MIT SCALE RESEARCH REPORT

The MIT Global Supply Chain and Logistics Excellence (SCALE) Network is an international alliance of leading-edge research and education centers, dedicated to the development and dissemination of global innovation in supply chain and logistics.

The Global SCALE Network allows faculty, researchers, students, and affiliated companies from all six centers around the world to pool their expertise and collaborate on projects that will create supply chain and logistics innovations with global applications.

This reprint is intended to communicate research results of innovative supply chain research completed by faculty, researchers, and students of the Global SCALE Network, thereby contributing to the greater public knowledge about supply chains.

For more information, contact
MIT Global SCALE Network

Postal Address:
Massachusetts Institute of Technology 77
Massachusetts Avenue, Cambridge, MA 02139 (USA)

Location:
Building E40, Room 267
1 Amherst St.

Access:
Telephone: +1 617-253-5320
Fax: +1 617-253-4560

Email: *scale@mit.edu*
Website: *scale.mit.edu*

MIT Global Scale Network

For full thesis version please contact:
Professor Shardul Phadnis
Director of Research
MISI
No. 2A, Persiaran Tebar Layar, Seksyen
U8, Bukit Jelutong, Shah Alam,
40150 Selangor, Malaysia.
Phone: +6 03 7841 4845
Email: sphadnis@misi.edu.my

Statistical Model to Validate Sales Force Driven Forecast

By: Ahmad E. Elarbi
Thesis Advisor: Dr. Albert Tan

Summary: Forecasting is what allows companies to prepare and plan their operations in advance. Inaccurate forecasts cause increased costs to all aspects of an organization and add stress to the supply chain network. This thesis investigates the accuracy of various time-series forecast models. It analyzes the influences in a Healthcare business operations and creates a statistical tool to forecast with better accuracy.

Ahmad Elarbi has joined the Campbell Soup Company as a Senior Demand Planner. Prior to MSCM, Ahmad worked for Ricoh as a Demand Planner. He also worked with Covidien as a Production Planner/ Buyer II and as an Analyst. Ahmad graduated from Pennsylvania State University with a Bachelor of Science in Supply Chain and Information Systems.

KEY INSIGHTS

1. The optimal forecast model will improve both the qualitative and quantitative aspects. With promotions and changing business environments a time-series model can never replace the collaborative insights of various business units.
2. Increased accuracy by one model for one item may not carry over to others. It is important to understand the drivers of demand and variation then tailor a model that best responds to those drivers.
3. Throughout the forecast design accuracy, simplicity and stability have been pointed out as important guidelines. A deeper understanding of assumptions in the past is essential to process improvement. The need to review the forecast and processes is important to maintaining the integrity of the process.

Introduction & Background
Demand Forecasting is one of the most pivotal points of a Supply Chain. It involves attempting to predict the movements of a product going forward so strategies and business plans can be developed to anticipate and meet the changing demands. The areas of Manufacturing, Sales and Finance all react to the plans created by the forecast. An inaccurate and inconsistent demand forecast significantly affects safety stock and inventory levels, inventory holding costs, and customer service levels.

Furthermore, when demand is primarily driven through sales leads the normal forecast methods become unreliable and can greatly impact the whole Supply Chain network. Traditionally safety stock or increased lead times are used to hedge against demand variability and again can cause increased costs.

With such an impact to the business why is there such little autonomy on methods used and results within the industry? The answer lies within the definition of a forecast: to estimate or calculate in advance. In essence, it is a best guess at what a future demand will be. While it is rare to ever be right all the time there are many tools and methods to help planners estimate the demand.

These individual tools though are limited in when they work best and how best to apply them to a specific item. By operating their business with better predictions the company can improve customer service by better meeting demand. From an operational point of view it can do this and take steps to improve inventory management, ultimately driving costs down.

Given the nature of working within a business of high value low volume items like the company covered in this thesis, it is important to understand the factors involved in creating demand. With Sales Representatives driving the business, it is important to look outside of the numbers and build a process that facilitates better communication and documentation to allow for improvements in the forecasting process based off past experience.

Research & Analysis
There are four main forecasting methods, namely, qualitative, time-series, causal and simulation. The two primary quantitative models that are most commonly used for forecasting are time-series and explanatory. Explanatory methods seek to identify the causality for why and how a trend occurred. The time-series model focuses entirely on the numbers within the historical data to forecast. This is how traditional statistical tools operate.

Where the explanatory method assumes an independent variable exists and seeks to identify it; the time-series approach looks at the entire data set as complete with no influence. Its aim is to use only the historical data to identify a pattern and use the findings to forecast future demand. Statistical tools when appropriately applied will add both efficiency and integrity to the forecast process.

There are five components that compose any time-series. They are listed as (a) level, (b) trend, (F) seasonal variations, (C) cyclical movements and (E) irregular random fluctuations. The level is essentially the base to forecast. If there were no variations it would be a flat and constant number. The trend identifies the rate at which the forecast is either growing or declining over time. Seasonality is a

predictable cyclic variation depending on the time within the year. Knowing if a product experiences seasonality, it can help to create a better forecast. Cyclical variations relate to the economic activity of business cycles, between expansion and contraction. Irregular fluctuations are the results of outliers or rare occurrences.

A case study on the current process at the sponsor company was analyzed and documented. Any time-series forecast will only be as good as the data that is put into it. If the data is incomplete or unreliable this can cause several issues. In the case being studied, we encountered several challenges. The first being the data set only goes back to the beginning of 2010. Also, a lack of documentation on assumptions made it difficult to normalize the history or any oddities that would be a one-time occurrence.
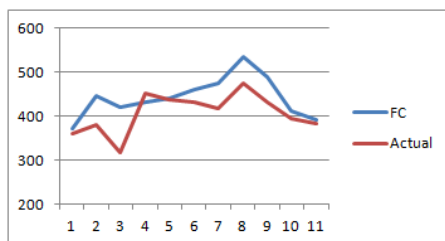
Image 1: Graph displaying forecasted demand versus actual demand from 2010 through Q3 2012

This research tested historical data against various models and compared the results. Different product families were tested using a Simple Moving Average, Exponential Smoothing and the Holt Winters method. The thesis aimed to understand the strengths of each method and draw on them to derive an optimum solution.

Solutions
The ideal tool would yield the best results with little to no manual adjustments. The tool would be robust and responsive to the changing business environment. To do this in sponsoring company's environment it would need to capture seasonality and more quickly respond to trends.

In this case, we chose to incorporate the best practices from each of the previously suggested models. The proposed solution was designed and demonstrated in the thesis. To capture an emerging trend the model looks to compare any period against the prior two periods - the prior two periods are averaged together. Comparing against the prior two periods allows for the model to be more responsive. As more periods are averaged together this smooth out any variation. This is why a model based on two periods versus three will capture a trend more quickly. Because each quarter is three months, it actually becomes a forecast based off 6 months of demand. This realization eases concerns that it could be overly responsive. To capture the seasonality we compare like quarters against the calculated average.

The objective of this project was to design a forecasting tool that could create the best statistical forecast based on time-series data. While the criteria did not include finding a model based on simplicity it was important to find a tool that provided a logical structure and gave way to increased forecast accuracy. With no clear methods to describe the current process a forecast that limited complexity and could be easily taught to others was important. The proposed solution is a model that is responsive to the environment, easy to use and yields the greatest forecast accuracy. This is all based off the limited data available when forecasting in quarterly intervals.