Jenni Moisanen

Demand forecasting in the apparel industry

Helsinki Metropolia University of Applied Sciences

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The relatively recent trend of offshore sourcing in the apparel industry has led to long production lead times due to which companies operating in the field need to buy products months in advance their sale. This has increased the importance of demand forecasting in the apparel industry. The latest literature presents hundreds of forecasting methods and measures which leave companies with the difficulty of choosing the correct one and applying it in an appropriate manner.

The aim of this thesis is to investigate demand forecasting in the apparel industry through two parts. The theory section introduces the most relevant concepts comprehensively and the case study utilizes the findings in order to select and endorse the most valid forecasting measure and method.

The case study section of this thesis was conducted in co-operation with a global apparel company, which in the public version of the thesis will remain anonymous. The company's demand forecasting method was evaluated and measured through weighted absolute percentage error calculations which indicated a need for improvement in forecasting. Two improvement suggestions were introduced: 1) standardize the existing judgmental forecast method which is most suitable for the company by applying the presented five principles, and 2) enhance the agility of the existing supply chain.

Keywords	Demand forecasting, fashion, apparel

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1 Introduction

Predicting sales accurately in the apparel industry is generally considered challenging due to volatile demand of apparel products, which is easily influenced by several factors such as vagaries of weather, actions of opinion leaders and external changes including fluctuations in the economic situation. Despite the acknowledged difficulties, predicting sales in the industry is considered to be crucial due to the long lead times caused by the relatively recent trend of sourcing production and operations to other countries. In order to deliver the apparel items on time, suppliers need to start the production at a very early stage in which no up-to-date sales information is available to be used as a reference for the ordered quantities. Additionally inaccurate sales predictions lead, among others, to stock outs or high inventory, unfashionableness of products and inefficient resource utilization, which are all extremely costly and therefore should be avoided. Alternatively accurately predicting sales brings several benefits including increased customer satisfaction, efficient production and better pricing.

The interesting concept of predicting sales, more commonly referred to as demand or sales forecasting, in the rapidly changing apparel industry has been greatly researched during the past two decades. This has resulted in a large number of published forecasting ideas, methods and measures aiming to produce as accurately predicted demand as possible while admitting that an error-free forecast is never achievable. The variety of ideas available, coupled with the generally large forecasting errors, have made the process of choosing a valid forecasting method and applying it in an appropriate manner difficult for the companies.

1.1 Aim and Method of Study

This thesis aims to provide an understanding of the key concepts and issues related to demand forecasting in the apparel industry by investigating the topic more closely. The research is divided into two parts; theory and a case study. The theory utilizes secondary research to provide a comprehensive view of the current leading ideas whereas the case section looks at the specific case of a company operating in the apparel industry.

The case is based on the real-life situation of a global apparel company that is experiencing problems in the topic area. The focus is in the company's footwear division whose current situation is first explained and then measured by utilizing primary research. Ways for improved forecasting is suggested with the help of secondary research. The case study combines both quantitative and qualitative methods.

1.2 Limitations

Empirical research would be required in order to quantify the actual benefit of the forecast improvement ideas suggested in the case section. However due to the complex nature of the ideas such measures would be too extensive and not feasible for a bachelor dissertation. Additionally, due to the same reason the cost of inaccurately forecasted demand will not be defined.

Due to confidentiality restrictions this version of the thesis excludes company specific chapters, appendix and other private information.

2 Predicting sales in apparel industry

The apparel industry consists of companies that design and sell clothing, footwear and accessories. The industry used to comprise mainly wholesalers who designed and sourced products which were sold to retailers whose task was to sell the marked up items to the end-consumer at a profit. However nowadays drawing a line between wholesalers and retailers in the apparel industry has become more difficult and most companies in the industry possess both types of operations (Spencer, 2014). The whole industry has undergone a significant transformation during the past two decades due to the changes in the business environment.

During the past twenty years consumers in the apparel industry have become significantly more fashion-conscious which correlates to their developed lifestyles. In order to satisfy the changing customer needs, companies moved away from mass production. Whereas they used to produce standardized styles that did not change frequently due to restrictions set by factories they now started to find ways to constantly provide unique and refreshing products. This resulted in the increase of seasons, indicating the time which fashion products are sold. Also competition between the companies began to increase due to which companies found the desired cost advantage in shifting supply chains from product driven to buyer driven type which meant developing alliances with the suppliers. Here started the commonly accepted trend in the industry; sourcing manufacturing and processes to offshore places with low labour costs. (Bhardwaj and Fairhurs, 2010: 165-168) Also technology plays a big role in the transformation of the apparel industry. The dramatic increase in instantaneous knowledge in relation to new trends and brands have highly contributed to the rise in customer requirements while at the same time improved retailers, wholesalers and manufacturers capabilities to share data and thus make better business decisions (Nenni, Giustiniano & Pirolo, 2013: 2).

As a result of the stated changes products in the apparel industry possess extremely short life cycles, highly unpredictable demand and long lead times due to which both sell-outs as well as overstock of merchandise caused by supply-demand mismatches are common and at the same time extremely costly. In order to drive efficient operations management plans in apparel industry where demand is uncertain, historical data lacking and seasonal trends usually strongly present forecasting demand is crucial (Nenni et al. 2013: 1). "Merchandise Planning Process" refers to the process of matching supply with demand in the retailing industry. Its fundamental aim is to ensure that the product is available to the customer at the right quantity, price, time and place (Rajaram, 2008: 106). Accurately forecasted demand may lead to increased customer satisfaction, reduced stock outs, efficient production, reduced product obsolescence, better managed shipping, superior negotiation terms with the supplier and more informed pricing as well as promotion decisions (Stock & Lambert, 2001: 281-282). These are all benefits which companies aim to attain when both practicing and improving demand forecasting in the apparel industry.

2.1 Demand management

When talking about predicting future demand, professionals tend to refer to both planning and forecasting which are often used as substitutes although a clear distinction can be made between the two terms. Planning seeks an answer what the future should look like while forecasting focuses on what the future situation will actually look like. Forecasts are only needed when there is uncertainty about future decisions as in case there is no uncertainty, events can be controlled. Planners can use different forecasting methods to predict the outcome of their plans and if the outcome is not satisfactory, they can revise their plans. Instead of forecasting themselves decision makers can buy insurance, leaving the forecasting to an external party or use just-in-time systems which push the forecasting to the supplier. (Armstrong 2001: 2-3) Although possessing different definitions, planning and forecasting are still highly related. "Proper control of materials management requires forward planning whereas forward planning, in turn requires good forecasts" (Stock & Lambert, 2001:281).

In broader terms, when discussing about planning and forecasting the future demand we can refer to demand management. According to Jacobs, Berry, Whybark and Vollmann (2011: 34) in demand management forecasts of the quantities and timing of the customer demand are developed in addition to which Stock and Lambert (2001: 69) define the concept of demand management as "balancing the customer requirements with the firm's supply capabilities". Demand management aims to provide capabilities to increased accuracy, flexibility and consistency in determining inventory requirements required due to increasing complexity of product offerings and marketing tactics in conjunction with shorter product life cycles. Essentially demand management integrates historically based forecasts with other information that could influence future sales activity such as promotional plans, pricing changes and new product introductions, to obtain the best possible statement of demand requirements (Bowersox, Closs & Cooper, 2010: 134). A well-functioning demand management system uses point-of-sale and key customer data to reduce uncertainty and provide efficient flows throughout the supply chain (Stock & Lambert, 2001: 69). Point-of-sale (POS) data tells the manufacturer and retailer what is sold, when and at what price however the data cannot explain why or what consumer needs, wants or desires (Brannon, 2000: 23).

2.2 Demand forecasting

"Part of managing demand involves attempting to determine what customers will purchase and when." (Stock and Lambert, 2001: 69) This is more precisely referred to as demand forecasting and it involves determining the amount of product that customer will require at some point in the future. The forecast identifies requirements for which the supply chain must schedule inventory and operational resources. Accurate forecasting should be a major focus for situations where long replenishment lead times and large economies of scale are both present (Bowersox et al. 2010: 141). Fashion items are exactly such, however their demand is also highly unpredictable due to their short life cycles which are typically just a few months. These items are often bought just once, at a time prior to the start of the actual sales season and thus the decision of how much to buy is not based on the actual sales of the product, but merely on the subjective judgment of merchandisers and buyers in how well it will sell (Rajaram, 2008: 109).

Making decisions under uncertainty is less than optimal and allocating resources among logistics activities without knowing what product will be needed is extremely difficult. Because of this it is imperative for organizations to undertake some type of demand forecasting after which they communicate the results to different departments that need to know precisely how much product will be required. Forecasts of future demand affect the promotional strategies, allocation of sales force, pricing and market research activities. Additionally the forecasts also determine production schedules, purchasing and acquisition strategies. (Stock & Lambert, 2001:20) Poor forecasting effects are stock outs or high inventory, unfashionableness of products, low service level, rush orders, inefficient resource utilization and bullwhip propagating through the upstream supply chain (Nenni et al. 2013: 1).

Sales forecast can be used as a synonym for demand forecast since sales forecast is defined as the projection of expected demand given a set of environmental conditions. According to Brannon (2000: 260-261) sales forecasting requires access to three kinds of information.

1) Internal data on sales volume and marketing actions
2) Future information regarding the marketing and product distribution
3) External data relevant to market and information on general economic political and cultural conditions

The internal data allows the forecaster to group the data in different ways to evaluate recent and past performance. Some of the basic ways to group data are by sales volume- comparing sales of product or product group to the actual sales, by geographic area- break sales down by geographic area and compare actual sales to potential sales given the demographics, by time period- discovering seasonal effects by comparing variations in sales against time and lastly by sales channel- comparing sales performance types of distribution and retail venues. The company can decide if the sales will be tracked on stock keeping unit- level. Stock-keeping unit, from now on referred to as SKU refers to an individual product in a certain model and color. Every SKU possesses an individual combi code which is the combination of material code and color code. Besides SKU- level recording, the company can also track the sales on more general level such as product or product family. The sales projections based on internal data will be inaccurate unless they are corrected to take into consideration external data such as expectations for the economy and the effects of the product life cycle.

2.3 Forecasting components

Several sources of literature including Bowersox et al. (2010: 142-144) introduce the basic forecasting components on SKU level. The forecast components include: (1) Base demand, (2) Seasonal, (3) Trend, (4) Cyclic, (5) Promotion and (6) Irregular. Base demand is assumed to be the average sale, whereas the other components excluding irregular, can be considered as multiplicative factors of the base level available to support positive or negative adjustments. The resulting model is as follows;

$$F_t = (B_t \times S_t \times T \times C_t \times P_t) + I$$

where

F_t = forecast quantity for period t
B_t = base level demand for period t
S_t = seasonality factor for period t
T = trend component index reflecting increase or decrease per time period
C_t = cyclical factor for period t
P_t = promotional factor for period t
I = irregular or random quantity.

Figure 1 Forecasting components

Base demand is the forecast for items which do not possess seasonality, trend, cyclic, or promotional components. The seasonal component is an annually frequent upward and downward movement in demand, such as increased demand for toys before Christmas. The trend component represents a long-range shift in periodic sales and it can be positive, negative or neutral. The cyclic component refers to period shifts in demand, lasting more than a year such as business cycle in which the economy typically swings from recession to grow cycles every 3 to 5 years. The promotional component is aimed to show the swings initiated by a firm's marketing activities such as advertising or promotion. The irregular component includes the unpredictable quantities that do not fit within the other categories. This component is impossible to predict as it is random in its nature. When developing a forecast the forecaster must aim to minimize the magnitude of the random component by tracking and predicting the other components.

While each forecast does not include all of the presented components, it is useful to understand the behavior of each so the components can be tracked and integrated accordingly (Bowersox et al. 2010: 142-144). Different forecast methods which are explained later refer to some of these forecasting components and thus it is important to be aware of the meaning behind them.

2.4 Forecasting process

"Although forecasting is far from an exact science, the forecast management process should incorporate input from multiple sources, appropriate mathematical and statistical techniques, decision support capability and trained and motivated individuals" (Bowersox et al. 2010: 144). Armstrong (2001:8) divides forecasting in to the stages presented in Figure 2.

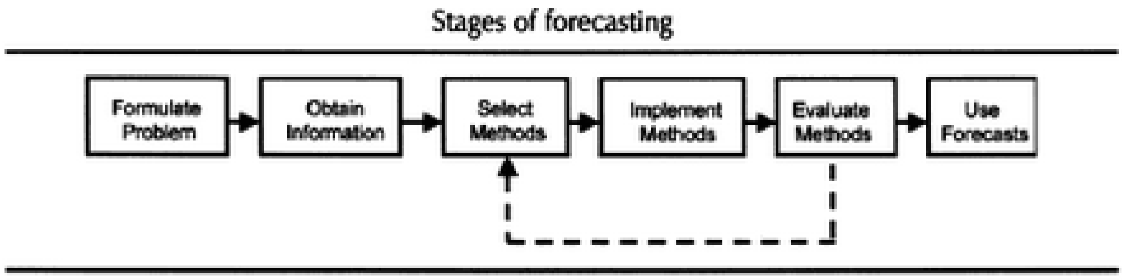

Figure 2 Forecasting process

The process starts by identifying the situation after which relevant data is collected. The forecasting method is selected and implemented which is followed by evaluation of the method by measuring the accuracy. Depending on the outcome, the method is either used or a new method needs to be chosen.

2.5 Forecasting methods and techniques

"Companies in the fashion industry have been trying to manage the demand for many years, which has brought about the development of a number of specific forecasting methods and techniques" (Nenni et al. 2013: 1). Demand forecasting requires the selection of appropriate mathematical or statistical techniques to generate periodic forecasts. (Bowersox et al. 2010: 147) Selecting which techniques are appropriate for a particular situation can be considered confusing. However, while there are hundreds of well-established forecasting methods and techniques, the manager needs to understand only a few basic techniques as all the others are variations on the basic group (Brannon, 200:261-264).

Different literature sources aim to categorize forecasting techniques into different categories, enabling the reader to understand the differences more clearly. Brannon (2000: 264) refers to earlier work (Menzer & Bienstock, 1998) and suggests that different techniques can be seen as falling into three broad categories: qualitative techniques, time series forecasting, and correlation or regression techniques to which Chase (2013:83-84) agrees. Bowersox et al. (2000:147) categorize the forecasting techniques into almost identical subgroups which they term as qualitative, time series and causal techniques. In order to understand the concepts of these forecasts these different techniques will be now further explained.

2.5.1 Qualitative forecasting technique

Qualitative techniques are time consuming and rely highly on expertise which is why they are also costly. Qualitative techniques are most ideal in situation where only a little historical data is available and therefore managerial judgment is required. Utilizing input from the sales force as the basis of the forecast for a new region or a new product is an example of a supply chain application of a qualitative forecast technique. Qualitative forecasts are developed by using surveys, panels and consensus meetings. However they are generally not appropriate for supply chain forecasting due to the fact that a lot of time is required to generate the forecasts on detailed SKU level (Bowersox et al. 2010: 147). Qualitative techniques are often referred to as subjective and judgmental techniques. (Brannon, 2000: 265)

> We have found that subjective forecasts typically have an average error of 50% or more. As a result, retailers frequently buy too little of some fashion products, resulting in lost sales and profit margin and too much of other products resulting in excess supply that must be marked down in price at the end of the season, frequently to the point where the product is sold at a loss (Rajaram, 2008: 109-110)

2.5.2 Time series forecasting technique

Time series techniques are statistical methods used when historical sales data contains relatively clear and stable relationships and trends are available. "Time series techniques are quantitative- that is they use values recorded at regular time intervals (sales history) to predict future values" (Brannon, 2000: 264) Time series analysis is used to identify seasonality, cyclical patterns and trends. Once individual forecast components are recognized, time series techniques assume the future will reflect the past which also suggests that past demand patterns will continue into the future. This assumption is often reasonably correct in the short term and therefore time series techniques are most appropriate for short-range forecasting. Time series techniques include a variety of methods that all analyze the patterns and movement of historical data to establish recurring characteristics. While there are many different approaches, two commonly used approaches are moving average and exponential smoothing.

Moving average forecasting uses an average of the most recent period's sales. In order to do this, the forecaster needs to decide how many periods of sales data to use in making the forecast. Each time a new period of actual data becomes available, it replaces the oldest period data, thus the number of time periods included in the average is held constant. Exponential smoothing is a way to conduct weighted moving average. The technique bases the estimate of future sales on weighted average of previous demand and forecast levels. The new forecast is a function of the old forecast modified by some fraction of the difference between the old forecast and actual sales realized. This technique cannot tell the distinction between seasonality and random fluctuations hence exponential smoothing does not eliminate the need for judgment (Bowesox et al. 2010:147).

"Sets of quantitative management tools are now available as software packages so that managers can manipulate data in spreadsheets and databases on their desktops instead of having to request an analysis from the management information staff" (Brannon, 2000:265). However according to Nenni et al. (2013:4) statistical methods are likely to cause poor performance if the demand pattern possesses a high level of "lumpiness". Lumpy demand means that the demand is affected by high numerousness of potential customers, high heterogeneity of customers and high variety of customer requests. The demand in the fashion industry can presumed to be lumpy.

2.5.3 Causal technique

Causal technique, often referred to as forecasting by regression is a quantitative method for investigating the cause-and-effect relationships between two or more variables. Usually the forecasters aim to discover the cause and effect of one variable to another, such as the effect of price change or advertising on demand of a product. This is done by first collecting data for the underlying variables of interest and then using regression to estimate the quantitative effect of the explanatory variables on the dependent, or target variable that they affect. (Chase, 2009: 129) If the forecast for a stock-keeping-unit is based upon one single factor the term used to describe the scenario is simple regression and if more than one forecasting factors are present the technique is referred to as multiple regression. It is important to note that no cause-effect relationship needs to exist between the product's sale and the independent event if a high degree of correlation is constantly present. A correlation assumes that the forecasted sales are preceded by some leading independent factor such as the sale of related product. Causal techniques have the ability to effectively consider external factors and events, such as changes in the economy which is why they are most suitable for long-term or aggregate forecasting (Bowersox et al. 2010: 147).

2.6 Forecasting using both quantitative and qualitative methods

"Forecasting attempts to predict the future using either quantitative or qualitative methods or some combination of both" (Stock, Lambert, 2001: 281). Time series methods identify and forecast trends and seasonal patterns by utilizing historical sales data. Causal techniques take external factors into consideration but they are unable to identify trends or seasonality. Also compared to time series method, causal techniques require more data and therefore do not pick up shifts as quickly. Qualitative method has a high advantage compared to both time series as well as causal methods as it can take into consideration the changes occurring in the business environment for which there is no historical data. To achieve the most accurate sales forecast the forecaster can use the time series technique to establish the initial forecast, causal technique to provide a broader perspective on environmental factors and finally the qualitative technique can be used to adjust the quantitative forecast (Brannon, 2000: 272-273). Evidence of on the value of combining forecast methods for improved accuracy is overwhelming in addition to which also empirical evidence indicates that the combination of forecast methods tend to outperform most single forecast (Chase, 2009: 189).

2.7 Measuring the forecasting performance

One of the most important elements of demand forecasting process is measuring forecast performance as it cannot be improved unless first properly measured. Still the number of companies that have never truly measured the accuracy of their demand forecast remains high in addition to which many forecasters tend to measure the accuracy on an aggregate level in which the outcome looks much better than in lower product group and SKU level. Whereas an aggregate demand forecast can be fairly accurate, around 15 to 25 percent error range, the same forecast on SKU level begins to escalate between 35 to 50 percent error range and in many cases it is as high as 100 percent (Chase, 2009: 78).

Brannon (2000: 260) defines the forecast accuracy simply by stating that it is the difference between forecasted values and what actually happens. However after studying different methods of measurement it becomes clear that most of them do not reflect reality, mainly due to the fact that positive and negative errors tend to offset one another, resulting in a better looking accuracy. Also many of the methods are clearly fine for financial target setting, not measuring forecast accuracy.

2.7.1 Weighted absolute percentage error

The most commonly used accuracy measure for a forecast is called mean absolute percentage error, from now on referred to as MAPE. It is calculated by dividing the absolute value of difference between actual sales, At and forecasted sales, Ft after which the result is divided by actual sales, At and multiplied by 100. The actual formula is displayed below, where At= actual sales and Ft= forecasted sales.

$$\text{MAPE} = \frac{1}{n}\sum_{t=1} \frac{[| A_t - F_t |]}{A_t} \times 100$$

Figure 3 Mean absolute percentage error

As with every measure of accuracy, also with MAPE there are problems. The formula penalizes less if the forecast is overachieved than underachieved. However if this is not intentionally misused the issue becomes insignificant. Additionally MAPE is undefined when actual demand is zero as it plays the role of denominator in the formula. Also when the demand is close to zero the value can easily explode to huge number and when averaged with the other values it can give a distorted image of the magnitude of errors.

A slightly improved method of forecasting addresses the issue of scale dependence and is called weighted absolute percentage error (WAPE), sometimes referred to as weighted MAPE. This method is preferred over MAPE because it accounts for each product's contribution to the total error by weighting the impact of the individual item value of each product within the group as it is related to the total. Figure 4 presents the formula of WAPE, where At= actual sales and Ft= forecasted sales.

$$\text{WAPE} - \sum_{t=1}^{n}[(|A_t - F_t|)] \div \left(\sum_{t=1}^{n} A_t\right) \times 100$$

Figure 4 Weighted absolute percentage error

Weighted absolute percentage error will be utilized in the example case of this dissertation. (Chase, 2013: 113-115)

2.8 Summary

The apparel industry has undergone significant transformation during the past two decades which has resulted in products possessing extremely short life cycles, long lead times and highly unpredictable demand due to which supply-demand mismatches are costly but common. In order to minimize these mismatches it is crucial to aim for accurately predicted demand. Demand management aims to provide capabilities to increase accuracy, flexibility and consistency in determining inventory requirements and a crucial part of it is demand forecasting which attempts to answer what the customer will purchase and when. Although it is widely acknowledged that accurately forecasting demand in the apparel industry is difficult, even impossible it is still considered as crucial due to the value of the benefits achieved by an accurate forecast.

There are several methods of demand forecasting which all possess different strengths and weaknesses. Qualitative techniques often referred to as subjective and judgmental techniques require managerial judgment and are useful in situations where only a little historical data is available. They are conducted usually by surveys, panels and consensus meetings however on an SKU level the method is time consuming and thus also costly. Time-series methods are statistical and quantitative in nature and they are used to identify seasonality, cyclical pattern and trends. Most popular time-series methods are moving averages and exponential smoothing. All time-series methods rely on historical data and assume that past demand patterns will reflect the future. Causal method, also referred to as forecasting by regression is a quantitative method for finding a strong correlation between two or more variables. It is conducted by collecting data for underlying variables and then using regression to estimate the quantitative effect. Causal techniques have the ability to effectively consider external factors such as changes in the economy. There is a lot of evidence of improved forecast accuracy when different methods are combined.

In order to improve accuracy of a demand forecast it needs to be first properly measured. Like forecasting methods, also a high number of measurement methods have been introduced in the recent literature. The most commonly used is mean absolute percentage error from which also an alternative weighted absolute percentage error is derived as it takes into consideration the magnitude of the error in comparison to the total. According to Chase (2009: 52) large swings in forecasting error result in poor planning and decision making make the users of forecast often disappointed. However expectations of error-free forecasts are unreasonable.

3 Methodology

In order to investigate the demand forecasting process in a fashion apparel company, it was necessary to collect information regarding the current forecasting procedures as well as historical sales and forecast data. The method of gathering information in regards to the forecasting process is primary in nature and collected via interviews whereas numerical sales and forecast data were received from the company. The aim of this case study is to investigate the current situation of demand forecasting in the target company's footwear division by first providing a clear explanation of how it is conducted after which the accuracy of the forecast will be defined by performing accuracy calculations. The calculations will be conducted by utilizing company's data and the accuracy methods introduced in the theory section of this thesis. If the calculations show need for forecast accuracy improvement, ideas for a better forecasting will be discussed in the next chapter, with the support of secondary research aiming to hypothetically define the possible benefits for the company. Case study section of this dissertation aims to investigate a real life example of demand forecasting in an apparel industry in order to apply the theory and further investigate the improvement ideas.

4.1 Demand forecasting in the footwear division

Sourcing to offshore places with low labor costs have resulted in long lead times hence often materials in the form of actual products need to be purchased months in advance in order to meet the promised delivery dates. At this stage no actual sales orders have been entered by the sales force which makes the prediction of what will be sold in the future relatively difficult. This is the case also in the footwear division of the target company and it can be considered as reason for the necessity of forecasting sales accurately despite the acknowledged volatile demand.

> The need for forward planning is great if the materials manager wishes to keep operations running smoothly, to adequately prepare for and meet future market conditions, and to minimize potential problems that can occur in materials acquisitions. (Stock & Lambert, 2001:281)

At the moment initial sales forecast, referring to the forecast established before the season for the purpose of the material buy is conducted by a team of footwear merchandisers. The division tracks sales on stock-keeping unit (SKU) level hence also the historical sales data is available on the very detailed product level. Merchandisers utilize the historical sales data and based on those numbers as well as their own intuition estimate the sales for each SKU indicating how many pairs of shoes in every style and in every color expected to be sold. A central merchandising team of the company sets up general sales targets in units and the forecast needs to take into consideration these objectives.

Buying and planning team of the division is responsible for conducting one material buy and three other buys during every each big season which in the company are always spring and fall seasons. The purpose of a material buy is to enable suppliers to start the production early enough to meet the delivery dates communicated to the customers whereas the point of the other three buys is to keep the productions on-going while the sales orders are gradually being entered to the system. During the three buys, quantities bought from the supplier equal to sales orders in the system at that time but since the sales have not yet started at the stage of the material buy, those quantities are based solely on the quantities forecasted by the team of merchandisers. When material buy is submitted the suppliers start the production of actual products ordered and it is clear that the risk of excess stock due to producing items that necessarily will not be sold, is notable. Because of the high risk in relation to the initial material buy, the focus of this case study will be demand forecasting before the season instead of during the season.

4.2 Current demand forecast accuracy

Historical sales data on SKU level is available but utilizing it is challenging. All quantitative time-series methods expect historical sales patterns to continue to the future but in a company placed in rapidly changing apparel industry the products offered differ dramatically each season. Although there are some carry-over styles which are similar from season to season, the majority of the products are introduced for the first time and there is no future sales reference against those items. Due to the lack of consistency in the historical sales information qualitative forecasting techniques, also referred to as subjective and judgmental techniques which rely highly on expertise are preferred and have been adopted.

4.2.1 WAPE

In order to provide an even better understanding of the current demand forecast procedure the accuracy of the forecast will be defined. “The best way to improve forecasting accuracy is to review actual sales figures against the sales forecast for the same time period” (Brannon, 2000: 260). In order to determine the current forecast accuracy and determine the need for improvement, weighted absolute percentage error calculation is conducted by utilizing initial forecasts as well as actual sales numbers for three similar seasons. Calculations (Appendix 1) show that the weighted average percentage errors for the three seasons are relative high. Table below represents the actual percentages. Armstrong (2001:5) points out that forecasts are often performed poorly because managers have too much confidence in their intuition.

Season	WAPE (%)
Fall 2011	86
Fall 2012	92
Fall 2013	75

Table 1 WAPE in %

Forecast is best when WAPE is close to zero (Louhichi, Jacquet and Butault, 2012: 91). According to Chase (2013:115) actual accuracy (error) across the organization might range from 50 to 1000 percent error and Rajaram (2008: 109-110) agrees by stating that error of a judgmental forecast is usually 50 per cent or more. This is the case also in the target company as the weighted percentage errors fall between 75 and 92 per cent. WAPE in this case can be considered as evidence to support the need for improvement of demand forecast accuracy in the company. Due to the limitations set by the bachelor’s thesis the actual cost of inaccurate forecasting will not be measured.

4 Findings and analysis

Weighted absolute percentage errors as well as absolute percentage errors conducted on SKU-level (Appenix 1) clearly demonstrate that there is room for accuracy improvement of the initial demand forecast. This section of the dissertation will further analyze the situation and based on secondary research in the form of literature findings two very different means to improve forecasting process in the target company will be introduced aiming to outline the possible benefits experienced by the company. The success of the improvement ideas will not be established through empirical research due to the complex nature of the relatively big changes and limitations set by the bachelor's thesis. However the possible benefits will be hypothetically analyzed in the form of qualitative research.

4.1 Improving judgmental forecast

Time-series forecasting methods require historical sales data which is utilized to identify demand patterns that are expected to reflect the future. However because in the case of the company's footwear the products are rarely similar thus historical sales data is lacking reliable pattern, statistical time-series methods cannot be considered as a way to improve forecasting accuracy. In addition to this, causal methods are out of the question as well since they also, to an extent, rely on historical data. Also the fact that all causal forecasting methods consider external factors such as changes in the economy effectively, they are most suitable for long-term aggregate forecasting instead of short-term forecasting on SKU-level.

Qualitative forecasting techniques can be considered the best method for this kind of demand forecasting situation as long as they are combined with the appropriate and available historical data since the combination of forecast methods tend to outperform most single forecasts. The problem with qualitative forecasting technique is however the unreliability which is the error in all judgmental forecasts and which in the long run only reduces the accuracy of forecasts. Research and theorists classify unreliability in two sections 1) unreliability of information acquisition and 2) unreliability of information processing.

> Studies indicate that judgments are less reliable when the task is more complex; when the environment is more uncertain; when the acquisition of information relies on perception, pattern recognition, or memory; and when people use intuition instead of analysis (Stewart, 2001: 81-82)

In order to get an understanding of how to improve the reliability of the existing judgmental forecasting method by reducing the unreliability of both information acquisition and information processing, five improvement principles will be presented utilizing the ideas of Professor Thomas R. Stewart (2001, 81-97).

1. *Organise and present information in a form that clearly emphasizes relevant information*

The purpose of the first principle is to reduce errors occurred in information acquisition by making the acquisition of relevant information easy and by paying attention to the most relevant information while removing the confusing irrelevant data.

2. *Limit the amount of information used in judgmental forecasting*

The greatest benefit of the second principle can be expected when environmental uncertainty is reasonably high and no analytical method for processing information is available. The aim is to improve reliability of information processing by avoiding the distractions of less relevant cues.

3. *Use mechanical methods to process information*

Preferring mechanical, generally computerized models over intuitive ones will generate to a smaller systematic error especially in uncertain forecasting environments. The models do not have to be complex and it does not mean that judgment should be excluded.

4. *Combine several forecasts*

This principle was also brought up earlier as evidence show that combining several forecast methods increases overall accuracy.

5. Require justification of forecasts

Reliability of a forecast might increase if the forecaster is asked to justify the forecast verbally. By having to justify opinions led to higher consistency and process was also moved away from intuitive one towards to a more analytical process.

Qualitative judgmental forecasting can be considered as the key forecasting method for the company due to the distinct problems with the other main methods. Therefore utilizing the qualitative method in a manner that unreliability is minimized is important, although it is acknowledged that unreliability to a certain extent is inevitable. The five principles should be considered as guidelines for implementing the judgmental method of initial forecast.

The principles present valuable points. Since historical sales information is tracked on a very detailed level, including, among others, SKU information on account, distribution channel and delivery date data level, it is important to separate the relevant information and ignore the less relevant information which might be interesting but also cause confusion. As the process becomes clearer and standardized amount of information will be automatically limited and as the second principle suggest, reduced amount of information available might lead into decreased unreliability. Third point is also respected since if computerized programs would be adopted the more analytical side could be emphasized. Whereas the fourth principle of combining several methods is already being adopted, the fifth point can be considered to be the most important.

Fifth phase of Stewarts (2001, 81-97) principles to improve reliability in judgmental forecasting suggests that justification of forecasts should be requested. At the moment there is a clear problem with responsibility distribution in the division as the merchandisers determine the initial forecast based on their interpretation of the historical sales data combined with their intuition after which buying and planning team of the division places the material buy in reference to those numbers and that team is automatically left with the responsibility of a successfully bought quantities. It seems more than probable that if the merchandisers were asked to provide justification of the forecasted quantities the process would move from intuitive one towards more analytical increasing the consistency, improving the reliability on thus generating to more accurate forecast quantities.

The historical forecast data prove that forecast quantities 500 and 1000 on SKU-level are most popular every fall season. The table below presents the percentage of these quantities from the total each season.

Season	Forecast of 500 (% of total)	Forecast of 1000 (% of total)
Fall 2011	17	16
Fall 2012	15	18
Fall 2013	17	18

Table 2 Popular forecasting values

This is a good example where justification of forecast quantities could help in order to increase accuracy. The values 500 and 1000 can be thought as easy values in a situation where historical sales reference is lacking and uncertainty of the future is strongly present. However the quantities might not have been questioned and requesting justification would most likely lead to increased consistency.

If the company decides to apply presented principles as guidelines and through that aim for increased accuracy to be measured later the following key ideas are valuable. According to Chase (2009: 78) demand forecasting performance improvements do not necessarily have to be large and in some situations a 5 to 10 percent improvement in forecast accuracy translates into significant improvements in finished goods inventory carrying costs, reduced back orders on the shelf, inventory returns, improved customer service level and much more. He continues (2013: 104-105) that companies tend to overoptimistically set their initial forecast error targets rather than set percentage improvements in forecast error and hence they almost always miss their targets setting the stage for disappointment that eventually leads to failure of the entire demand forecasting process. Given that the primary goal is to improve demand forecast performance, setting forecast error or accuracy targets are not always the best approach, particularly if your forecast error is extremely high.

4.2 Supply chain development as an option

> "The reality that is now gradually being accepted both by those who work in the industry and those who study it, is that the demand for fashion products cannot be forecasted. Instead, we need to recognize that fashion markets are complex, open systems that frequently demonstrate high levels of "chaos". In such conditions, managerial efforts may be better expended on devising strategies and structures that enable products to be created, manufactured and delivered on the basis of 'real-time' demand. The difficulty of predicting demands has led companies to focus on the improvement of supply chain" (Nenni et. al, 2013:1-2)

The quote above summarizes the core of an alternative idea for demand forecasting in the apparel industry. According to Christopher, Lowson and Peck (2004: 367) conventional organizational structures together with forecast-driven supply chains are not adequate to meet the challenges of volatile demand of the industry but instead a creation of an agile organization embedded within an agile supply chain is required. Christopher et al. (2004: 368) acknowledge that the traditional ways of responding to customer demand have been forecast-based with the subsequent risk of over-stocked and under-stocked situations and that the conventional wisdom holds that the way to cope with this uncertainty is to improve the quality of forecast. However, earlier described unpredictable demand combined with short life cycles of the products make it highly unlikely that forecasting methods that will constantly and accurately predict sales at an item level will ever be developed. Ways have been found to reduce the reliance that organizations place upon the forecast as instead they can focus on lead-time reduction.

Longer lead times caused by the growing tendency to source products and materials offshore have been brought up several times in this thesis as they are key reason for difficulties faced by demand forecasting. Distance is not the only cause for long lead times but also the delays and variability caused by internal processes at both ends of the chain as well as the import/export procedures in between result in lengthier lead times. (Christopher et al, 2004: 368) Shorter lead-times mean by definition that forecasting horizon is shorter hence the risk of error is lower.

4.2.1 Agile Supply Chain

"In markets with high-level competitiveness, companies can keep their competitive advantage only through re-modulation of company processes oriented to achieving greater flexibility and dynamism" (Iannone et al, 2013: 1).

In recent years there has been growing interest in the design and implementation of agile supply chain strategies. The idea of agility in the context of supply chain management focuses around responsiveness. Whereas conventional supply chains have been lengthy with long-lead times and hence, of necessity have been forecast-driven the agile supply chains are shorter and seek to be demand-driven. The agile supply chain possesses a number of characteristics. It is market sensitive meaning that it aims to be closely connected to the end-user trends and listen to the customer since in apparel industry that is vital. Agile supply chain is also virtual as it is connected and integrated through shared information so that all parties in the chain are all working to the same set of numbers and goals. In order for this to operate smoothly, an agile supply chain requires a high level of process alignment both within the company and externally with partners. Process alignment means the ability to create seamless connections and thus no delays caused by hands-off or buffers between different stages in the chain. This is enabled by the new generation of web-based software that permits the different entities to connect although their internal systems might be different. In order to achieve quick response, the ultimate agility, coordinating and integrating the flow of information is critical. An important feature of an agile supply chain is also the flexible arrangements with the suppliers. (Christopher et al, 2004: 368)

4.2.2 Quick response

The ultimate agility of a supply chain is often referred to as quick response strategy. It was introduced in 1980 when several characteristics of the apparel industry suggested that the firms could benefit from reduction in the lead times. A research called Salmon was conducted and it estimated the length of the average supply chain for apparel to be 66 weeks of which only 6-17% represented actual production. The demand forecasts produced for time periods so far into the future were subject to large errors. (Drake and Marley, 2010:3)

Quick response was introduced targeting to solve the issue with lead times, referring to the problem that the time it takes to source material, covert them into products and move then into the market is longer than time customer is prepared to wait. (Christopher et al, 2004: 369)

The implementation of a quick response program relies on electronic data interexchange (EDI) and point-of-sale (POS) data (Drake and Marley 2010:3), however the mere possession of the various processes and technologies will be insufficient if close linkages between all the parties are not established within the whole supply chain. Close relationships enable the ability to compress time in the chain which can condense the whole supply chain to about one third of its traditional length and thus it reflects more accurately the updated consumer information. This allows the buyers to place or adjust their orders closer to the selling season and the additional time to collect information can be used to produce more accurate forecast of the demand as more information will be available.

In 25 years many apparel companies have successfully implemented the quick response programs. Good example is international clothing brand Zara which possess a developing lead time from design to delivery of less than three weeks. One of the keys to Zara's success in implementing quick response is the simplicity of the company's offerings as for most garments Zara keeps its variety limited to three colors and sizes and the garments are always already available. Also Swedish based Hennes and Maurtiz utilizes quick response in a profitable manner as they are able to design, produce and distribute a good to shelf within 21 days. The company operates within two distinct supply chains. Asian supply chain focuses on manufacturing methods to increase profits and decrease costs while European supply chain uses "rapid reaction" for the unpredictable fashion items. (Drake and Marley, 2010:4) It does not mean that Zara or Hennes and Mauritz do not forecast demand; more likely they instead rely on marketing approaches. (Nenni et. al, 2013: 4)

To reduce the length of lead times which play a significant role in the challenge of predicting sales and therefore in achieving more accurate initial forecast, the target company could move its supply chain towards greater agility and consider quick response as an option. Quick response requires that materials are already available as in the case of Zara. Huang (2013:1158) explains that the product lead time of a small batch is very short, only a few days if the materials are available and he suggest that instead of buying raw material in small quantities, maybe large quantities can be bought and, relying on the fact that the same material is used for more than on SKU, the material can be used according to actual demand. The extent to which this can be done depends on the magnitude of the aggregation that exists at the material level. In order for several SKU's to possess the same resources, designers of the division would need to co-operate by designing products that share more or less the same materials on an aggregate level. This would be easier if the large number of SKU's per season would be reduced.

The large number of SKU's themselves can also be considered as a factor for inaccuracy. Nenni et al. (2013: 3) state that high number of stock-keeping units reflects as low sales volume and also demand per SKU within the same product line can vary significantly. Therefore although aggregate demand can be predicted with some certainty it is extremely difficult to predict how the sales will be distributed over the many products that are offered hence the inaccurate forecast. During the seasons analyzed in this thesis the amount of stock-keeping units per season fell between 1101 and 1165 indicating a large number of product offering. Large collections have an issue of SKU's not getting enough attention but when a smaller collection is offered each time quantities per SKU are high. With focus attention on a smaller range more quantities per individual SKU is received. (Mohanty, 2012)

In order to move the supply chain towards agility, indicating it to be closer to the customer, more virtual and process aligned, the seasons should be more consistent in terms of materials in addition to which they would need to possess smaller amount of stock-keeping units. These changes together would enable the purchase of materials in big quantities as they could be utilized later in the season. In the case of successfully adapted agile supply chain and quick response system lead times would get shorter and the risk of material buy would become insignificant as large quantities could be purchased later, and the materials could all be utilized.

5 Conclusion

At the beginning of each season, the buying and planning team of the target company's Footwear division places a material buy which enables the suppliers offshore to start production early enough for the goods to be delivered on time. At this stage of the season no sales orders have yet been received and the material buy relies on a demand forecast conducted by a team of merchandisers. Results of weighted absolute percentage error calculations indicate that the forecasting errors of the initial demand forecasts for the previous three seasons fall between 75 and 92 per cent. Although an error above 50 per cent can be considered normal in the apparel industry it still proves that there is need for accuracy improvement to avoid inefficient resource utilization caused by inaccurate material buys.

Because products offered vary dramatically each season, historical sales data tracked on stock-keeping unit is relatively useless in terms of predicting future sales. Quantitative forecasting methods including time-series and causal techniques rely heavily on historical sales data hence qualitative methods are more suitable for the situation. As a qualitative method in the form of judgmental forecasting has already been adopted as the main forecasting technique by the team of merchandisers, one way to increase the forecast accuracy is to improve the existing method instead of changing the technique completely or acquiring new expensive forecasting software. Another approach to improve the current forecast accuracy is to implement changes to the existing supply chain.

One issue with the currently used judgmental forecasting is unreliability which leads to inaccurately forecasted quantities. Ways to minimize unreliability were introduced, highlighting principles which suggested that the information should be organized in such a way that important information is emphasized and less relevant data ignored while limiting the total amount of information used in the forecast. The key principle dictates that justification of forecast should be requested. It seems more than reasonable that if the merchandisers were asked to provide justification of their forecast, the process would move from intuitive towards more analytical increasing the consistency and at the end improving the reliability. Additionally, quantities predicted most often would need to be supported by evidence, leading to a more structured forecasting approach.

The demonstration of the principles for reduced unreliability lead to an understanding that the qualitative forecasting process needs to be well-structured in order to avoid unnecessary confusion or bias. The aim of the principles is to introduce general improvement ideas to be adopted as guide lines. As judgmental forecasting method seems to out rule the other techniques it should be used in an appropriate manner which is proved to correlate with increased accuracy.

The need for material buy as well as the need for accurately forecasted demand is caused by long lead times. The second alternative for improving forecast accuracy suggests that instead of improving the actual forecasting process it is superior to pay attention to the lead time reductions. According to this indication volatile demand will always result to inaccurate forecasts whereas an agile supply chain solves the issue by shortening the lead times and therefore at the stage of a material buy more information is available and the risk of incorrectly bought quantities is significantly reduced. An agile supply chain is demand-driven, close to the market and virtual in a sense that all of its members are working towards the same goals. In an agile supply chain processes are aligned and connections between all the parties are seamless thus buffers are avoided. Ultimate agility is received by quick response systems which rely on electronic data interexchange (EDI) and point-of-sale (POS) data together with close linkages between all parties in the supply chain. Quick response systems can condense the whole supply chain about one third of its traditional length.

In order for the company to benefit from a quick response system closer relationships as well as aligned processes with all the parties of the supply chain need to established. In a quick response system materials are suggested to be bought in big quantities to be available when producing the actual products. In order to assure that there are no material left overs, the designers of the division would need to design products that share the same material resources on an aggregate level. Reduced number of stock-keeping units offered per season would also help both in the material planning as well as forecasting since the amount of options would be smaller and sales per SKU larger.

To conclude, the accuracy of the current demand forecast can be improved by either developing the existing judgmental forecasting method which in its qualitative nature is most suitable for the apparel industry or by enhancing the agility of the recent supply chain. Improving the judgmental forecast by utilizing the presented principles is relatively simple as only some guide lines needs to be followed. The aim is to establish a forecasting process which is consistent, systematical and well-supported. This option can also be considered cost-efficient as it does not require any specific resources. The disadvantage of improving the judgmental method with the suggested principles is that the demand forecast will always be inaccurate to an extent hence the risk of incorrectly bought quantities in the material buy will remain present. Alternatively more agile supply chains in the form of quick response systems will remove the problem of risky material buy but the method is expensive as developing new processes requires several resource investments.

Due to the complex nature of the accuracy improvement alternatives and the limitations set by the bachelor’s thesis, the success of the ideas will not be measured through empirical research. The aim from the beginning was to investigate the interesting concept of demand forecasting in the apparel industry through secondary research and utilize the findings in a real life case study which was completed successfully.

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