89	87	86	88	83	88	85	64
	16 Apr	99	43	46	61	78	85	83	83	85	81	86	83
	17 Slay	104	63	62	59	69	81	87	85	85	66	82	87
	18 Jun	60	101	88	72	66	74	85	89	57	87	88	84
	19 Jul	59	82	88	81	70	67	72	61	86	85	84	66
	20 Aug	59	59	74	80	77	68	65	71	79	83	62	82
	21 Sep	65	59	59	70	76	74	67	65	69	77	81	80
	2.2 Oct	77	72	48	66	73	78	78	69	67	71	78	81
	23 Nov	77	61	74	70	66	74	76	75	70	68	72	78
	24 Dec	95	77	80	75	71	69	74	77	76	71	69	72
	Total	1,915											

4. Sample of Bottom up forecasting with Holt's exponential smoothing

High Growth Items:
Bottom-UP
Holt's Exponential
Sticker Label 44

				Sell?			Sat 16			Set 19			646 23			84 21		
				Level	Trend	New	Level	Trend	New	level	Trend	New	Level	Trend	New	Level	Trend	New
			Actual *(P28)*	0.1	01	Forecast	0.1	33	forecast	0.1	0.5	Forecast	0.1	3.7	Forecast	03	3.1	Forecast
Year 05	1	Jan	3,529	3.529	566	-	3,529	566		3.529	566		MD	566		3,529	566	-
	2	Fat	4.095	4,095	566	-	4,095	564		4,035	566		4095	546		4,805	566	-
		Mar	7,219	4,916	591	4,660	4,915	642	4,660	4,916	693	4,660	4,916	745	4,660	5,426	642	4,660
	4	Apr	8.331	5,769	619	5,507	5,835	725	5.558	5.852	830	5,609	5,928	932	5.661	6,748	710	6,3%
	5	May	6,493	6.41?	620	6,409	6,554	723	6.561	6.689	819	6,711	6,823	906	6,659	7,169	551	7.458
	6	cur	5,331	6.867	603	7.037	7.083	665	7.278	7.290	710	7.506	7,489	735	7,726	7.094	606	7,850
	7	3a	3,854	7,109	567	7,470	7.360	549	7,748	7,557	503	8.000	7,731	433	5,227	6,553	491	7,700
		Aug	6,634	7.572	557	7,676	7,761	510	7,908	7,944	439	8,090	8.064	322	6223	6,928	478	7,380
	9	Sep	7.796	8.095	553	8,129	6,241	495	8,291	6316	401	8.374	6,337	250	8.386	7,516	490	73%
	19	Oct	6,560	6,440	532	5,649	6,519	410	8,737	5,502	293	8,718	8432	137	5,697	7,573	447	8,006
	11	3c	12,516	6327	568	8972	9,306	537	6949	0165	460	8,795	5.937	415	6539	9,389	561	6,019
	12	Dec	5,731	9,775	556	9,895	9,732	534	9.643	9,554	434	9,647	9293	272	9.353	9.585	545	9,951
Year 06	13	:an	7.889	10.090	532	10.335	19,391	433	10,235	9.779	319	9,969	9,465	245	9,642	9,466	476	10,139
	14	Feb	6.878	10.247	494	11,622	10.079	327	10,435	9.765	167	10.108	9,447	45	3,732	9.019	386	9,936
	15	M	6.593	13.32?	453	10,742	10.024	212	10,406	9.616	1	9,952	9.209	- 155	9,495	6,560	302	9,405
	16	Apr	5,449	10.246	420	10,779	9.758	69	10,236	9,193	209	9,515	6,589	- 407	9,045	7.838	199	8,862
	17	May	26,147	12,266	562	10.846	11,528	579	9,825	10.775	614	5986	10,115	692	6.262	13,651	7E4	8,036
	15	hr.	13,759	12,021	541	12,828	11.573	535	12,12	11,355	649	11.459	11.003	571	11.030	13,339	653	14,444
	19	Jul	5,597	13,405	465	13,162	11,820	331	12,512	11,394	327	12.038	11.248	434	11,576	11.473	401	13,392
	20	Aug	7.010	12,254	437	12.870	11,537	177	12,151	11,249	91	11,720	11,215	107	11.682	10.415	255	11,875
	21	Sep	6,284	12,042	342	12,691	11.254	9	11,814	10.827	165	11,34)	10,612	- 252	11,321	9,331	122	10,671
	22	Oct		11.736	276	12,384	10,716	155	11.262	13.175	459	10.661	10.082	- 365	10.555	8.357	12	9,453
	13		11.201	11,911	268	12,002	10,623	136	10,561	9.410	337	9,75,6	9E65	- 465	9,498	9.215	97	6,366
	24	Dec	16.25?	12,756	329	12.189	11.266	97	10.489	13,442	97	9.573	10.108	168	9,302	11,955	365	9,316

5. Sample of forecasting performance by using MSE with Top down forecasting

Top-Down

Forecast Accuracy By Simple Exponential S thin

Com 42·342

			0,1 MSE	0.2 MSE	0,3 MSE	0,4 MSE	0.5 MSE	0.6 MSE	0,7 MSE	0,8 MSE	0.9 MSE	1 MSE
Year 05	1	Jan										
	2	Feb	23.51	13,55	23,55	23.55	23.55	23.55	2155	23.56	23.55	23.55
	3	Mar	52.16	52,16	52.16	52.16	52.15	52,15	52,16	52.16	52.16	52.16
	4	Apr	856.41	911.75	937.45	963.51	989.92	1,01649	1,043.91	1471.30	1,099,14	1.127,33
	5	May	1,37	11.13	31,42	63,64	109,29	169,90	247,10	342.55	458,03	595,26
	6	Jun	10134	3.30	32.22	152,31	328.29	526,16	714,75	966.91	960.84	96167
		3t	16.78	13,35	644	4,31	4.37	6.51	11,43	20.19	33.60	51.69
	5	Aug	285.18	108.37	31,77	4.34	0,46	9,54	29.66	64.63	122,64	215,36
	9	Sep	999.14	931.50	701.38	655.46	642.51	650.12	672.23	707.53	758,57	931,26
	10	Oct	58.50	0,13	2155	96.90	156,72	295,97	427.28	595.04	775,47	1,056,52
	11	Nov	87.20	3.45	64,65	124.62	151.64	145,57	113.26	65.56	33,06	0,11
	12	Dc	6.478.60	5,741,46	5,54431	5,62157	8643.44	6.141,41	6.479,65	6418.45	7,116.33	7,366.82
`fear 06	13	Jan	1.635.94	892.82	501,14	260.56	104.91	18.04	4,23	76.70	251.68	543.41
	14	Feb	596.29	1,334.76	1.940,32	2,414.49	2,776.49	3,026.74	3152.25	3,136.01	3,965.10	2433,07
	16	Mar	3,394.01	4.501.00	4,92117	4.690.66	4,265.26	3,728,47	3,104,64	2.483.24	1.919.86	1.455.69
	16	Apr	441	0,07	9,33	59.37	165.15	330.80	527.31	[illegible].39	913.32	1,057,54
	17	May	639.37	487,60	545,99	642,19	704.74	698.86	618.76	482.34	321.92	172,53
	16	Jun	2.66159	3.305,26	3.070,55	2,808.40	2.726.95	2.815.86	3,000.82	3.181.70	3,253,36	3,133,18
	19	Jul	252.08	240,64	292.66	347.44	391.77	429,07	466,91	111.07	563.05	619.37
	10	Aug	1,447.56	1.582.80	1,473,46	1.425.98	1.460.34	1,549,96	1676.14	1436.74	2.041.1	2.302,91
	21	Sap	25.49	33,30	63.10	93.91	122,33	151,61	185.10	228.11	380,91	349,03
	22	Oct	175.93	165.26	228.50	246.66	242.70	22532	20033	185.97	131.42	90.03
	23	Nov	1,705.75	1.876.70	1,949,01	2,147.76	2,431.06	2,756.09	3,098.56	3.440.46	3,760,99	4.032.78
	24	Dec	71.69	7762	97,79	111,89	127.70	151,77	188.29	24049	31303	407,29
		Total	**946.16**	**564,75**	976.26			1	1.		223,75	1,263.33