# Case Study: A-CAT CORP

## Unit 8

**Aniruddha Vaidya, Anya Robertson, Harshal Pandit, Josh Schneider, Jon Nelson**

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**Instructor: Raj Kamal**

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### *Situation Analysis -Ani*

In the Vidarbha region of India, A-CAT Corporation, a medium-sized electrical appliance manufacturer, focuses on domestic electrical appliances tailored for the rural market. Their primary product, the voltage regulator (VR-500), safeguards household appliances from voltage fluctuations, yet the company faces competition and pricing sensitivity in the market. Recently, sales of voltage regulators have declined, prompting concerns attributed to shifting consumer preferences and heightened competition. The crux of the matter lies in inventory management, particularly concerning transformers, the key component for voltage regulators. A-CAT's current strategy of maintaining a significant transformer buffer raises issues of tying up capital and potential price hikes from the supplier. Additionally, the rush-order nature of voltage regulators and the shift to a single supplier have exacerbated supply chain complexities. A-CAT's sales division is responsible for demand forecasting, yet their method, based on recent sales data, results in under-stocking and overstocking dilemmas.

### *Problem/Objective -Ani*

At A-CAT Corporation, the key challenge is finding the optimal level of transformer inventory: enough to meet variable demand without holding excess that could tie up resources. The primary aim is to refine demand forecasting, enhance inventory management, and shield against supply chain interruptions. The imperative is to offer timely and well-founded suggestions for transformer procurement, ensuring the supply chain runs seamlessly.

### *Decision Criteria-Anya*

### *Options/Alternatives-Anya*

## Decision Matrix - Jon

| | | |
|---|---|---|
| **i.** | | |
| **ii.** | | |
| **iii.** | | |
| **iv.** | | |
| **v.** | | |
| **vi.** | | |

## Recommendation -Harshal

**Final Recommendation:**

## Implementation -Harshal

## Appendix:

### In Depth Explanation of Analysis

Methods #1 - #5 are the primary methods we used to predict the forecast for "transformer requirements" for January of 2011. The data we used for forecasting was from the data set given by A-Cat for known transformer requirements each month from January 2006 through December 2010.

After utilizing methods #1 - #5 to make a forecast for January of 2011, we calculated the MAD and MAPE of the dataset. The best MAPE value we were able to attain was ~9.3% (Naïve method).

The company A-Cat also shared all their quarterly data on fridge sales which utilize transformers from 2006 through 2010. Our team calculated the correlation between the "transformer requirements" and the "fridge sales" data and were able to prove a high correlation value of 0.925 (calculation made from the correlation function within Excel).

Due to the high correlation, we ran the same forecasting methods #1 - #5 on the fridge sales data set to see if we could get a smaller MAPE value. The lowest MAPE value we received from analyzing the "fridge sales" data between all forecasting methods was 13.3% (single variable linear regression method) which is higher than the lowest MAPE value from analyzing the "transformer requirements" data. Therefore, the fridge sales data was not utilized in our final forecasting method for the transformer requirements.

If the resultant MAPE value from fridge sales was significantly lower than the MAPE value from the transformer requirements, then we would have considered utilizing the fridge forecast for Q1 of 2011 as an input into a single linear regression model to forecast transformer requirements. The regression model would use fridge sales as the independent variable and the transformer requirements as the dependent variable. Then we would average the quarter over three months to get our January estimate or run a seasonality study to help us deduce how to best average the forecast to get our January estimate. Even though this data was not used, our team created a single variable linear regression equation to compare the data. The single variable regression resulted in a MAPE of 4.7% which is a great value. The downside is that the forecast to estimate the independent variable (fridge sales) in the regression equation had a MAPE of 13.3% and these errors compound so this method was not the preferred / suggested method to use.

Our other option in the above scenario could be to run a double variable linear regression model with our second independent variable as time but the compounding error is again too high when considering our alternative options.

## Forecasting Methods:

Forecasting methods used:

1. Naïve Method → $F(t+1) = A(t)$

2. Moving Average (3 Period) → $F(t+1) = [A(t-2) + A(t-1) + A(t)]/3$

3. Moving Average (5 Period) →

   $F(t+1) = (A(t-4) + A(t-3) + A(t-2) + A(t-1) + A(t))/5$

4. Exponential Smoothing → $F(t+1) = F(t) + (alpha) * [A(t) - F(t)]$

   For this method we tried multiple values for "alpha" from 0.1 to 1.0. Once you get to an "alpha" value of 1.0, the equation becomes identical to the Naïve method.

5. Single Variable Linear Regression (utilized "Data Analysis" function in Excel)

   The resultant is a function → $y = m_1(x_1) + b$

   $y$ = dependent variable

   $x_1$ = independent variable

   $(m_1)$ and $(b)$ = regression coefficients (given outputs from Excel)

6. Double Variable Linear Regression (utilized "Data Analysis" function in Excel)

   The resultant is a function → $y = m_1(x_1) + m_2(x_2) + b$

   $y$ = dependent variable

   $(x_1)\ and\ (x_2)$ = independent variables

   $(m_1)$ , $(m_2)$ and $(b)$ = regression coefficients (given outputs from Excel)

## Other Calculations

MAD → $A = \frac{1}{n}\sum_{t=1}^{n}|x_i - m(X)|$

A = Mean absolute deviation

m(X) = average value of the data set

n = number of data values

$x_i$ = data values in the set

MAPE → $M = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|$

M = Mean absolute percentage error

n = number of times the summation iteration happens

A(t) = actual value

F(t) = forecast value

## Forecasting with Prior Transformer Requirements Data

<u>Forecasting Method #1: Naïve Method</u>

| | |
|---|---|
| Mean of absolute Deviation (MAD) | 90 |
| Mean Absolute Percentage Error (MAPE) | 9.3% |
| Forecast of Transformer Requirements for January 2011 | 1053 |

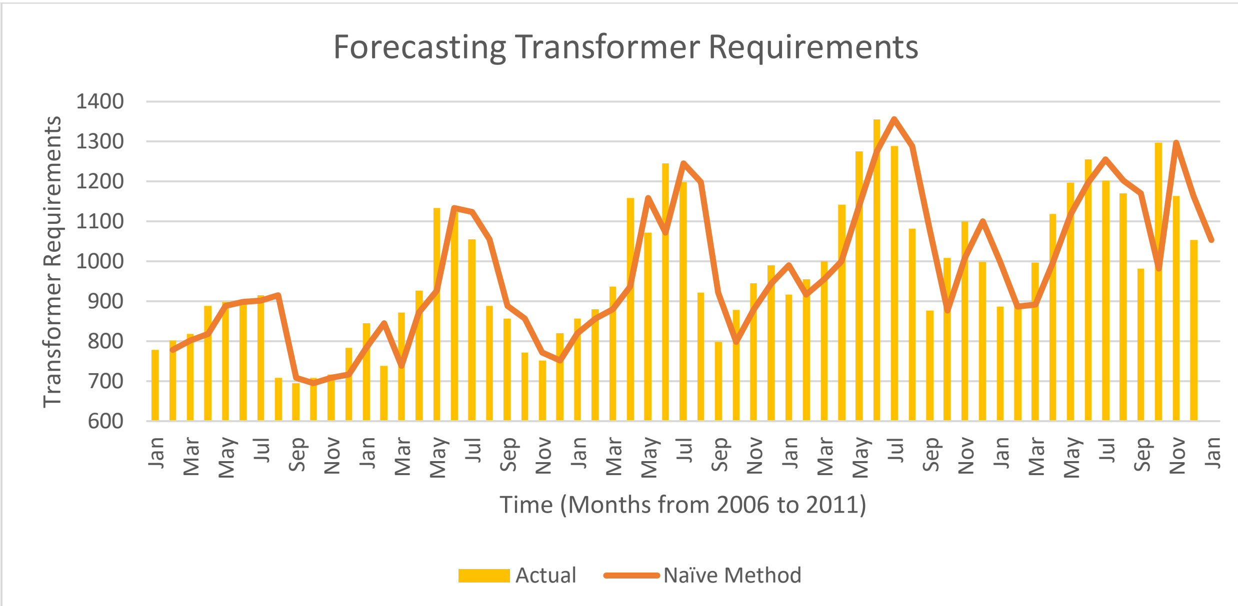


Figure 1: Depicts the Naïve method overlayed with the actual data for "Transformer Requirements"

Forecasting Method #2: Moving Average (3 Period)

| | |
|---|---|
| Mean of absolute Deviation (MAD) | 119 |
| Mean Absolute Percentage Error (MAPE) | 12.2% |
| Forecast of Transformer Requirements for January 2011 | 1171 |

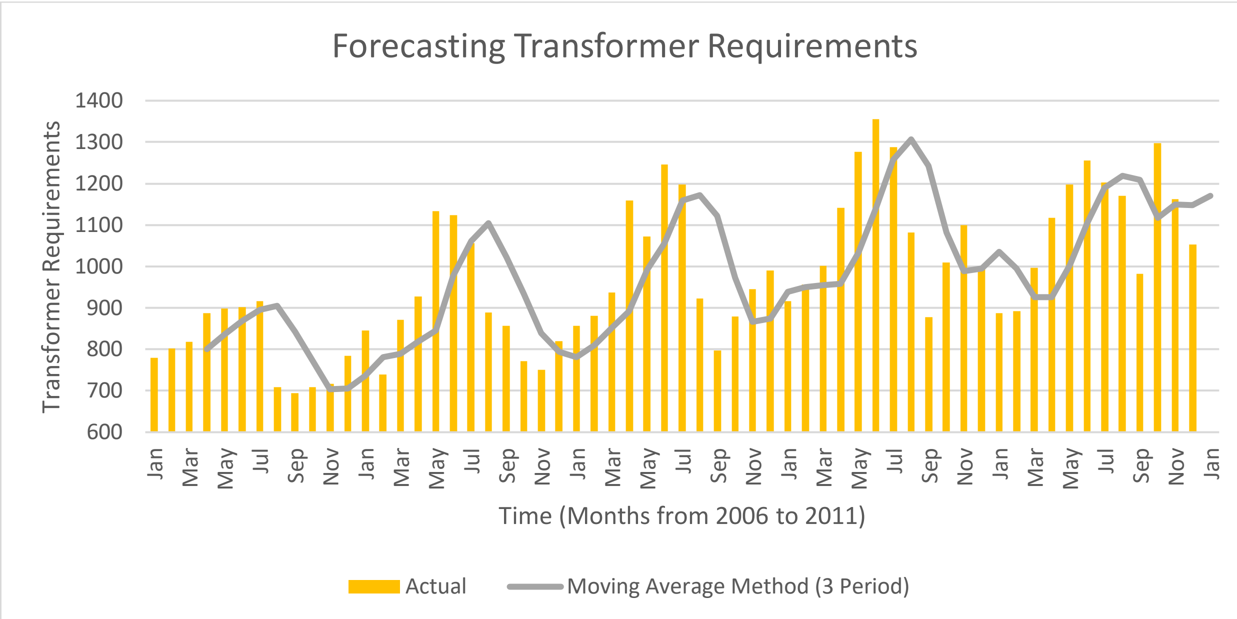


Figure 2: Depicts the Moving Average method (3 period) overlayed with the actual data for "Transformer Requirements"

<u>Forecasting Method #3: Moving Average (5 Period)</u>

| | |
|---|---|
| Mean of absolute Deviation (MAD) | 137 |
| Mean Absolute Percentage Error (MAPE) | 14.0% |
| Forecast of Transformer Requirements for January 2011 | 1133 |

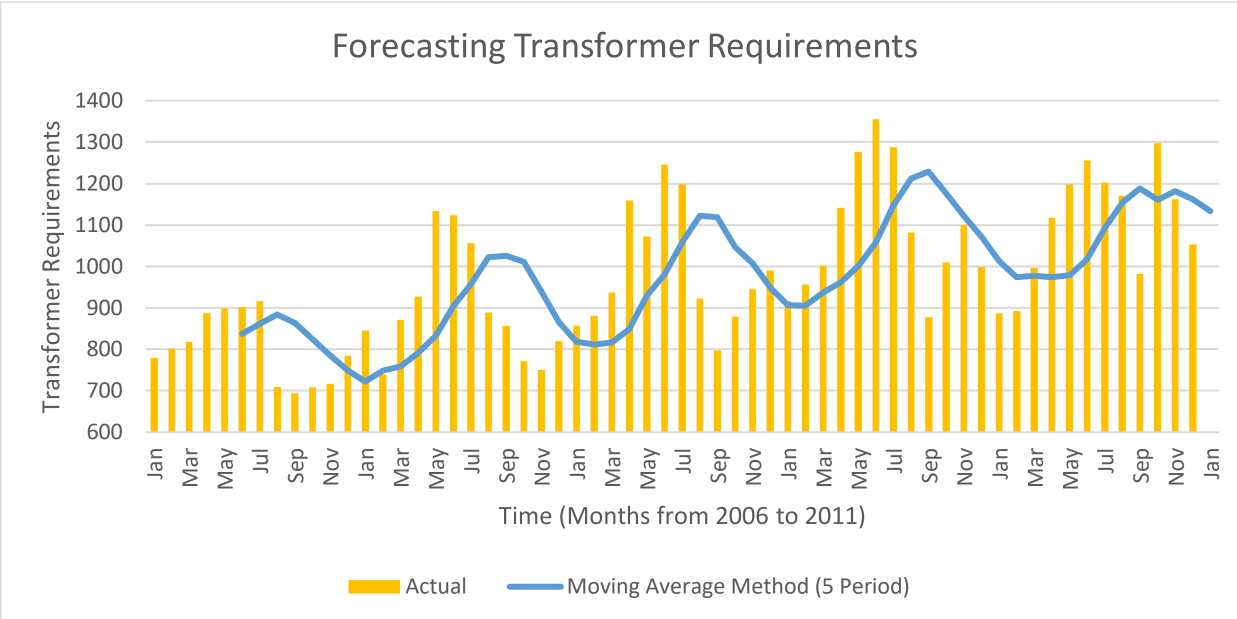


Figure 3: Depicts the Moving Average method (5 period) overlayed with the actual data for "Transformer Requirements"

<u>Forecasting Method #4:</u> Exponential Smoothing

For this method we tried multiple values for "alpha" from 0.1 to 1.0. The MAPE value decreased as the alpha value increased. Once you get to an "alpha" value of 1.0, the equation becomes identical to the Naïve method.

| | |
|---|---|
| Alpha Value | 0.3 |
| Mean of absolute Deviation (MAD) | 113 |
| Mean Absolute Percentage Error (MAPE) | 11.6% |
| Forecast of Transformer Requirements for January 2011 | 1129 |

| | |
|---|---|
| Alpha Value | 0.5 |
| Mean of absolute Deviation (MAD) | 103 |
| Mean Absolute Percentage Error (MAPE) | 10.5% |
| Forecast of Transformer Requirements for January 2011 | 1115 |

| | |
|---|---|
| Alpha Value | 0.7 |
| Mean of absolute Deviation (MAD) | 96 |
| Mean Absolute Percentage Error (MAPE) | 9.8% |
| Forecast of Transformer Requirements for January 2011 | 1091 |

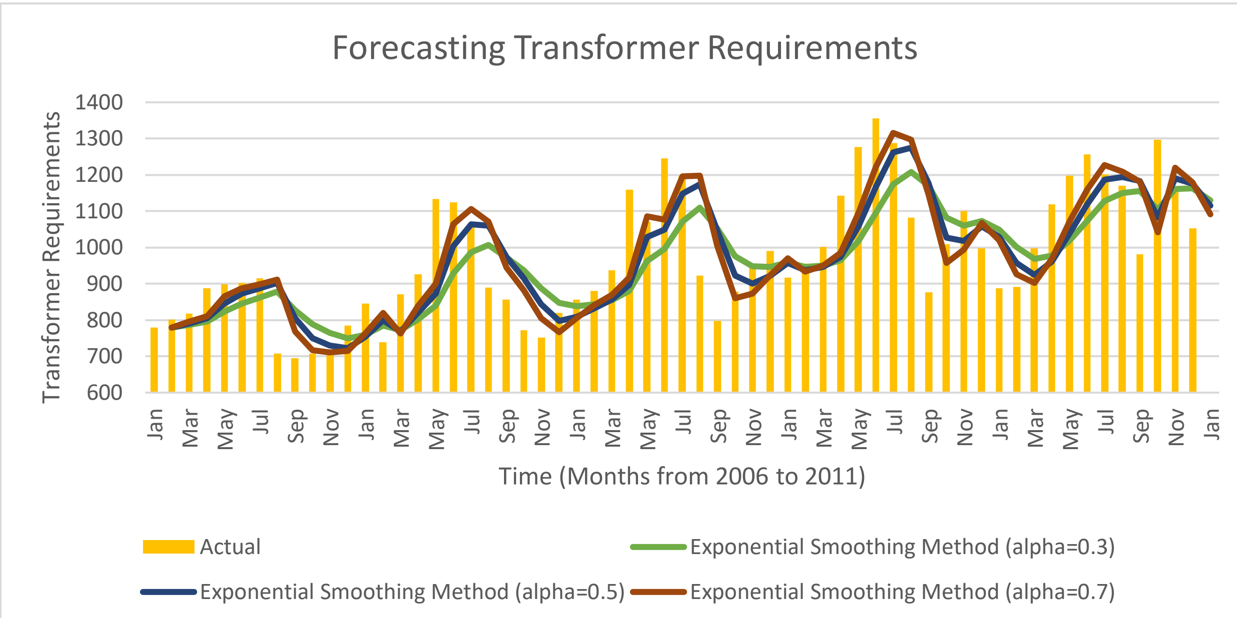


Figure 4: Depicts the Exponential Smoothing method (alpha of 0.3, 0.5, and 0.7) overlayed with the actual data for "Transformer Requirements"

Forecasting Method #5: Single Variable Linear Regression

Dependent variable is "Transformer Requirements" and the independent variable is "Time."

The output in Excel from running the single variable regression through the "data analysis" tool:

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.62581112 |
| R Square | 0.391639559 |

| | |
|---|---|
| Adjusted R Square | 0.380966568 |
| Standard Error | 135.2924654 |
| Observations | 59 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 671657.183 | 671657.183 | 36.69445498 | 1.16E-07 |
| Residual | 57 | 1043330.919 | 18304.05121 | | |
| Total | 58 | 1714988.102 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* |
|---|---|---|---|---|---|
| Intercept | 784.0607247 | 36.58282682 | 21.43248056 | 5.88958E-29 | 710.8049 |
| 1 | 6.265400351 | 1.034304957 | 6.057594818 | 1.15733E-07 | 4.19424 |

| | |
|---|---|
| Equation based on Excel “data analysis” tool | y = 6.27x + 784.1 |
| Mean of absolute Deviation (MAD) | 110 |
| Mean Absolute Percentage Error (MAPE) | 11.2% |
| Forecast of Transformer Requirements for January 2011 | 1166 |

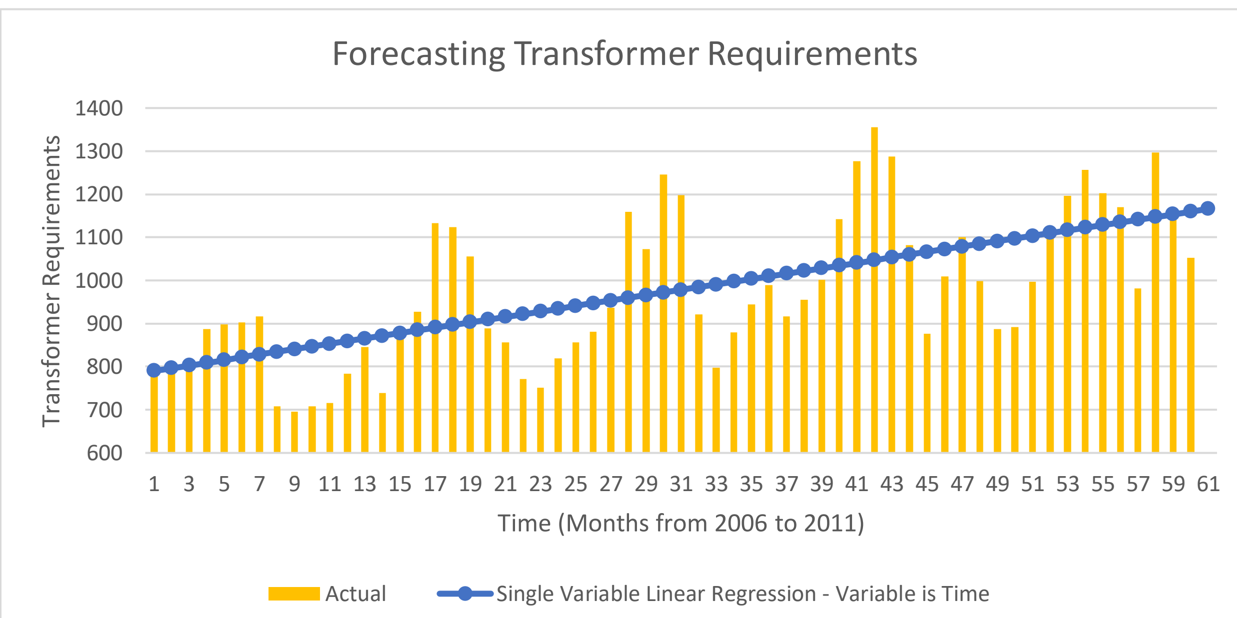

Figure 5: Depicts the Single Variable Linear Regression method overlayed with the actual data for "Transformer Requirements"

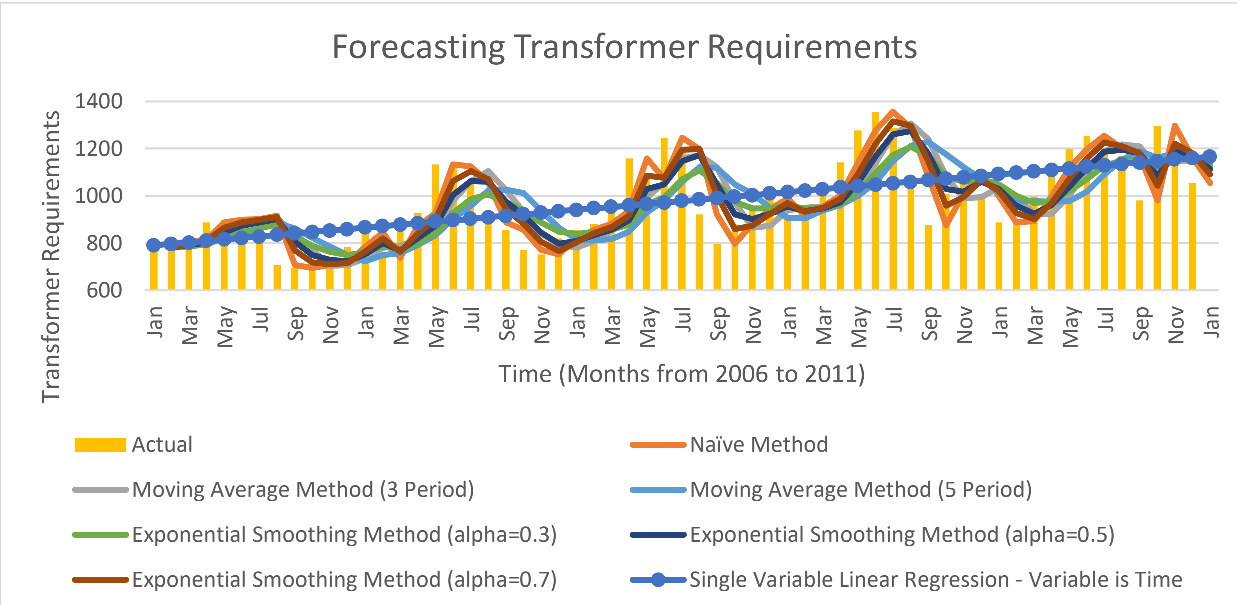


Figure 6: Shows all forecast methods overlayed with the actual data for "Transformer Requirements"

## Correlation of Fridge Sales and Transformer Requirements

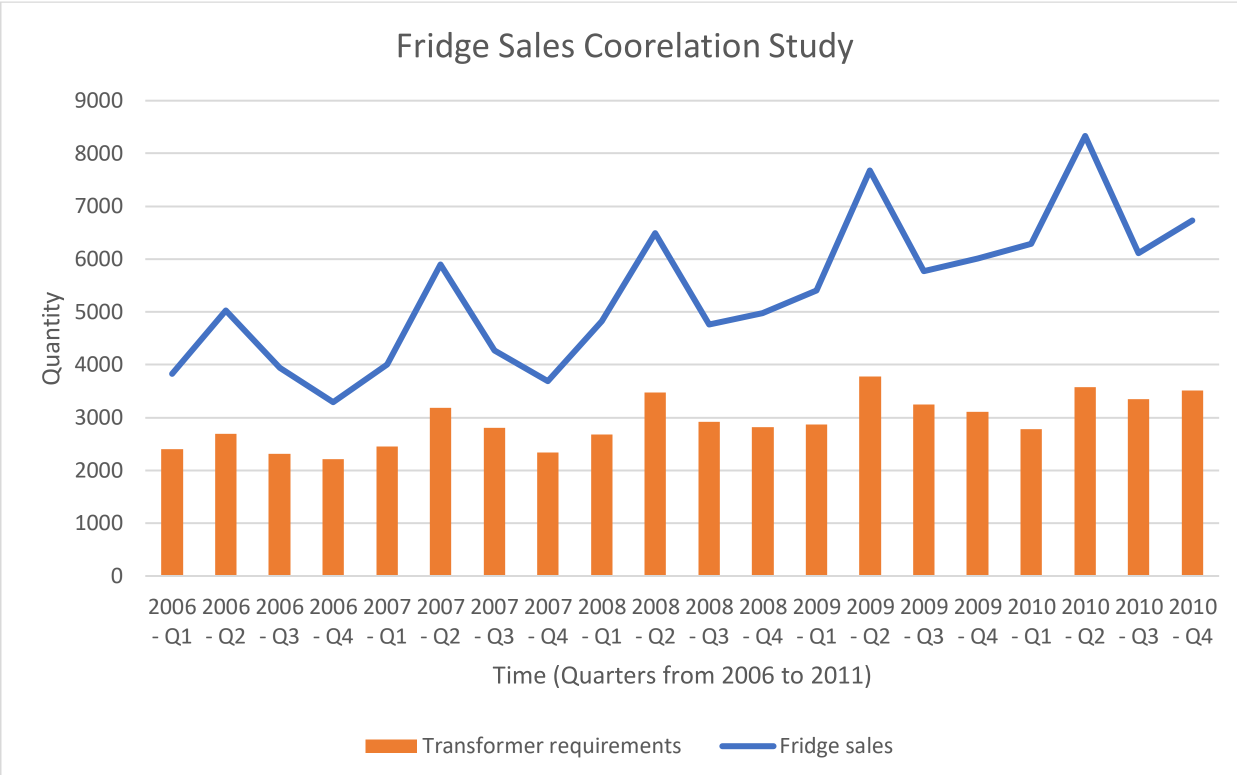


Figure 7: Showcases the data movement between fridge sales and "Transformer Requirements"

After putting the two data sets through Excel's correlation function we got a value of 0.925 which means there is high correlation between the data sets

| | *Fridge sales* | *Transformer requirements* |
|---|---|---|
| Fridge sales | 1 | |
| Transformer requirements | 0.925158731 | 1 |

## Forecasting Fridge Sales

We utilized all the same forecasting methods to forecast fridge sales to understand if a single and double linear regression model could be best suited for our application and received the results below:

Forecasting Method #1: Naïve Method

| | |
|---|---|
| Mean of absolute Deviation (MAD) | 1185 |
| Mean Absolute Percentage Error (MAPE) | 22.1% |
| Forecast of Fridge Sales for Q1 2011 | 6729 |

Forecasting Method #2: Moving Average Method (3 period)

| | |
|---|---|
| Mean of absolute Deviation (MAD) | 826 |
| Mean Absolute Percentage Error (MAPE) | 15.4% |
| Forecast of Fridge Sales for Q1 2011 | 7056 |

Forecasting Method #3: Moving Average Method (5 period)

| | |
|---|---|
| Mean of absolute Deviation (MAD) | 813 |
| Mean Absolute Percentage Error (MAPE) | 15.1% |
| Forecast of Fridge Sales for Q1 2011 | 6693 |

Forecasting Method #4: Exponential Smoothing

| | |
|---|---|
| Alpha Value | 0.3 |
| Mean of absolute Deviation (MAD) | 113 |
| Mean Absolute Percentage Error (MAPE) | 11.6% |
| Forecast of Fridge Sales for Q1 2011 | 1129 |

| | |
|---|---|
| Alpha Value | 0.5 |
| Mean of absolute Deviation (MAD) | 103 |
| Mean Absolute Percentage Error (MAPE) | 10.5% |
| Forecast of Fridge Sales for Q1 2011 | 1115 |

| | |
|---|---|
| Alpha Value | 0.7 |
| Mean of absolute Deviation (MAD) | 96 |
| Mean Absolute Percentage Error (MAPE) | 9.8% |
| Forecast of Fridge Sales for Q1 2011 | 1091 |

Forecasting Method #5: Single Variable Linear Regression

Dependent variable is "Fridge Sales" and the independent variable is "Time."

The output in Excel from running the single variable regression through the "data analysis" tool:

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.732393 |
| R Square | 0.5364 |
| Adjusted R Square | 0.509129 |
| Standard Error | 941.267 |
| Observations | 19 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 17426862 | 17426862 | 19.66951 | 0.000363 |
| Residual | 17 | 15061719 | 885983.5 | | |
| Total | 18 | 32488582 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* |
|---|---|---|---|---|---|
| Intercept | 3525.516 | 484.4666 | 7.277108 | 1.29E-06 | 2503.381 |
| 1 | 174.8526 | 39.42533 | 4.435032 | 0.000363 | 91.67245 |

| | |
|---|---|
| Equation based on Excel "data analysis" tool | y = 174.9x + 3525.5 |
| Mean of absolute Deviation (MAD) | 713 |
| Mean Absolute Percentage Error (MAPE) | 13.3% |
| Forecast of Fridge Sales for Q1 2011 | 7197 |

## Forecasting Transformer Requirements from Forecasting Fridge Sales

Forecasting Method #5b: Single Variable Linear Regression → Dependent variable is "Transformer Requirements" and the independent variable is "Fridge Sales"

The major change here is that you need the forecast for fridge sales in Q1 of 2011 to forecast the transformer requirements for January of 2011.

The output in Excel from running the single variable regression through the "data analysis" tool:

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.925158731 |
| R Square | 0.855918677 |
| Adjusted R Square | 0.847914159 |
| Standard Error | 180.3859314 |
| Observations | 20 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 3479386 | 3479386 | 106.9294 | 5.32E-09 |
| Residual | 18 | 585703.5 | 32539.08 | | |
| Total | 19 | 4065090 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* |
|---|---|---|---|---|---|
| Intercept | 1231.707567 | 168.636 | 7.303943 | 8.74E-07 | 877.4165 |
| Fridge sales | 0.315420391 | 0.030503 | 10.34067 | 5.32E-09 | 0.251336 |

| | |
|---|---|
| Equation based on Excel "data analysis" tool | y = 0.3154x + 1231.7 |
| Mean of absolute Deviation (MAD) | 138 |
| Mean Absolute Percentage Error (MAPE) | 4.7% |

| | |
|---|---|
| Forecast of Transformer Requirements for Q1 2011 | 3307 |
| Forecast of Transformer Requirements for January 2011 | 1103 |

The single variable linear regression study above allows us to forecast the Q1 transformer requirements which we then divide by 3 to get a single months forecast to get 1103. This value is not recommended to be used though. The MAPE value is only 4.7% but this error compounds with the forecast error for fridge sales in Q1 since we pulled that value from the single variable linear regression model which had a MAPE of 13.3%.