Predicting Injuries at Michael D Computer Company

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6.780 – Semiconductor Manufacturing

Agenda

- Background
- Qualitative Data Analysis
- Poisson Regression Model
- Injury Model Results
- Sensitivity Analysis
- Summary

Background

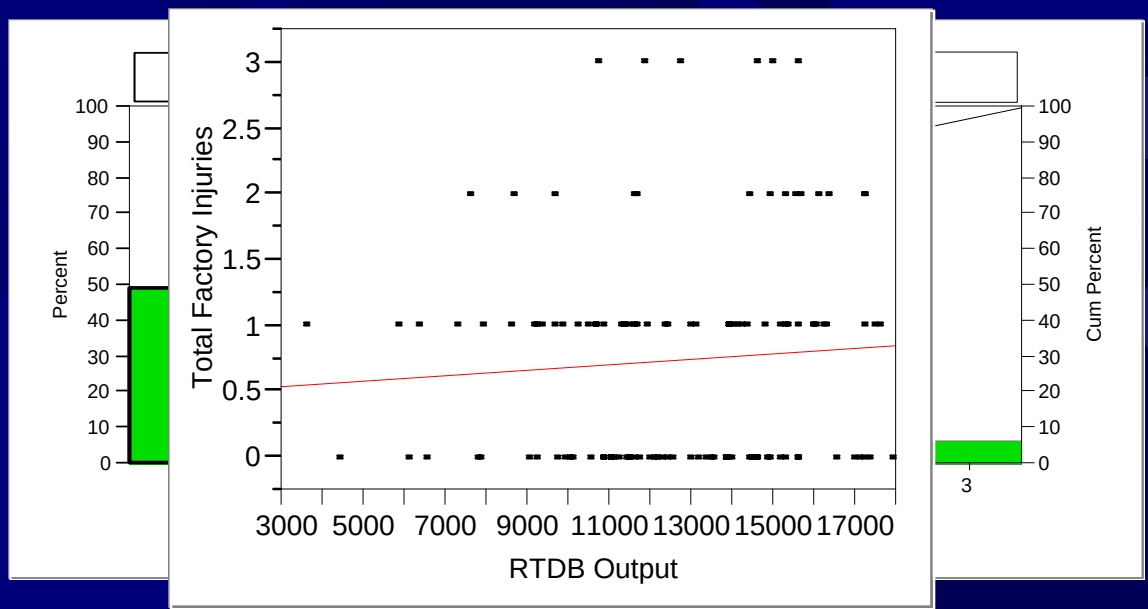
- Internship at Michael D Corp
- Task: To correlate Headcount and factors of Productivity
- Concern: Non-Productivity factors such as Injury Rates and Quality are important too

Background (2)

- This Report: Determine how Headcount and Other factors impact the number of Injuries seen in the factory
- Given: Injuries are Poisson distributed with value of 0, 1,2, or 3

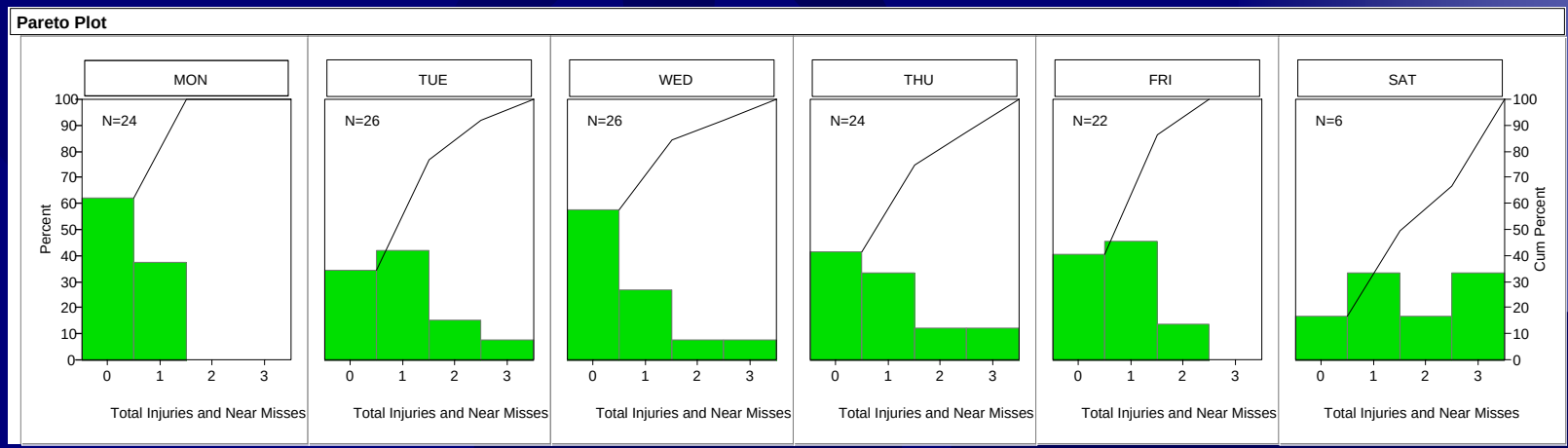
Qualitative Analysis

- Output seems to have an impact on Injury levels (not certain)
- Shift data shows Shift 2 appears to have more Injuries (0.96 vs. 0.67 average)



Qualitative Analysis (2)

- Day of the Week (hard To determine trends)
- Saturday and Monday look significant, but it is hard to tell.



Poisson Regression Model

- Poisson Distribution is described with the following equation:
  - $P(Y=k) = Exp(-\mu)*\mu^{n} / n!$
- μ can be value or linear equation
- The Poisson Loss Function guarantees
  - No negative values
  - No skewness
  - No growing variability with mean growth
- Final Poisson Loss function
  - (3) $Ln(Y) = -(InjuriesAndNearMisses*model- \text{Exp}(model)) -Log(\Gamma(InjuriesAndNearMisses+1))$

Poisson Regression Model (2)

- The model setup included these factors:

Variable	Description
Injuries and Near Misses	This variable is the target of the study. It is a count of the Injuries that occurred in the factory, as well as incidents recorded that could have resulted in an injury on the factory floor, but was avoided. This information is collected by shift.
Shift	This is the shift of the factory for which the injury data was collected.
Total Headcount	The total headcount of the TMC factory floor, collected by the shift.
Hours in the Shifts	This is a measure of the total number of hours worked in each shift.
Total Output	This measures the total output, as the number of units shipped from the factory, for each shift.
Percent Temporary Employees	This measures the number of temporary employees used in the factory, as a percent of the total workforce. This would be used to measure the impact of using temporary employees on the number of injuries seen in the factory.
Day of the Week	This is the day of the week for the model.

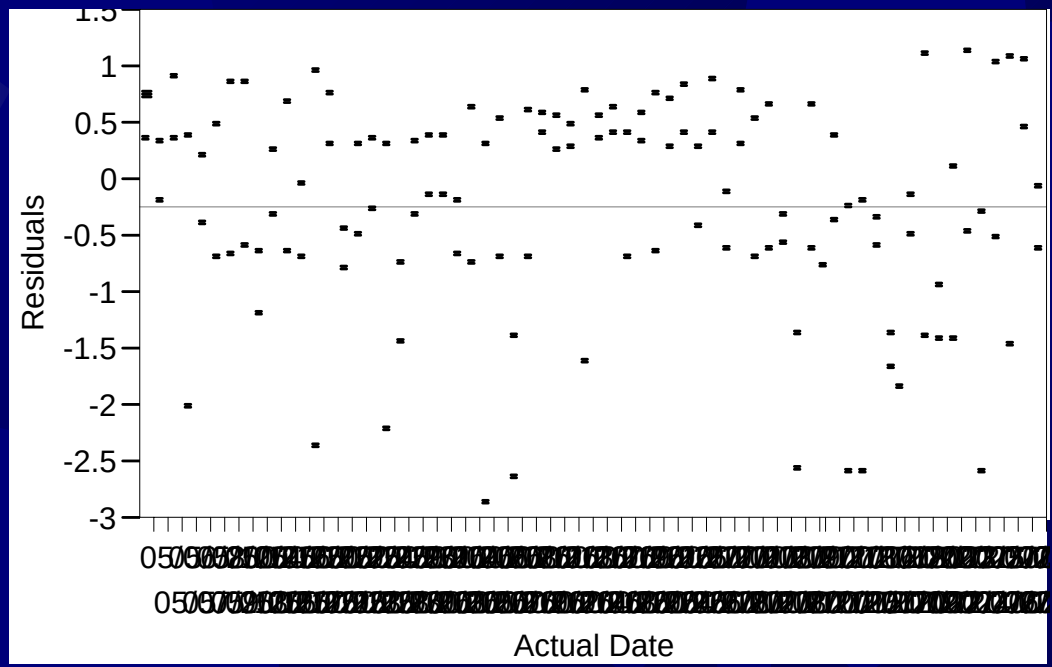
Injury Model Results

- Output gives Estimate, Upper and Lower Limits
- Confidence Limits test effect significance

Parameter	Estimate	ApproxStdErr	Lower CL	Upper CL
Monday	-0.836	0.405	-1.681	-0.072
Tuesday	-0.012	0.292	-0.584	0.566
Friday	-0.032	0.341	-0.716	0.63
Saturday	1.102	0.459	0.152	1.967
Wednesday	-0.422	0.321	-1.066	0.202
Second	1.048	0.385	0.299	1.812
Intercept	-0.125	1.688	-3.36	3.277
rcentTempCo	-7.711	3.65	-14.885	-0.542
rsWorkedCoe	0.068	0.181	-0.3	0.41
eadcountCoe	0.879	0.439	0.025	1.75
OutputCoeff	-0.008	0.097	-0.187	0.192

Injury Model Results (2)

- Analysis of Residuals shows no trends
- Concern: Unexplained low values
- Std Dev = MSE = 0.867 for the model



Sensitivity Analysis

- Manager want conservative estimate of Day and Shift effects.
- Assume: Model predicts three Injuries for Wednesday, Second shift.
- Use average Estimates for all other Factors
- Sensitivity shows Injury rate could vary between 1.973 and 4.027 Injuries per Shift.

Factor	Avg Case	Best Case Adjustment	Worst Case Adjustment
Wednesday	-0.422	-0.642	0.642
Second Shift	1.048	-0.385	0.385
Total		-1.027	1.027

Conclusion

- Poisson Regression used to predict Poisson Distributed output.
  - No skew, negative numbers, or growing variance
- Allows for Confidence Intervals to test factor significance
- Prediction Equation can be used to estimate total Injuries.
- Sensitivity Analysis can be done to get best and worst case scenarios.