Manufacturing Defects Analysis

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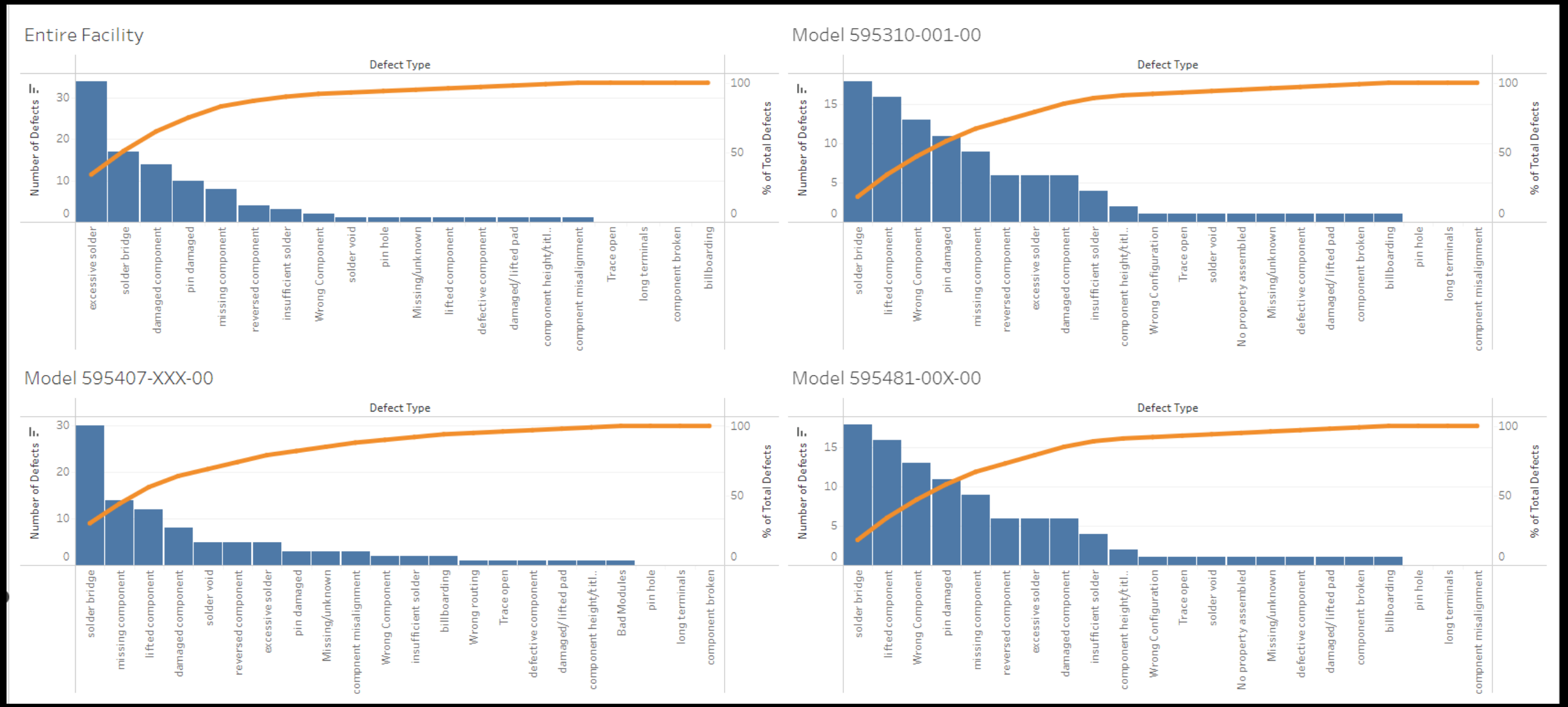
Increasing Number of Manufacturing Defects

- The company has seen increased demand for our electronic boards
- There has also been an increased number of detected manufacturing defects

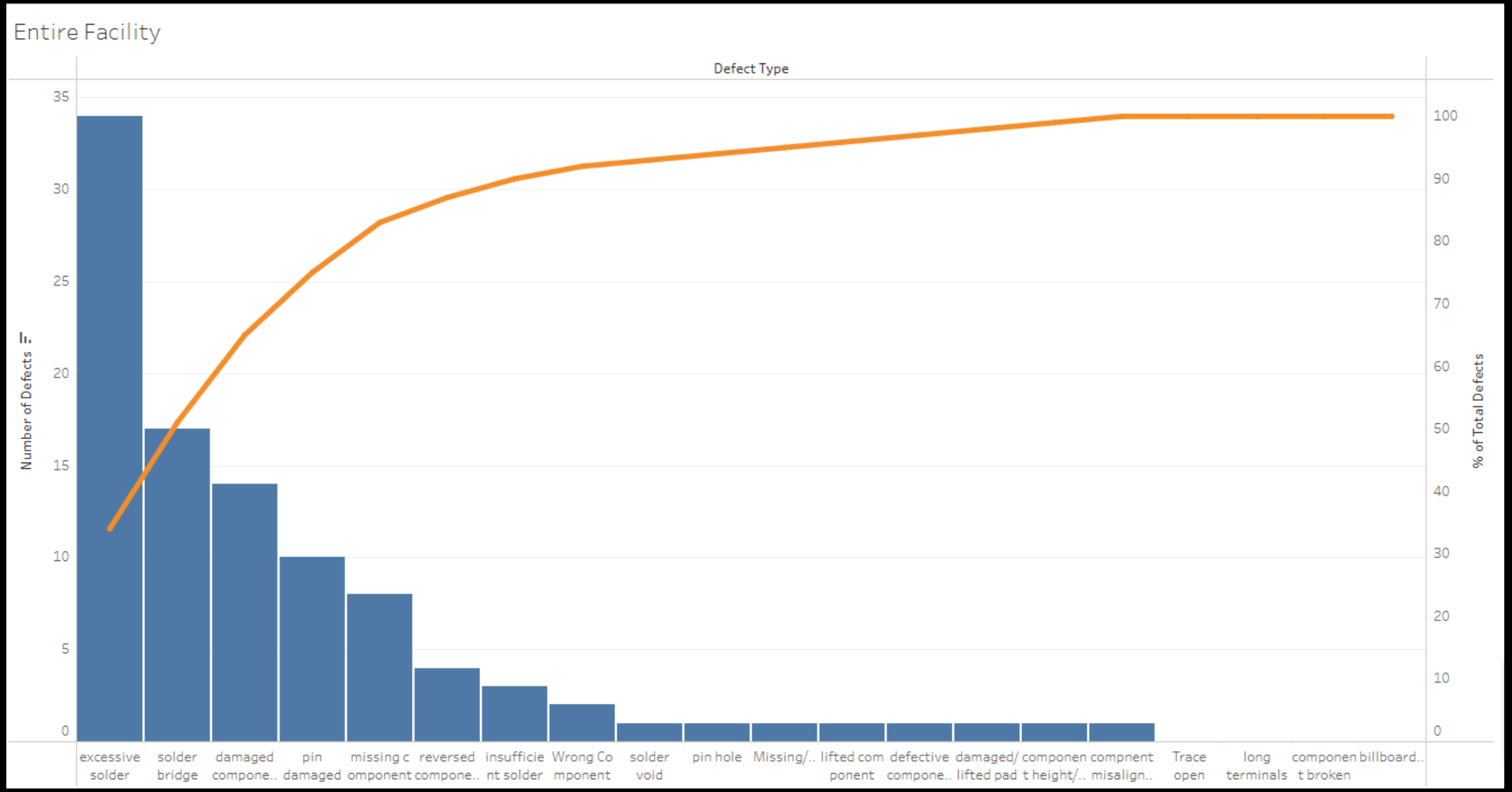
An example of the type of defects are missing, lifted and damaged components, solder bridges, and insufficient and excessive solder

- It's cost-prohibitive to correct the defects post-final assembly, but the company will make corrections prior to product release, in compliance with the IPC-A-610E standard for electronic components
- A project to improve the manufacturing defects in the three double production lines have been requested with two outcomes:
  - A 20 percent defects reduction generated during the welding process
  - A 20 percent capacity increase in production without increasing the percentage of defects

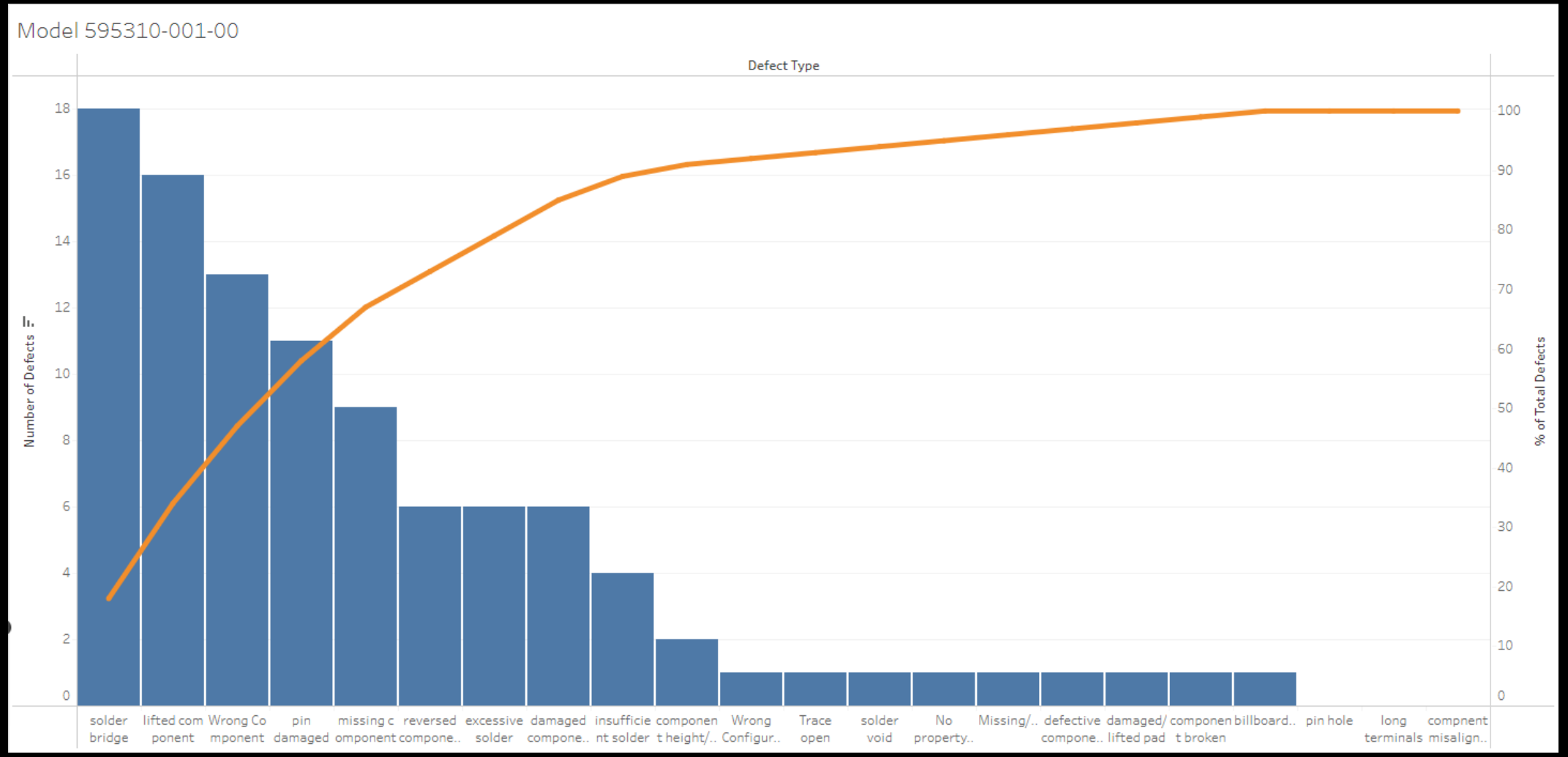
Tableau Dashboard



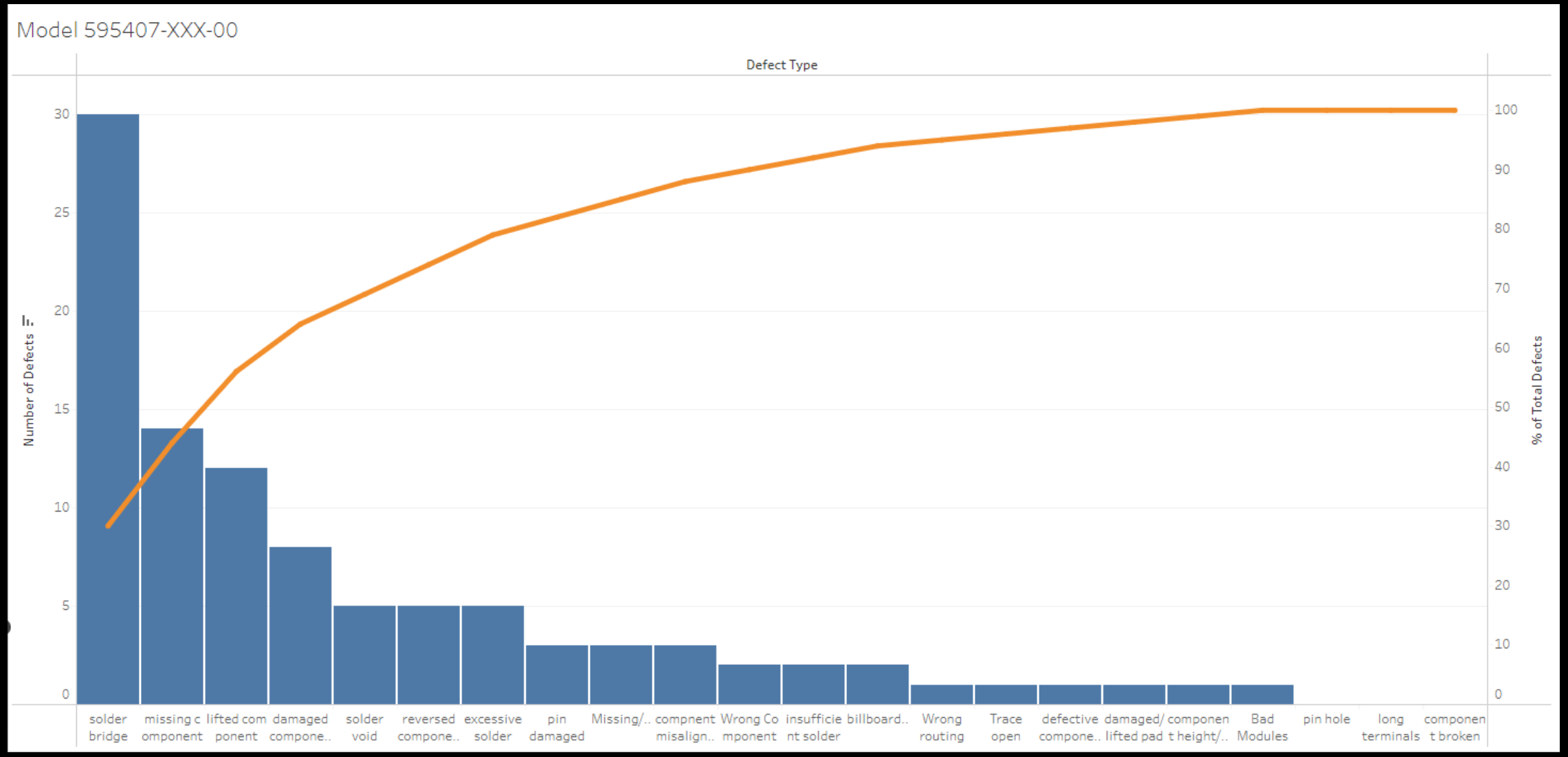
Entire Facility



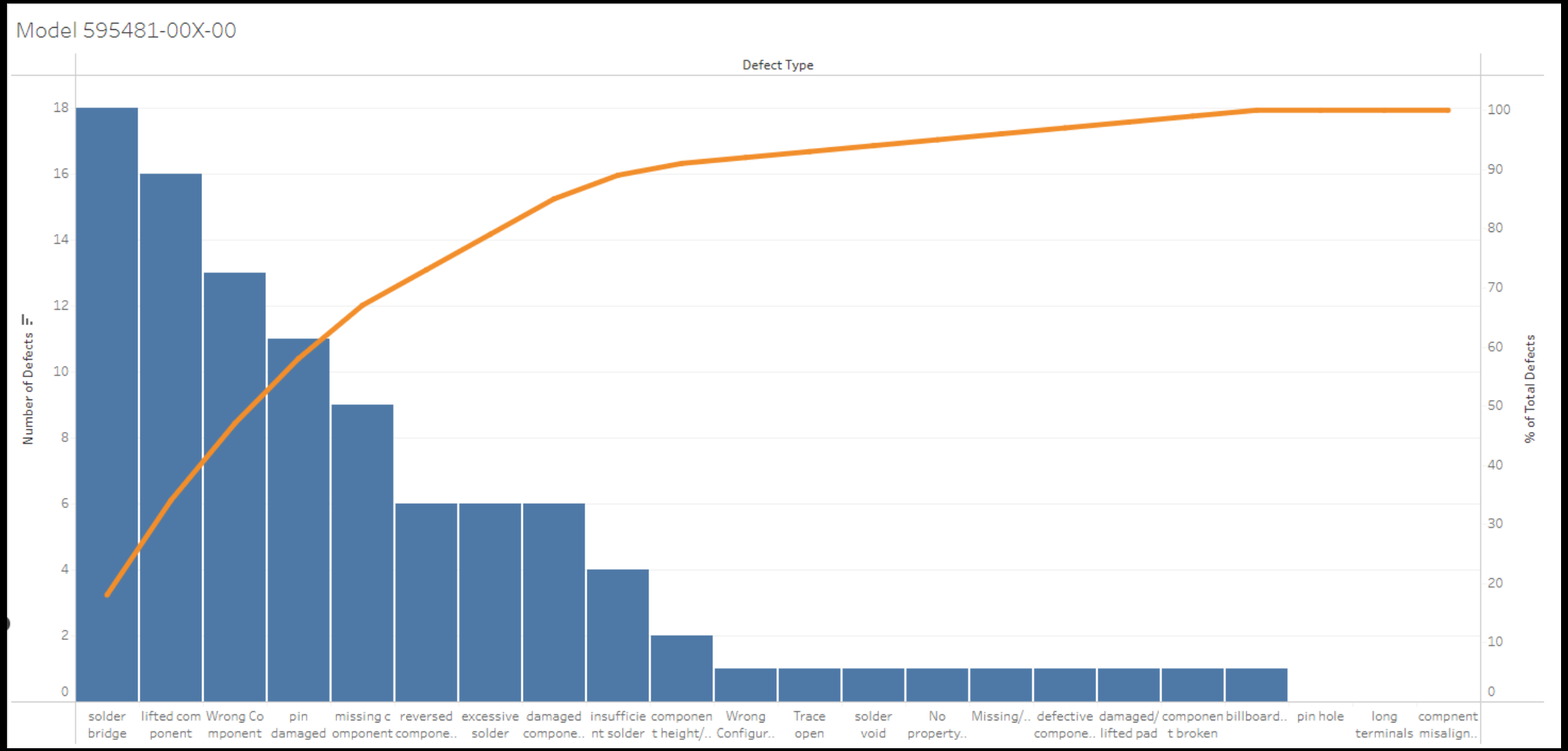
Model 595310-001-00



Model 595407-XXX-00



Model 595481-00X-00



Hypothesis Test

Hypothesis testing was conducted to determine if the defects are specific to a model or the entire manufacturing facility

We performed a one-way ANOVA hypothesis test, which can give an estimate of any variation in manufacturing defects explained by the model.

Data used in hypothesis testing:

Model 1	Model 2	Model 3
30%	6.67%	7.23%
14%	3.11%	3.37%
11.50%	2.56%	2.77%
8%	1.78%	1.93%
5%	1.11%	1.20%

```
> one.way <- aov(Percentage ~ Model, data = df)
> summary(one.way)
            Df Sum Sq Mean Sq F value Pr(>F)
Model        2  369.6  184.78   5.285 0.0226 *
Residuals   12  419.5   34.96
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Post-Hoc Test

We did more testing to show how significant the differences are between the models.

```
> TukeyHSD(one.way)
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = Percentage ~ Model, data = df)

$Model
                    diff        lwr       upr     p adj
Model2-Model1 -10.654 -20.630789 -0.677211 0.0362961
Model3-Model1 -10.400 -20.376789 -0.423211 0.0409467
Model3-Model2   0.254  -9.722789 10.230789 0.9974603
```

This testing shows that Models 2 and 1, and models 3 and 1, had significant differences in percentage of defects, while model 3 and model 2, had no significant difference in the percentage of defects.

Analysis Results

- There is a significant difference between the mean number of defects across the three production lines,
- Between models 3 and 2, the mean defect percentage difference were the lowest,
- Between models 2 and 1, and models 3 and 1, the mean defect percentage difference were the highest,
- The corrections to the manufacturing process should first start with model 1 (it has the highest mean defect rate, and significantly larger difference between it and the other models,
- Use the individual model charts to focus on the highest percentage defects on the remaining two lines
- The company will be able to make corrections in the manufacturing process, and meet the goals of reducing defects by 20 percent, and increasing production by 20 percent, without increasing defect percentage.

References

Ranganathan, P., & Cs, P. (2019). An Introduction to Statistics: Understanding Hypothesis Testing and Statistical Errors. Indian journal of critical care medicine : peer-reviewed, official publication of Indian Society of Critical Care Medicine, 23(Suppl 3), S230–S231. https://doi.org/10.5005/jp-journals-10071-23259

Singh, G. (2023). ANOVA: Complete guide to Statistical Analysis & Applications (Updated 2023). Analytics Vidhya. https://www.analyticsvidhya.com/blog/2018/01/anova-analysis-of-variance/

Bevans, R. (2023). One-way ANOVA | When and how to use it (With Examples). Scribbr. https://www.scribbr.com/statistics/one-way-anova/