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**Walker and Sons Plumbing Supply**

**Analysis and Forecasting Case**

Managerial Report

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To: J.P Walker and sons

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MEMORANDUM

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**Executive Summary**

As a data analyst intern at J.P. Walker & Sons Plumbing, I have performed an analysis of the provided data in 3 years and made observation on the pattern to pick the most appropriate forecasting method. The sales data has been plotted and determined to have a seasonal pattern and linear pattern in annual sales. Two different multiple regression models, include “Seasonality with Trend” and “Seasonality Only”, were tested until the optimal method was found. To find the most optimal prediction model, mean square error was used. Mean square error is a common forecasting method used in supply chain. The model with the lowest MSE (Mean square error) is the best choice.

Though there is a remarkable up and down pattern to our sales over a 12 month period, an upward trend slowly occurs over time. It is reasonable to believe that Walker & Sons can use this monthly data to reduce costs by maintaining proper monthly inventory levels. Considering the volatility in sales over 12 months in a reoccurring pattern, proper future inventory levels should significantly reduce costs. Thus, my recommendation is producing more **before** every peaks (as a preparation) so we will have enough inventory to meet the demand during the peak season. If demand loss occurred, we would need to increase capacity **higher** and **sooner** to minimize the loss demand. The production level (capacity) should be adjust based on the predicted sales so that, again, we would not loose demand during the peak seasons (during Christmas time and New Year) but also not produce too much which may cause increase in warehouse cost or inventory cost.

In conclusion, the most optimal forecasting method found in this analysis will allow the company to better plan for future growth that will inevitably occur when the company launches the mobile platform and also enables the company to accurately forecast plumbing supplies sales by months for up to one year in advance.

All of my statistical findings and analysis including prediction equation, regression, and some charts are given in the appendix of this report.

**Appendix**

**Charts, Sales Equation, and MSE**

As you can see from the spreadsheet, the month continues after the 12th, so month 13 is the first month of the second year.

**Actual Sales**

Graph 1

Graph 1 shows the annual actual sales in the first 3 years, plotted from the raw data provided. As mentioned in the executive summary, the chart indicates a seasonal pattern as well as linear pattern with the peaks are around the end of each year and beginning of the following year (around Christmas and New Year time).

1. **Seasonality and Trend (with time variable)**
   1. **Predicted Sales**

Graph 2

Graph 2 shows the predicted sales in 4 years using the sales prediction equation. The chart indicates both seasonal and linear pattern with trend going slightly upward. We can easily recognize the similarity between the actual graph and the predicted graph above.

MSE = 13.35

We use this indicator to compare with the MSE of the other model with seasonality only. The method having the smaller MSE will be selected.

**Predictive Equation with time variable:**

Sales = 199+1\*month+49\*M1+29\*M2+33\*M3-23\*M4-21\*M5-68\*M6-62\*M7-57\*M8-101\*M9-86\*M10-59\*M11

With M1, M2, M3, … , M11 are the dummy variables representing 11 months of a year.

**Regression for Seasonality and Trend**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |  |  |
| Multiple R | 0.996889673 |  |  |  |  |  |  |  |
| R Square | 0.993789021 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.99054851 |  |  |  |  |  |  |  |
| Standard Error | 4.570700641 |  |  |  |  |  |  |  |
| Observations | 36 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 12 | 76882.5 | 6406.875 | 306.6766 | 2.12E-22 |  |  |  |
| Residual | 23 | 480.5 | 20.8913 |  |  |  |  |  |
| Total | 35 | 77363 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 198.8333333 | 3.231973 | 61.52072 | 5.01E-27 | 192.1475 | 205.5192 | 192.1475 | 205.51918 |
| M1 | 49.38194444 | 3.828704 | 12.89782 | 5.17E-12 | 41.46167 | 57.30222 | 41.46167 | 57.3022219 |
| M2 | 28.68055556 | 3.81209 | 7.523578 | 1.21E-07 | 20.79465 | 36.56646 | 20.79465 | 36.5664645 |
| M3 | 33.3125 | 3.796996 | 8.773384 | 8.5E-09 | 25.45782 | 41.16718 | 25.45782 | 41.167184 |
| M4 | -23.38888889 | 3.783439 | -6.18191 | 2.63E-06 | -31.2155 | -15.5622 | -31.2155 | -15.5622486 |
| M5 | -20.75694444 | 3.771437 | -5.50372 | 1.35E-05 | -28.5588 | -12.9551 | -28.5588 | -12.9551323 |
| M6 | -67.79166667 | 3.761004 | -18.0249 | 4.6E-15 | -75.5719 | -60.0114 | -75.5719 | -60.0114363 |
| M7 | -62.49305556 | 3.752154 | -16.6552 | 2.5E-14 | -70.255 | -54.7311 | -70.255 | -54.7311336 |
| M8 | -57.19444444 | 3.744897 | -15.2726 | 1.57E-13 | -64.9414 | -49.4475 | -64.9414 | -49.4475343 |
| M9 | -101.2291667 | 3.739243 | -27.0721 | 6.03E-19 | -108.964 | -93.494 | -108.964 | -93.4939525 |
| M10 | -85.59722222 | 3.7352 | -22.9164 | 2.44E-17 | -93.3241 | -77.8704 | -93.3241 | -77.8703732 |
| M11 | -58.63194444 | 3.732771 | -15.7074 | 8.68E-14 | -66.3538 | -50.9101 | -66.3538 | -50.9101188 |
| Months (t) | 1.034722222 | 0.077749 | 13.30846 | 2.73E-12 | 0.873886 | 1.195559 | 0.873886 | 1.19555869 |

1. **Seasonality Only (no time variable)**
   1. **Predicted Sales**

**Regression:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |  |  |
| Multiple R | 0.972604949 |  |  |  |  |  |  |  |
| R Square | 0.945960386 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.921192229 |  |  |  |  |  |  |  |
| Standard Error | 13.1982743 |  |  |  |  |  |  |  |
| Observations | 36 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 11 | 73182.33333 | 6652.939 | 38.1926 | 1.68E-12 |  |  |  |
| Residual | 24 | 4180.666667 | 174.1944 |  |  |  |  |  |
| Total | 35 | 77363 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 223.6666667 | 7.620027219 | 29.35248 | 2.56E-20 | 207.9397 | 239.3936 | 207.9397 | 239.3936 |
| M1 | 38 | 10.77634584 | 3.526242 | 0.001726 | 15.75872 | 60.24128 | 15.75872 | 60.24128 |
| M2 | 18.33333333 | 10.77634584 | 1.701257 | 0.101817 | -3.90795 | 40.57462 | -3.90795 | 40.57462 |
| M3 | 24 | 10.77634584 | 2.2271 | 0.035578 | 1.758715 | 46.24128 | 1.758715 | 46.24128 |
| M4 | -31.66666667 | 10.77634584 | -2.93853 | 0.007178 | -53.908 | -9.42538 | -53.908 | -9.42538 |
| M5 | -28 | 10.77634584 | -2.59828 | 0.015765 | -50.2413 | -5.75872 | -50.2413 | -5.75872 |
| M6 | -74 | 10.77634584 | -6.86689 | 4.21E-07 | -96.2413 | -51.7587 | -96.2413 | -51.7587 |
| M7 | -67.66666667 | 10.77634584 | -6.27918 | 1.72E-06 | -89.908 | -45.4254 | -89.908 | -45.4254 |
| M8 | -61.33333333 | 10.77634584 | -5.69148 | 7.31E-06 | -83.5746 | -39.092 | -83.5746 | -39.092 |
| M9 | -104.3333333 | 10.77634584 | -9.6817 | 9.21E-10 | -126.575 | -82.092 | -126.575 | -82.092 |
| M10 | -87.66666667 | 10.77634584 | -8.1351 | 2.34E-08 | -109.908 | -65.4254 | -109.908 | -65.4254 |
| M11 | -59.66666667 | 10.77634584 | -5.53682 | 1.08E-05 | -81.908 | -37.4254 | -81.908 | -37.4254 |

Graph 3

Graph 3 shows the predicted sales in 4 years with no time variable, also using the sales predictive equation. The chart indicates both seasonal and linear pattern with trend going slightly downward, which is opposite direction with the first model.

**Predictive Equation with time variable:**

Sales = 223.67 +38\*M1+18\*M2+24\*M3-31\*M4-28\*M5-74\*M6-68\*M7-61\*M8-104\*M9-88\*M10-60\*M11

MSE = 116.13 is much higher than the MSE in the first model (MSE = 13.35). Therefore, we pick the first model (Seasonality and Trend/with time variable) as the optimal forecasting method that we should use to predict sales for Walker and Sons Supply.

In addition, the actual sales data show the growth in sales every year.

Demonstration of Sales Growth Year over year:

|  |  |  |
| --- | --- | --- |
|  | Actual sales | % growth |
| Year 1 Month 1 | 240 |  |
| Year 2 Month 2 | 263 | 9.583333 |
| Year 3 Month 3 | 282 | 7.224335 |

Therefore, by combining these 2 convincible reasons, we can conclude that the first model – Seasonality and Trend – is definitely the optimal forecasting method in this case.