**Case Study 3:**

**Master Class Analytics LLP**

**Firm Analysis**

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BANA 5301 – Business Analytical Statistics

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**Case Study 3: Master Class Analytics**

I will serve as a data analyst for Master Class Analytics (MCA), LLC. MCA is a consulting firm who uses a collaborative team-based approach to provide data analytics. This case study focuses on the business operations of Molded Devices, Inc. (MDI) and Emerson. MDI is requesting an evaluation on its acquisition of Seitz Corporation in 2021. The evaluation will focus on the production process and product quality. The technology company Emerson bought the subsidiary of Clarkson, a manufacturer of knife-gate valves, in 2017. Emerson’s evaluation will focus on the effectiveness and efficiency of Clarkson in the past year.

**Methodology**

The provided data has been reviewed to ensure accuracy and completeness. For the purpose of consistency, each evaluation for MDI and Emerson will be contained in one report. Since the evaluations are both performed by Master Class Analytics, I will deliver them in one report. It is then up to MCA to properly distribute the evaluations.

Molded Devices, Inc. will receive an evaluation containing pre- and post-acquisition metrics on the performance of Seitz Corporation. I will categorize the main points into average sales per customer, customer satisfaction, perceptions of quality, and variance in pulleys. Emerson received performance metrics of the knife-gate values produced by Clarkson. The main evaluation points will focus on wafer strength, seal replacement costs, and valve production.

**Molded Devices, Inc. (MDI) Acquisition**

**Average Sales using Hypothesis Tests**

This section will determine whether the average dollar amount per transaction per customer has fluctuated from last year. In order to determine this, I will perform a hypothesis test. The end result of the test impacts how stakeholders react to fluctuating sales. Lower average sales indicate a need for new strategies, whether in the form of pricing or marketing strategies.

Our null hypothesis states that the average sales are the same for both years. The alternative hypothesis states that average sales are different from last year. If the p-value is less than the significance level (0.05), it is safe to reject the null hypothesis. This would mean average sales have not changed. The opposite is also true, a p-value greater than 0.05 indicates average sales have changed over the year.

The test performed in the code uses a two-sample t-test for independent samples. The T-statistic for Seitz is -0.957. It was found comparing last years and this year’s sample data. Based on a p-value of 0.344, we will fail to reject the null hypothesis. There is no notable change in the average dollar amount per transaction per customer from last year.

**Customer Satisfaction using Confidence Intervals**

This section indicates whether the customer satisfaction surveys rating change across plant locations. In order to determine this, I will find the confidence interval for the two plants. This test will use each plant’s mean, standard deviation, sample size, and p-value to make an educated decision. A zero within a confidence interval represents a failure to find a significant statistical difference in customer satisfaction ratings. If there is not a zero in the confidence interval, I can confirm there is a significant statistical difference in customer satisfaction ratings.

Based on the python code, there is no significant difference in the proportions of customers rating excellent quality between the two plants. To ensure there is a significant difference, I used an alpha of 0.05 for a 95% confidence interval. This provided a lower bound of -0.020 and an upper bound of 0.349. In comparison to the estimated difference in proportions (0.165), Seitz’s satisfaction at plant one is no different than plant two.

**Perceptions of Quality using Two-Sample T-Tests**

This section focuses on the overall quality ratings during 2020 and 2022. In order to determine this, I will perform a two-sample t-test since the data comes from two independent years. This test will use each year’s mean, standard deviation, sample size, and p-value to make an educated decision. A positive difference on a t-test indicates improved quality after the acquisition. Vice versa, a negative difference on the t-test indicates a decrease in product quality. The information gained from this test informs managers on the acquisitions overall quality rating.

To begin this analysis, I will input the data into Python. Each year (2020, 2022) has an associated mean, variance, and number of observations value. I then implemented an alpha of 0.05 and a t-statistic of -2.34. These values come directly from MDI’s report. I found the degrees of freedom (df) by adding the total number of observations and subtracting two for each variable. This creates a df of 166, which indicates a large robust sample size.

Our first critical t-value is for the one-tailed test. The t-statistic obtained is 1.654. This result is statistically significant Because it is greater than -2.34 and has a P value smaller than 0.05. The two tailed tests demonstrates the exact same thing. The critical t-value is 1.974 and is statistically significant. The results of these tests implicate that MDI Has obtained a positive impact from the acquisition of Sietz.

**Variance in Pulley Batches using F-Tests**

This portion of the analysis strives to determine a difference in variances of pulley diameters. The data collected is from a singular location across time. We will focus on week one and Week 5 for the purpose of this study. The sample variance in week one is less than week five. This indicates more variability in the diameters of week five.

To properly compare the variance of diameters between the two weeks, I will perform a f-test on the variances. The F-statistic is a result of dividing the larger variance (week 5) by the smaller variance (week 1). This results in an f-statistic of 2.056. The next part is to determine the critical value. A two-tailed test with a significance level of 95% results in a critical value of 6.978. This large statistic means that we failed to reject the null hypothesis that the two batches have equal variances. Since there is no significance, we can determine that the variability in week one does not differ from week five.

**Emerson Acquisition**

**The Impact of Supplier and Temperature on Wafer Strength**

The engineers at Emerson are looking to produce a wafer that is able to withstand elevated temperatures. There are two suppliers being assessed at 70°F, 110°F, and 150°F temperature conditions. The main purpose of the experiment is to understand the effects of temperature and suppliers on wafer strength (psi). The temperature and supplier are independent variables while pressure (psi) is a dependent variable.

I will perform a two-factor ANOVA (Analysis of Variance) test. This will measure the effects of the two independent variables, temperature and supplier, on the dependent variable, pressure. The null hypothesis will focus on three main points. First, temperature has no effect on the strength of the wafer. Second, Supplier has no effect on the strength of the wafer. Third, one independent variable does not influence the other. Alternative hypothesis state says act opposite of the three points. Temperature affects the strength of the wafer, the supplier affects the strength of the wafer, and there is an influence between independent variables. The ANOVA test We'll demonstrate if we reject or fail to reject the null hypothesis.

A two-factor ANOVA test has six steps. The first step is to formulate the hypothesis as we have done above. The second step calculates the group means and the overall mean of all data. After we calculate the means, we will then partition the variance. I will calculate the total variance for all means as SST. The between-group variance (SSB) will consist of the supplier and temperature variance. It is important to note at this stage the between-group variances are calculated separately. Finally, I will determine the within-group variance (SSW) by subtracting between group variance from the total variance.

The fourth step calculates the mean squares for each independent variable by dividing the between-group variance by the within-group variance. This will demonstrate the average variance within a given group. The fifth step calculates the f-statistic by dividing the mean-square between (MSB) by the mean-square within (MSW) for the temperature and supplier. Finally, I will calculate the p-value for each variable. This process compares MSBs to MSWs.

The results of the test have established two things. We failed to reject the null hypothesis for the supplier independent variable. This means that all supplier means are equal. The second result is that we reject the null hypothesis for the temperature independent variable. This means at least one temperature mean is different from the rest. The results stem from a P value being less than the f-statistic.

**Seal Replacement Costs**

Emerson is looking to understand the seal replacement cost in four countries. The main goal of this section is to determine if seal replacement costs differ based on marketing techniques. This will be evaluated through an ANOVA test, which uses one independent variable to establish a dependent variable. The null hypothesis states that there is no difference in seal replacement costs between the countries. The alternative hypothesis states there is a significant difference in at least one country.

I will perform a one-way ANOVA test using python code. If the p-value obtained is less than 0.05, I will reject the null hypothesis and confirm the existence of a difference in seal replacement costs. A low p-value indicates that one of the four countries within the data set has a higher replacement cost. This directly goes against all cost-effective measures in the marketing strategy. A high p-value indicates there are other factors, internal or external, that affect cost.

The obtained f-statistic shows how variance differs between countries. A lower f-statistic indicates there is less variability in replacement cost. The dataset produces an f-statistic of 32.676 and a p-value of zero. Based on the Python code, we reject the null hypothesis. There is a significant difference in the cost of seal replacements between countries. There is high variability within seal replacement cost represented in both measurements.

**Lead Time for Valve Production**

There is a current debate at Emerson evolving lead times for valve production. Stakeholders and upper management want to know how each type of valve affects lead time. In addition, each weekday is considered as a valuable variable. The main goal of this evaluation is to determine how weekdays and valve type affect lead time.

The solution to this problem is the same as wafer strength. We will utilize a two-factor ANOVA test. Similarly, the data provided consists of two independent variables and one dependent variable. The dependent variable in this case is lead time, while the independent variables are valve type and weekday. The null hypothesis states that lead times are not affected by the type of valve, the day of the week, and there are two separate independent variables. The alternative hypothesis states the exact opposite: lead time is affected by type of valve and/or weekday.

Based on the info given, there are two conclusions. With a f-statistic of 32.393 and a p-value of zero, we reject the null hypothesis. Lead times differ significantly between valve types. Conclusion leads us to reject the null hypothesis for weekdays with a f-statistic of 5.232 and a p-value of 0.004. These results tell us Emerson needs to find stability within the valve production process.

**Conclusion**

**Molded Devices, Inc. Summary**

Since there is no significant change in average sales per customer, managers need to identify factors to change this. After the acquisition, there should be a positive improvement in sales. To achieve this goal, management should investigate strategies towards customer retention. Due to the small nature of the sample size, it may be beneficial for MDI to collect a larger sample size. This may indicate a different story than what the data currently tells. Another solution is to identify key demographics for products.

The results of customer satisfaction has revealed no significant research. Plant one and Plant two produce a rating in between the lower bound and upper bound of the confidence interval. Since the confidence interval includes zero, we must conclude that there is no significance. A method to solve this problem is to produce another data set with more observations. A common theme with MDI is small datasets. A lack of data collection leads to no further insights.

My recommendation for quality management is for management to follow these three steps. The first one is to leverage the positive results into customer retention efforts. Whatever current strategies are occurring in this department's work period any sudden change could disturb the customer market and reduce quality ratings. The second step is to investigate a positive factor. This investigation will lead management towards the key cause of positive quality ratings. The final and third step is to monitor activity. Continuous tracking of quality ratings in the following years will benefit the company.

The variances of pulley batches shows A consistent variability across time. This is a positive result because management can see the stability of production processes. These indications let stakeholders know there are no major adjustments in the production process. For our future notice, we should keep a close eye on variability due to the high nature of week five.

**Emerson Summary**

Due to the fact that we reject the null hypothesis on temperature, this indicates that we need to specify the ideal temperature range for the wafer. There is no significant difference between suppliers for the wafer; therefore, the optimal wafer performance must be found. My recommendation for Emerson is to find the supplier with the most cost-friendly wafer and test temperatures on that. For this situation, there is not an inherent reason to choose one supplier over another.

Emerson's seal replacement cost strategy needs to be changed. A p-value indistinguishable from zero and a high f-statistic tells stakeholders there is no stability within the cost strategy. We can use that information obtained to dissect which regions to focus on. By targeting these countries, we can focus on the market’s desires for a long-lasting product. If Emerson does not want to change the cost strategy, we can implement different marketing techniques. One example would state that seals are cost effective in comparison to the longer lasting valves.

The lead times during valve production are significantly different based on valve type and weekday. A major contributor to this fact could be the interaction between the independent variables. Whether this is the fact that one type of valve is produced on one day or another similar one, solving this issue will increase efficiency in the production cycle.

**Programming Script**

Molded Devices, Inc. Python Code 

Emerson Python Code 