Sales Forecast at Frisian Flag Indonesia

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Management summary

Theme and motive

The forecasting accuracy for powder does not meet the standard set by Frisian Flag Indonesia. Currently the sales forecast (SALFO) for powder products does not meet the standard for forecasting accuracy of 90% of more set by the management. For some powder products the accuracy is less than 80% accurate. By applying a forecasting framework from literature a recommendation is given to adjust the sales forecast policy.

Recommendation

First of all, in the new policy Frisian Flag Indonesia should include a moment to perform a data clean up. Next we recommend exponential smoothing because it is easy to understand and implement. Furthermore, we show that it will not perform worse than the current method. Another advantage is that it is much faster than the current method. After a forecast is created using the mathematical model, human input should be taken into account using an inter-disciplinary meeting. Personnel from different departments should be present and give their adjustments to the SALFO, including the reasons for the adjustment. Personnel present at this meeting must have decision power to change the SALFO. After the meeting the SALFO should be fixed. For the 3 month forecast we suggest to forecast on an ingredient level. Forecast accuracy should be measured before and after human input, making it possible to measure the performance of the human input and the mathematical model seperately.

Arguments

- For the historical data to be useful, it should depict ***demand*** and not ***sales.*** Sales are influenced by a lot of issues from the company like problems in production and promotion activities. These issues are of a temporary nature. For example decreased sales due to problems in production are not representative for following months. This is the reason why sales figures should be cleaned in order to get demand figures.
- Currently the SALFO preparation includes a lot of checks and adjustments on different levels in the company. These checks and adjustments take a lot of time and result in a delayed delivery of the SALFO to the production department.
- Using a smoothing procedure such as exponential smoothing helps ensure a speedy delivery of the SALFO. Also it will probably outperform the current mathematical model, although this is not known for sure. This is because the current forecast accuracy before and after the human input is not known. The accuracy before the human input is necessary in order to measure the performance of the mathematical model. Measuring before and after the human input also makes it possible to measure the performance of the human input.

Contents

1 Introduction

FFI is the leading producer of dairy products in Indonesia. It produces sweetened condensed milk (SCM), powders in different flavors, liquid milk in small bottles, and creamers for a sister company named Kievit. Most of the goods that are produced are for the domestic market, 12% is exported to Nigeria and West Africa and since the 2nd semester 2006 another extension is made to the Friesland Foods affiliates in Malaysia and Vietnam. In Indonesia, Frisian flag is the number one player in the dairy market; the second largest player is Nestle. The company is experiencing higher than desired forecasting errors. The primary subject of this research is to find cause(s) and solutions for this problem.

1.1 Problem Identification

The forecasting accuracy for powder does not meet the standard set by Frisian Flag Indonesia. Currently the sales forecast (SALFO) for powder products is lower than the goal of 90% accuracy. Certain powder products have an accuracy of less than 80%. For a detailed overview of the forecasting errors on product level, the reader is referred to the second column of the table in appendix X). The management has set the goal for forecasting accuracy at 90% accuracy or higher. The company defines accuracy of a SALFO as the difference in percentage between the forecast and the actual sales in the predicted period. Important applications of the SALFO in Frisian Flag Indonesia are planning production and ordering raw materials. Possible consequences of forecasting errors are stock outs of raw materials, lost sales, and high working capital due to excessive safety stock (Silver, Pyke, and Peterson, 1998). The production and logistics department sees the forecasting error as a problem. The departments are having difficulties in planning because of the forecasting error. Figure 1 gives a synopsis of the problem.

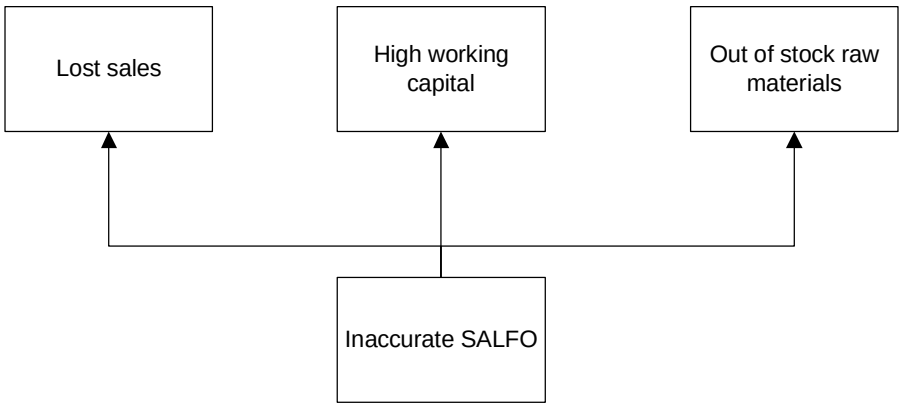

Figure 1 Problem identification

1.2 Goal

Goal of this research is to come to a recommendation for Frisian Flag Indonesia on how to improve the accuracy of their sales forecast for powder products, looking at the sales forecast preparation process. To reach this goal it is necessary to identify what is causing the current forecasting error. After the cause(s) of the error is (are) found, we can look for different solutions to improve the forecast accuracy.

1.3 The Research Question

The goal of this research is to recommend the company on how they can improve their forecast. To do this we will have to investigate the current forecasting policy. With forecasting policy we mean the method by which the forecast is being created. This current policy is then compared with recommendations on forecasting policies from the literature. The result will be a set of recommendations on how to improve the policy. Also experts inside the company are a source of information concerning the specific case of FFI. Furthermore, because it is important to use the right tool to measure the forecast accuracy in the first place, we need an investigation of the literature on appropriate measures.

How can the sales forecast of Frisian Flag Indonesia's powder products be improved?

1. *How is the sales forecast currently being prepared?*
2. *Which SALFO preparation policy is suggested by research?*
3. *What measures are there in the literature to measure forecast accuracy?*

1.4 Scope and Limitations

This research will only focus on the accuracy of the SALFO for powder products. Although the SALFO's for all products are created in the same manner, the focus of this research will be on the powder products' SALFO, because the accuracy of these forecasts are not up to standard. The SALFO's for the sweetened condensed milk and the liquid products is up to the standard set by Frisian Flag Indonesia. The research will investigate the SALFO for the short term, 1 and 3 months, because this is the period for which an accurate forecast is needed. The reason for this is that the lead times for raw materials is about 3 months and the production cycle length for this type of product is 3 weeks. One week is added for distribution. For sweetened condensed milk and liquid products, adjustments can be made during the month to cope with unexpected differences between actual demand and forecasted demand. Because of the way production of powder products is organized, this is not possible for powder products.

1.5 Research Methodology

The research consists of two main parts, a literature review and a review of the company. The literature review starts from the book of Silver, Pike, and Peterson (1998). In this book a model is presented with which we will analyze the company.

We have conducted the research of the company by performing interviews with personnel at Frisian Flag Indonesia as well as an analysis of the SALFO data, actual sales data and SALFO accuracy data for the period January 2006 to April 2007. In this period some products were abandoned and others were introduced. Therefore we adjusted the data to the products currently produced by Frisian Flag Indonesia. We then analyzed the data using Microsoft Excel.

Interviews with personnel were performed in person using a predetermined questionnaire. Decisions made on who to interview were made using own judgment as well as suggestions from Mr. Ario, my supervisor at Frisian Flag Indonesia, and suggestions made by interviewees themselves. To increase the validity we asked the same questions to multiple personnel, checking for consistency.

We have performed a literature review to determine different methods of forecasting and methods to analyze forecast accuracy. Also, the literature is a source for possible ways to improve the SALFO accuracy at Frisian Flag Indonesia.

To test the different proposed mathematical models, the models will be implemented in Microsoft Excel. Because the calculations for the models are repeated numerous times, a macro is used. This macro automatically calculates the parameters needed for the mathematical model.. To simulate actual forecasting, forecasts are generated for each month from August 2006 to April 2007. The parameters are calculated after each month with the objective to minimize the forecasting error in the preceding months. Data before April 2006 is not representative for current sales (missing products), therefore we do not incorporate data before this date.

Because this is a non standard way of working we have also established forecasts using a recommended method from literature for establishing the parameters needed for the different forecasting methods The results of this (and an explanation of these methods) are in appendix XI. The results are comparable to that presented in the research.

Because the historical sales data is not cleaned from irregular events in any way it will be difficult to compare different mathematical models. Unfortunately there is not much we can do about this because information about these irregular events is not available. Also, there is no information available about forecast accuracy before and after the human input, making it even more difficult to compare different methods. In this research we will assume that human input improves the forecast generated by the mathematical model. Therefore, if a different mathematical model than the one currently used by FFI, will generate a forecast that is just as good as the current method, we assume that this forecast with added human input will perform even better.

2 Theory

This chapter presents a forecasting framework. Later on in our research we will use this framework to analyze the forecasting policy at FFI. The forecasting framework is constructed out of three elements, historical data, mathematical model, and human input. Together these elements generate a forecast. To evaluate the forecast performance we need a measure of forecast accuracy. For this purpose we present different measures of the forecast error.

Predicting the future always exactly right is impossible. However, it is possible to improve the sales forecast by using the right policy and the right techniques. Hopp and Spearman (2001) point out the limitations of forecasts in the three laws of forecasting:

1. Forecasts are always wrong.
2. Detailed forecasts are worse than aggregate forecasts.
3. The further into the future, the less reliable the forecast will be.

There are many factors influencing customer demand. Dilworth (1999) describes some of them in his article. The factors can be internal or external to the company.
Internal factors are for example:

- Advertising
- Sales effort
- Credit policies
- Quality

External factors are for example:

- Time of the year
- Competitor's efforts and prices
- Products life cycle
- Customers plans

A company, and especially the forecaster, has to be aware of these factors. By knowing what influences demand, the company can anticipate on future changes in demand. There are basically two different ways in which the forecast performance can be improved. The first is to actually improve the forecast itself by using a better policy. Second, it is possible to lessen the dependence on the forecast by, for instance, using shorter production cycles (Hopp and Spearman, p 415, 2001). Because lessening the dependence on the SALFO lies outside the scope of this research it will not be investigated. It is however worth noticing that Frisian Flag has made efforts in lessening the dependence by delaying the product differentiation in their production process.

We will now introduce a forecasting framework which we will use for our analysis. After that we take a closer look at the different elements of the forecasting framework and their influence on forecasting accuracy. The different elements are:

- Historical data
- Mathematical model
- Human input

Finally Section 2.5 will describe what forecast accuracy is according to literature and how it can be measured.

2.1 Forecasting Framework

Silver, Pyke, and Peterson (1998) suggest the forecasting framework as shown in Figure 2. A key element of their forecasting framework is a mathematical model. The mathematical

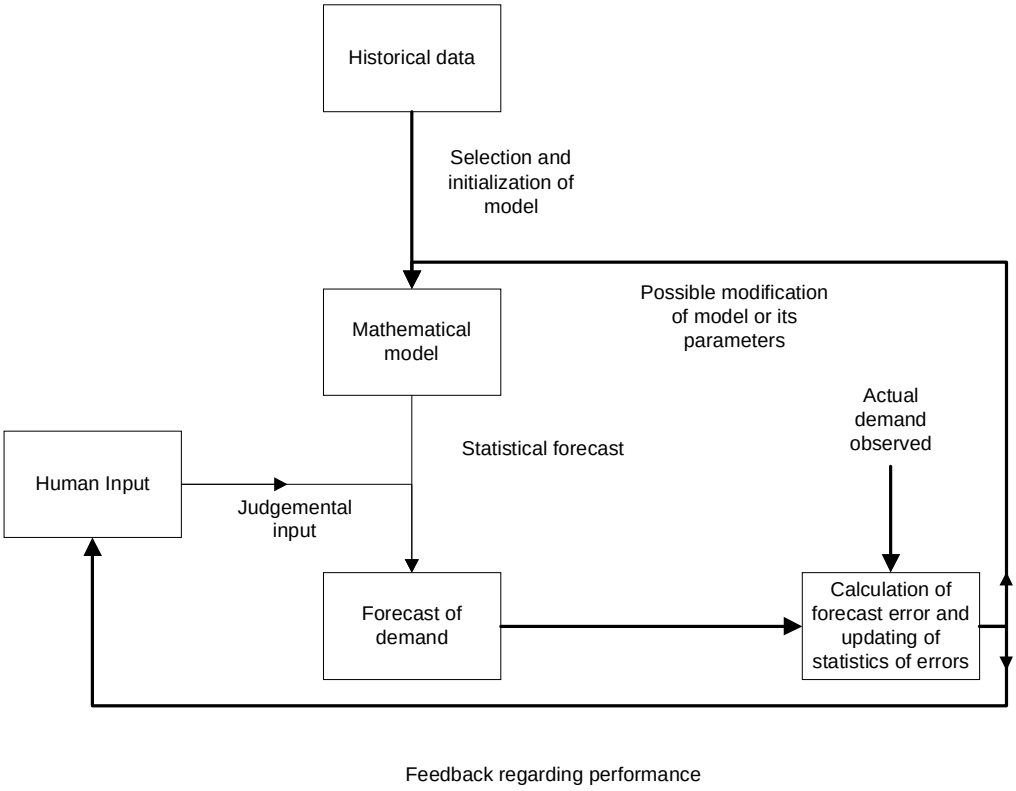

Figure 2 Forecasting framework (adapted from Silver, Pyke, and Peterson (1998))

model generates a forecast using historical sales data. This forecast is then judged by humans and if necessary they adjust it. This check makes it possible to adjust for future events known by the person but that are not taken into account by the model. Examples are an upcoming festivity that will increase sales or a promotion that will increase sales. Silver, Pyke, and Peterson (1998) call this informed judgment. When the forecast is finished and actual demand has occurred, the two are compared and the sales forecast error is calculated.

2.2 Historical Data

The input for the mathematical model in the forecasting framework is historical data. As indicated in the introduction this data should depict actual demand for the given period and not the sales generated. However, because it is very difficult to measure actual demand, it is necessary to adjust actual sales data for any irregularities that cause the sales data to not depict actual demand. These causes can be numerous but the main causes are:

- Missed sales due to stock out
- Higher sales due to promotions
- Higher sales before price increases or higher sales after a price decrease

These irregular events should be filtered out of the data (Dilworth, 1999). Not filtering the changes, caused by irregular events, from the data will cause the raw sales data to not depict demand. Using this data in any forecasting policy will result in bad performance. This is called the "garbage in, garbage out" syndrome (Silver, Pyke, and Peterson, 1998).

2.2.1 *Influence on forecast accuracy*

The use of historic sales information that does not reflect actual demand results in a forecasting error. The amount of products sold in one month does not necessarily reflect actual demand. Data should be adjusted for lost sales. These lost sales can have a lot of causes, for example lack of product or capacity (Dilworth, 1999). In this case demand can be higher than sales. On the other hand, if the company decides to have a promotion in this month, sales are likely to go up. This rise in sales however is not likely to be of a permanent nature and therefore will not be a good measure of future demand because future demand will be overestimated. Historical data has to be adjusted for these events (Dilworth, 1999).

2.3 Mathematical Model

There are many ways to use historical sales to predict future sales. Maybe the simplest method is to use last month's sales as a prediction for next month's sales. A bit more sophisticated is taking an average over a couple of months of historical data. In general there are two groups of forecasting methods. The first group is the so called time series analysis. The two methods mentioned, using last month sales and taking averages, fall into this category. Other methods in this category are moving average, exponential smoothing and double exponential smoothing. The second category of forecasting methods uses causal models. These models try to predict future sales using another variable that moves in the same direction as sales, only earlier. For example, the oil price can predict the price of plastics. Causal models are not used in this research.

Next the formulas are given for exponential smoothing and exponential smoothing with a trend (Hopp and Spearman, 2001, p421-425). Both fall into the time series analysis group.

2.3.1 *Exponential smoothing*

The underlying demand pattern assumed for this model is (Silver, Pyke, and Peterson, 1998):

$$A(t) \quad a + \varepsilon_t \qquad 2.1$$

In this formula a is an estimator of A(t), the actual sales for this period. ε_t is an error term, part of the demand that cannot be predicted.

The smoothing formulas are:

$$F(t) \quad \alpha A(t) + (1-\alpha)F(t-1) \qquad 2.2$$

$$f(t+\tau) \quad F(t) \qquad \tau \quad 1,2,... \qquad 2.3$$

- Where α is a smoothing constant between 0 and 1 chosen by the user.
- f(t+ τ) = the forecast in period t for period t+ τ
- A(t) = the actual sales in period t
- F(t) = smoothed estimate in period t (estimator of a in Eq. 2.1)

The method works by taking a weighted average of this period's demand and from the prediction made in the previous period for this period's demand (F(t-1)). Because in each period a certain part of previous forecasts is taken into account, information from many

periods back is stored in F(t).Two points about the exponential smoothing model (Hopp and Spearman, 2001, p422):

1. Lower values of α will make the model more stable, but less responsive, to changes in the process being forecast.
2. The model will tend to underestimate parameters with an increasing trend, and overestimate parameters with a decreasing trend.

2.3.2 *Exponential smoothing with a linear trend*

The underlying demand pattern assumed for this model is (Silver, Pyke, and Peterson ,1998):

$$A(t) \quad a + bt + \varepsilon_t \qquad 2.4$$

In this formula, A(t) are again the actual sales, a is an estimate of the level trend and ε_t is an error term. The difference with simple exponential smoothing is the addition of the term bt. This term is the describing the linear trend, i.e. how much demand is growing per period.

The smoothing formulas are:

$$F(t) \quad \alpha A(t) + (1 \quad \alpha)\left[F(t \quad 1) + T(t \quad 1)\right] \qquad 2.5$$

$$T(t) \quad \beta\left[F(t) - F(t-1)\right] + (1 - \beta)T(t-1) \qquad 2.6$$

$$f(t+\tau) \quad F(t) + \tau\, T(t) \qquad 2.7$$

Where α and β are smoothing constants between 0 and 1 to be chosen by the user. F(t) and A(t) have the same meaning as in the simple exponential smoothing model. Furthermore:

- T(t) is the smoothed estimate of the trend. (estimator of b in Eq. 2.4)

The difference with simple exponential smoothing is that a trend is added. With a trend we mean that sales increase (or decrease) from month to month. The trend (T(t)) value is calculated in the same way as F(t) is calculated in the model without trend. So by taking the weighted average of the actual observed trend and the trend value of the last period. This is done in Eq 2.6. The actual trend value for this period is calculated by subtracting the smoothed estimator for the level demand made in the last period (F(t-1)) from F(t). The forecast for period t+τ is then F(t) + τT(t).

2.3.3 *Influence on forecast accuracy*

The mathematical model generates the basic forecast and is therefore a key influence on the SALFO accuracy. The mathematical model can consistently over- or underestimate the future sales if an inappropriate model is used.

2.4 Human Input

After the chosen mathematical model produces a forecast human input is required (see Figure 2). This human input is necessary because no mathematical forecasting model is able to keep into account all factors influencing the forecast (Hopp and Spearman, 2001, p 430). Therefore it is a good idea to adjust the model using knowledge about future sales not incorporated in the model. This knowledge can be about price discounts for instance. Price discounts have an influence on sales but they are not incorporated in the mathematical model.

The performance of the human input should be measured. This can be done by keeping the forecast created by the mathematical model and comparing its performance with the forecast after the human input (Silver, Pyke, and Peterson, 1998). Furthermore, Silver, Pyke, and

Peterson (1998) point out that forecasts are sometimes changed by personnel to serve their own goals, for instance reaching certain targets. An example that Silver, Pyke, and Peterson (1998) give are sales personnel underestimating demand if they are rewarded for exceeding sales targets that are, partially, based on the sales forecast.

2.4.1 Influence on forecast accuracy

The human input used for preparing the sales forecast is one of the key aspects determining the accuracy of the forecast. The human input adjusts the forecast made by the mathematical model. If the wrong people are asked for their input, the forecast error will increase.

2.5 Forecast Accuracy

There are at least three reasons for calculating the forecast error (Silver, Pyke, and Peterson, 1998).

1. To check whether model parameters need to be adjusted or if there is a need to adjust the entire model.
2. The forecast error determines the level of safety stock needed in order to maintain the desired customer service level.
3. With the forecast errors it is possible to review the performance of informed judgment to adjust the forecast generated by the mathematical model.

The literature suggests a couple of measures of forecast accuracy. The measures penalize errors in different ways. The mean square error for instance penalizes large errors more than small, whereas mean forecast error checks whether the forecast is on average biased. We will use these different measures to measure the current accuracy and the accuracy of alternative policies. Below we shortly explain four different measures for forecast error. (Dilworth, 1999). In each formula A(t) are the actual sales in period t, F(t) are the forecasted sales for period t, and n is the total number of periods.

2.5.1 *Mean Absolute Deviation (MAD)*

This is simply the average absolute error over a certain time period. The formula for calculating MAD is:

$$MAD \quad \frac{\sum_{t=1}^{n} | A(t) - F(t) |}{n} \qquad 2.8$$

2.5.2 *Mean Square Error (MSE)*

This measure penalizes large errors more than small ones by taking the square of the error
The formula is:

$$MSE \quad \frac{\sum_{t=1}^{n} (A(t) - F(t))^2}{n} \qquad 2.9$$

2.5.3 *Mean forecast error (MFE)*

This measure checks if the forecast is unbiased. It simply takes the sum of the forecast errors over a certain period and divides them by the number of periods.
The formula is:

$$MFE \quad \frac{\sum_{t=1}^{n} (A(t) \quad F(t))}{n} \qquad 2.10$$

2.5.4 *Mean Absolute Percentage Error (MAPE)*

This measure divides the error by the actual sales. The result is a percentage error of total sales.

$$MAPE \quad (\frac{100}{n}) \sum_{t=1}^{n} | \frac{A(t) \quad F(t)}{A(t)} | \qquad 2.11$$

3 Current SALFO policy

The previous chapter introduced forecasting theory that we are going to use in our research. This chapter begins with a short description of the company. After this, Section 4.2 gives a detailed description of the current process of creating a SALFO at Frisian Flag Indonesia.

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4 Analysis

In this chapter we analyze the current SALFO policy using the framework from Silver, Pyke, and Peterson (1998) presented in Chapter 3. Three key aspects of the framework are applied to FFI, namely the historical data, mathematical model, and human input. Finally we analyze the accuracy measure used by FFI.

Most sales forecasting techniques use historical data to predict future sales. To come from historical data to a prediction of future sales certain steps have to be performed. These steps are (adapted from Silver, Pyke, and Peterson(1998). see also Section 3.1):

1. Collecting the historical data
2. Using this data to build a mathematical model that predicts future sales based on the historical data
3. Having persons adjust the forecast based on their informed judgment

The reason for an inaccurate SALFO can lie in either one of these steps. Therefore we will analyze the SALFO preparation process as described in Chapter 3, using these steps. Figure 4 depicts causes and effects of the inaccurate SALFO. The effects were already described in Chapter 1.

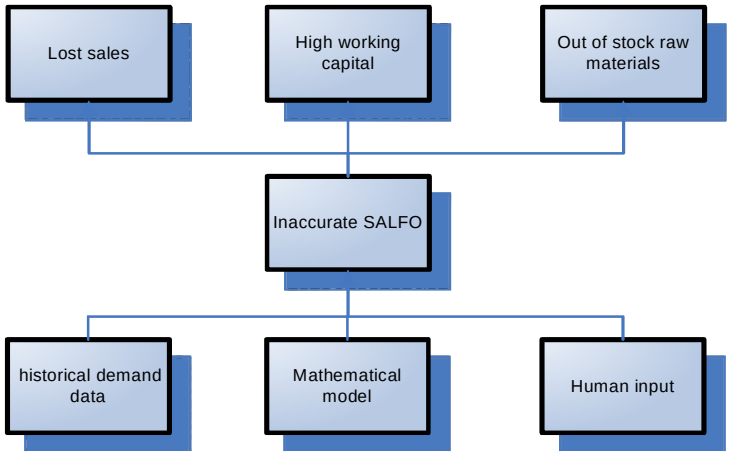

Figure 4 Problem analysis

4.1 Historical Data

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4.2 Human Input

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4.3 Mathematical Model

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4.4 Accuracy

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4.5 Conclusion

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5 Alternative SALFO policies

We will now come to an advice for an alternative policy that will deal with the issues revealed in Chapter 4. Because the policy must fit the company, we will add constraints on the new policy.

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6 Conclusion

There are certainly possibilities to improve the SALFO accuracy at Frisian Flag Indonesia. There are three key aspects which are currently the cause of the inaccurate forecast.

- First, there is no data clean up. Historical sales figures are not adjusted for lost sales, promotions and other irregular events. For the historical data to be of any use it should depict *demand* and not *sales.* Sales are influenced by a lot of issues from the company like problems in production and promotion activities. These issues are of a temporary nature. Decreased sales due to problems in production are not expected to be representative for following months.
- Currently the SALFO preparation includes a lot of checks and adjustments on different levels in the company. These checks and adjustments take a lot of time and result in a delayed delivery of the SALFO to the production department.
- Using a smoothing procedure such as exponential smoothing helps ensure a speedy delivery of the SALFO. Also it will probably outperform the current mathematical model, although this cannot be known for sure. This is because the forecast accuracy before and after the human input is not known. The accuracy before the human input is necessary in order to measure the performance of the mathematical model. Measuring before and after the human input also makes it possible to measure the performance of the human input.

The recommendation for the new SALFO policy is then:

First of all in the new policy there should be a moment to perform a data clean up. Next we recommend exponential smoothing because it is easy to understand and implement. Furthermore, research suggests that it will not perform worse than the current method. Added advantage is that it is much faster than the current method.

After the mathematical model creates a forecast, human input should be taken into account using one interdiciplenairy meeting. Personnel from different departments should be present and give their adjustments to the SALFO, including the reasons for the adjustment. Personnel present at this meeting should have decision power to change the SALFO. After the meeting the SALFO should be fixed. Section 4.2 desctibes how this meeting can be organized For the 3 month forecast the suggestion is to forecast on an ingredient level. Ingredient usage is less variable because of pooling effects. Disadvantage of using ingredients is that changes in recipes have to be taken into account. See appendix VI for a flowchart of this policy. Appendix VII shows an alternative policy in which the confirmed monthly orders are also taken into account when making the SALFO. This policy will take more time.

Production has to make an estimation of raw material demand using the SALFO. This estimation is used by the purchasing department for their procurement. The SALFO only incorporates the opinion on future demand from the different distribution wholesalers for the next month. Purchasing however needs an estimate for month 3 and beyond because of the lead times on raw materials. It would therefore be better to let the distribution wholesalers make a prediction for the next three months. An alternative would be to predict three months ahead using historical data on ingredient usage. Ingredient usage is less variable because of pooling effects. Disadvantage of using ingredients is that changes in recipes have to be taken into account.

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7 Recommendations

The recommendations below are intended to help Frisian Flag Indonesia deal with the SALFO inaccuracy and follow from the report. Furthermore we give recommendations for further research.

- Measure forecasting accuracy before and after human input. This makes it possible to measure the performance of the mathematical model and the human input separately.
- Create clarity on how the SALFO created by the mathematical model is adjusted using human expertise of for instance the trade marketing director or the consumer marketing director. State the reason for the adjustment and make it clear why the SALFO should be adjusted by the amount suggested. For instance by using the percentage increase in sales a promotion created in the past as a prediction for the increase in sales a promotion in the future will create. By making it clear how a certain SALFO figure is established the chances of it being accepted by the consumers of the SALFO increase.
- Apply a smoothing technique to prepare a SALFO instead of the current method used to analyze historical sales data. Further research however is necessary to determine if smoothing will increase accuracy. Before this can be done, historical sales data should first be adjusted for lost sales, promotions etc. The author has used Microsoft Excel to analyze the accuracy of exponential smoothing and exponential smoothing with a trend on the current data. It is a matter of minutes to create a SALFO using exponential smoothing or exponential smoothing with a trend in Microsoft Excel using macros.
- Plan promotions at least three months ahead so they can be taken into consideration when buying raw materials.
- Realize that the current forecast accuracy measure, dividing the forecast error by the SALFO figure, penalizes under-forecasting more than over-forecasting. Also it appears that the current SALFO policy of FFI results in a bias were the policy on average predicts higher than actual sales.
- Have a plan on how to deal with forecasting errors. Expect the forecast to make errors because it is impossible to predict the future with very high accuracy (SP&P, 1998, p133)
- Because lessening the dependence on the SALFO lies outside the scope of this research, we have investigated it. It is however worth noticing that Frisian Flag has made efforts in lessening the dependence by delaying the product differentiation in their production process. –*CONFIDENTIAL*-
- –CONFIDENTIAL-
- Because large volume products have a higher influence on the performance of the company than small volume products, it is wise to put more effort in predicting sales for the high volume products, for example during the interdisciplinary meeting where the SALFO is discussed. –*CONFIDENTIAL*-

Recommendations for further research:

- Investigate the source of the current forecasting bias: is it human input, a trend in the data, or a another source we do not know about?
- Investigate the possibility to implement the SAP APO module. SAP APO makes it possible to incorporate promotion items etc. in the forecast. Also, it can automatically choose the best mathematical model for the forecast. Exceptions can be entered manually. (www.sap.com).
- Investigate if it is possible to forecast 3 months ahead on an ingredient level. This is also done in the Netherlands at Friesland Foods Cheese (Herman, 2007).
- Investigate the possibility to determine safety stock levels using the forecast accuracy. (Chockalingam, 2004)

8 Literature

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9 Appendices

Appendix 1 Distribution

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Appendix II CMO Process

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Appendix III SPO Process

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Appendix IV SALFO Process

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Appendix V General Workflow Production Planning and Inventory Control (PPIC)

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Appendix VI Proposal I SALFO Policy

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Appendix VII Proposal II SALFO Policy

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Appendix IX Sales per SKU per month in cartons

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Appendix X Accuracy of different SALFO mathematical methods for period August 2006 – April 2007

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Appendix XI Standard methods for finding F(0), T(0), and alpha

With the method employed in the main body of the article, every month the alpha values are recalculated, minimizing the average error in the last 6 months. This method is unorthodox. Therefore we have also calculated the values for alpha, T(0) and F(0) using a method recommended by literature (Silver, Pyke, and Peterson, 1998).

First we use as initial value for F(0) in the exponential smoothing model the average sales in January 2006 to May 2006. The initial values for F(0) is the average sales over the first five months January to May 2005. For exponential smoothing with trend we have used linear regression over the first five months to estimate the starting parameters.

To find a value for alpha we have minimized the average MSE in the months June 2006 to April 2007. We choose to round its value to one digit. Exponential smoothing is then performed using this value. The alpha value is now perfectly fitted to the data, overestimating the accuracy of the method.

To see if the fitting has a major influence on the performance we have divided the data in two parts. The first part is used to establish a value for alpha. With this value we measure the performance using the second part of the data. The results are comparable to that found by the method of the main article.

Results	fitted			
	MSE	MFE	FFI	MAD
exp sm	*–CONFIDENTIAL*		*–CONFIDENTIAL*	
exp sm trend	*–CONFIDENTIAL*		*–CONFIDENTIAL*	

	data 2 parts			
	MSE	MFE	FFI	MAD
exp sm	*–CONFIDENTIAL*		*–CONFIDENTIAL*	
exp sm trend	*–CONFIDENTIAL*		*–CONFIDENTIAL*	