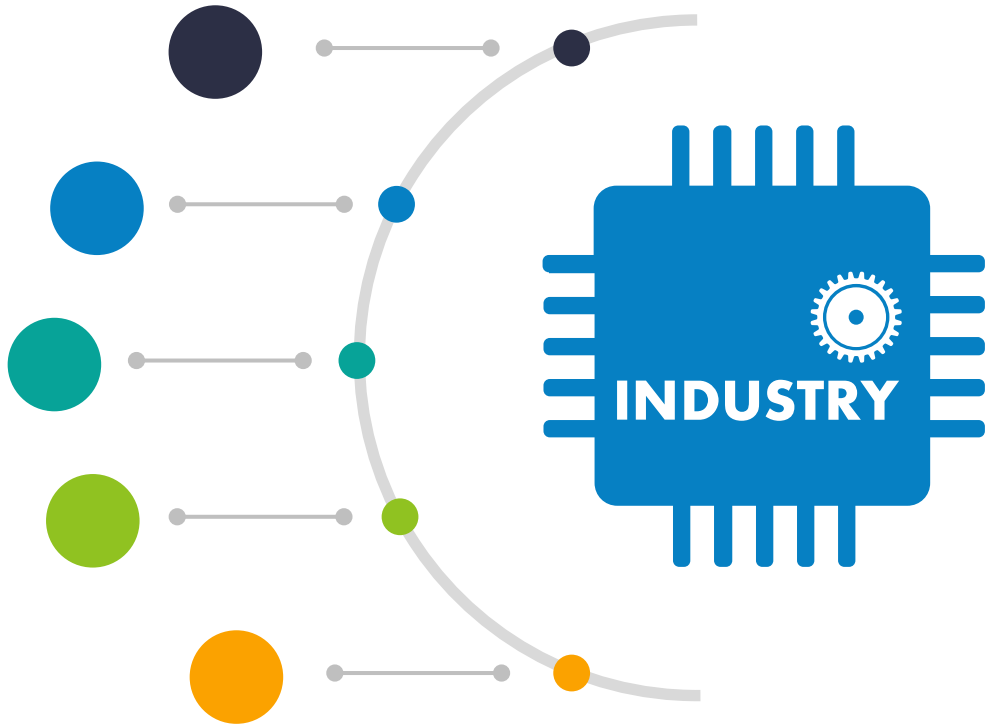
KPIs

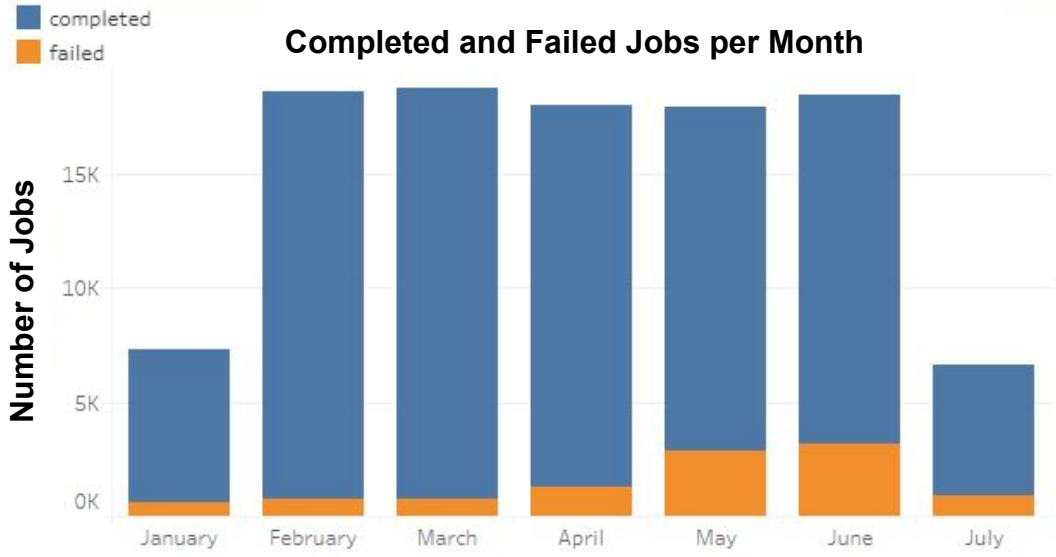
Panasonic

1. Number of Completed Jobs per time interval (per day, week, month, etc)
2. Number of Failed Jobs per time interval (per day, week, month, etc)
3. Number of components picked (Total per day per zone)?
4. Pick Job completion time per time interval
5. Compare number of picks between zones
6. Compare pick times between zones
7. Average pick time per time interval (Pick Rate)
8. Most common parts picked – Part based
9. Most frequently picked parts – Time based
10. Busiest pick zone / Slowest pick zone
11. Job-In-Queue time
12. Reacted time per zone (Added In KPI 4)
13. Error rate per zone (Added In KPI 5)
14. Ended time per zone (Added In KPI 6)
15. Number of Jobs and Time per Shift (Added In KPI 6)



Dashboard: Jobs per Time Interval (KPI 1 & 2)

Number of Completed and Failed Jobs per Time Interval

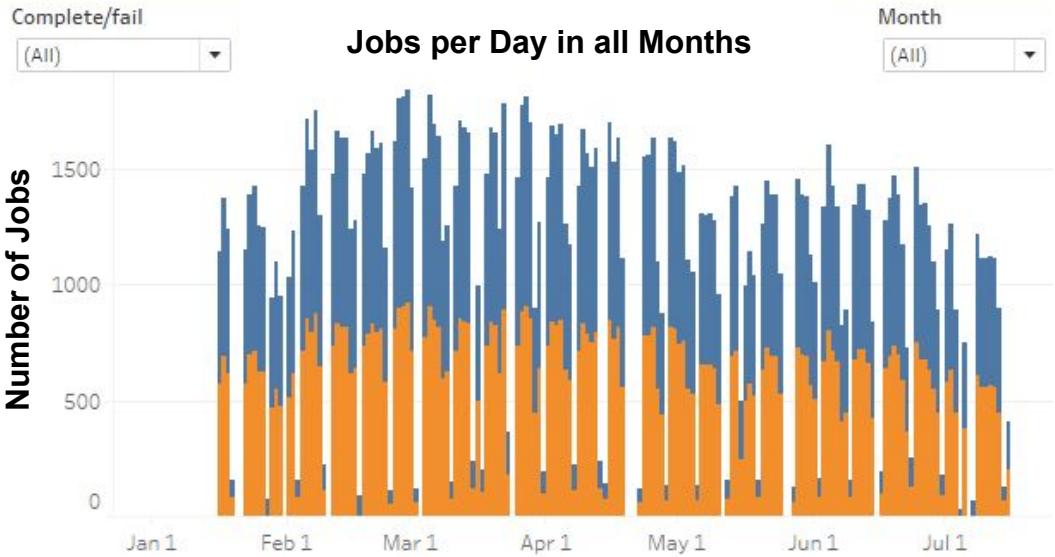


Total Jobs

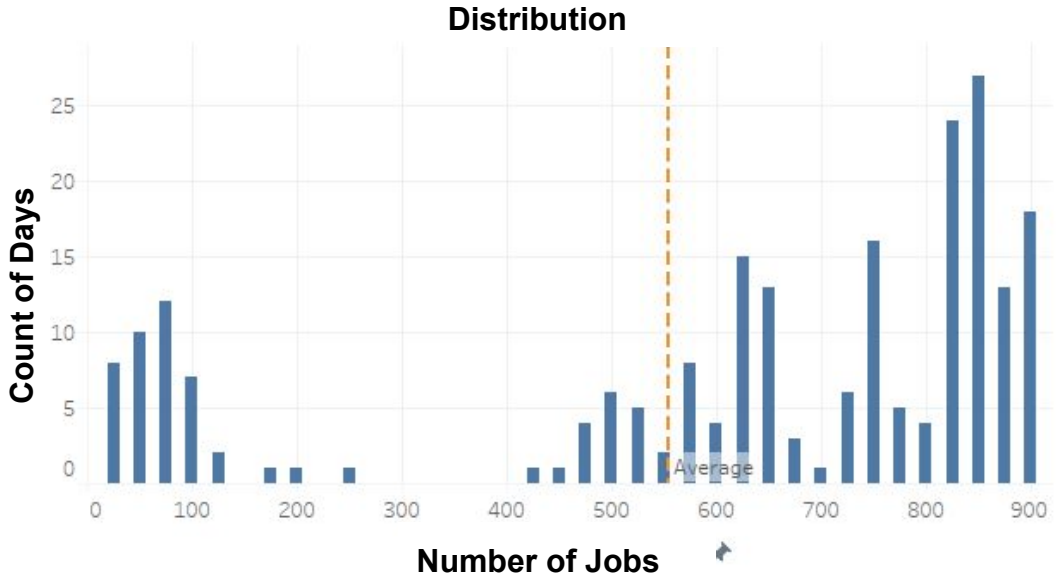
105,664

Failed Rate

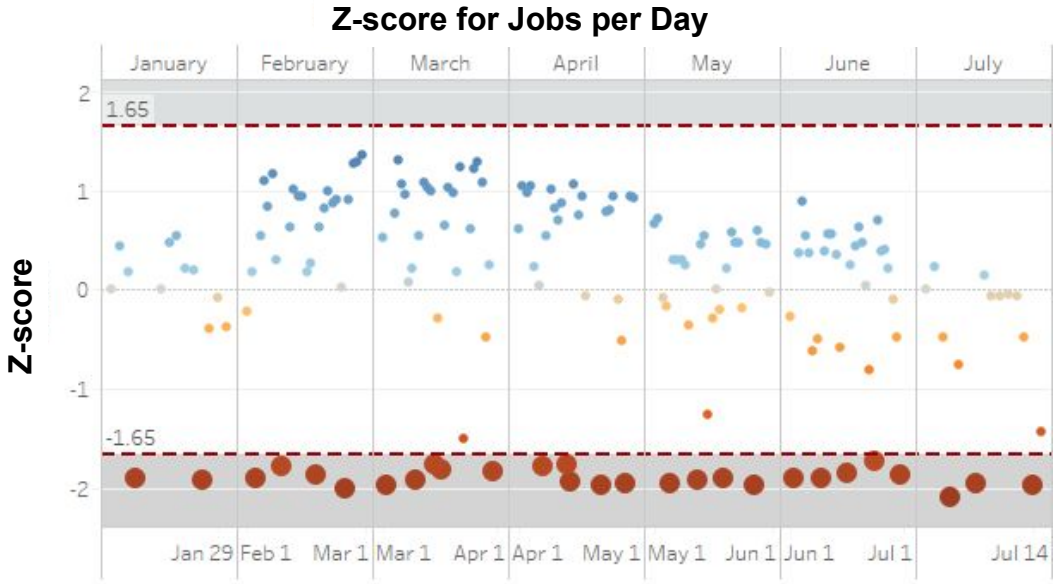
10.02%



Distribution & Outliers

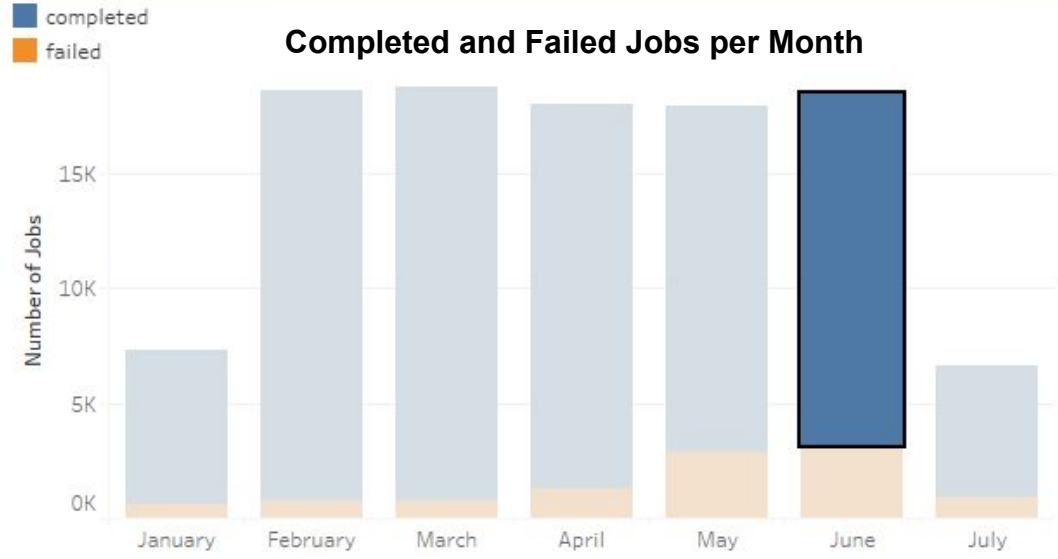


Sunday
471
Monday
2,728
Tuesday
2,875
Wednesday
2,837
Thursday
2,650
Friday
1,962
Saturday
1,757



Dashboard: Jobs per Time Interval

Number of Completed and Failed Jobs per Time Interval

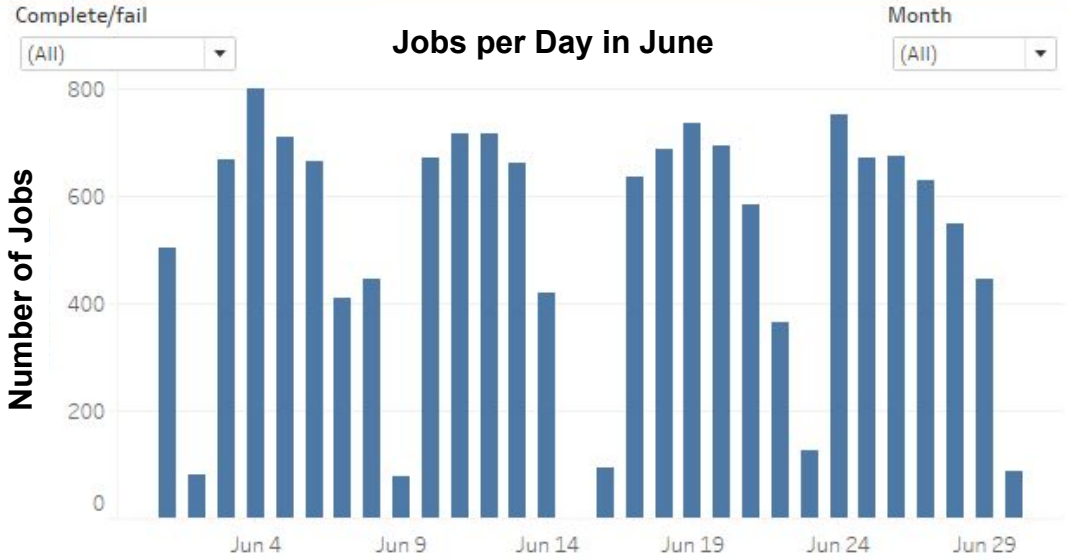


Total Jobs

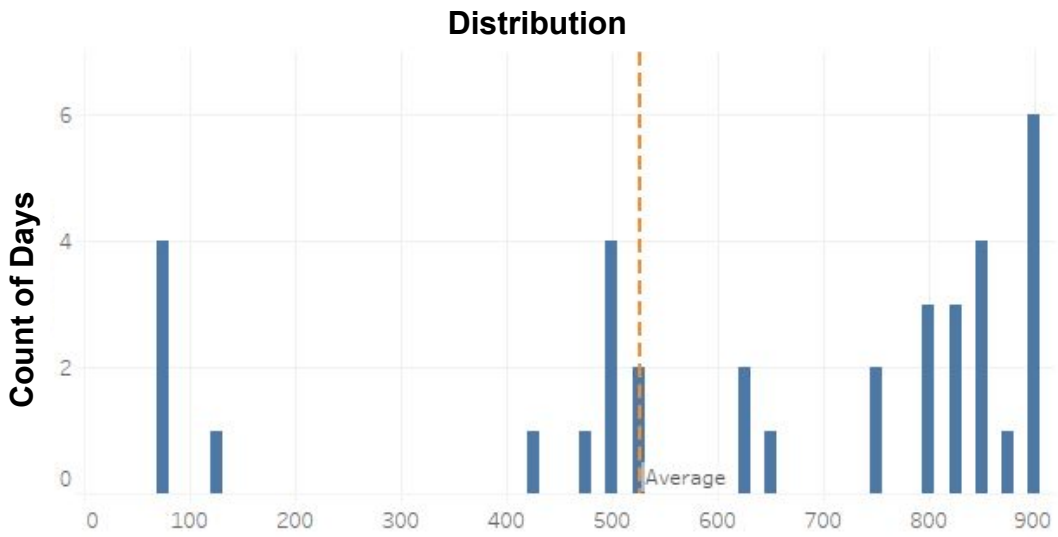
18,419

Failed Rate

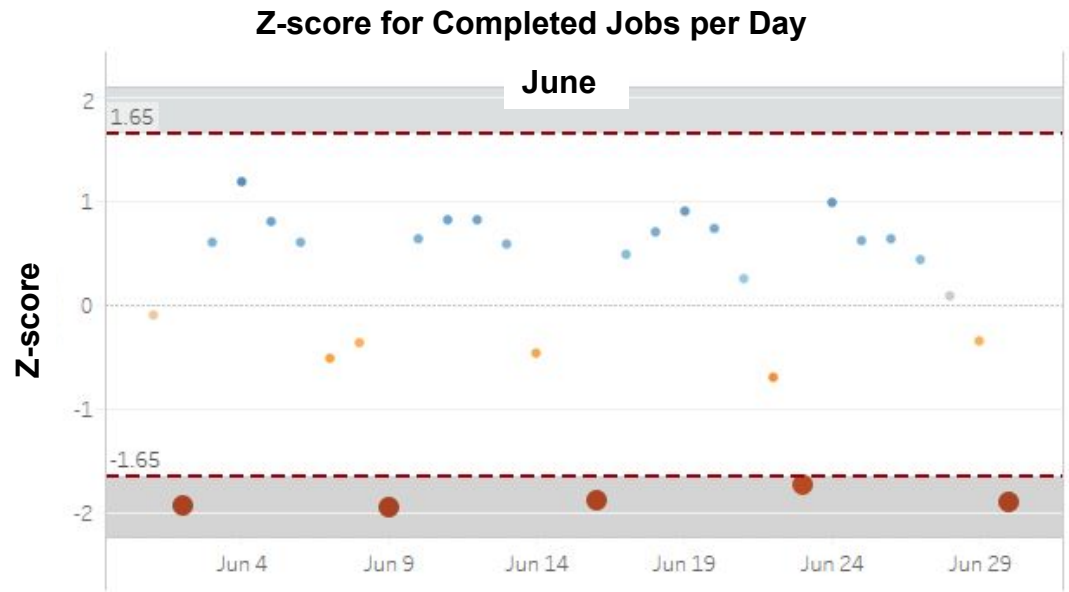
17.04%



Distribution & Outliers

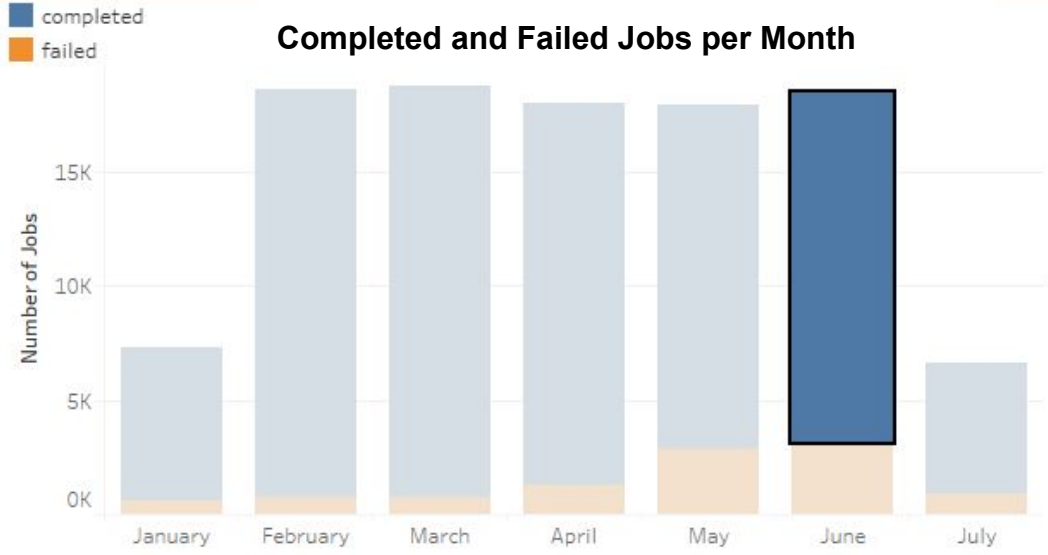


Sunday	471
Monday	2,728
Tuesday	2,875
Wednesday	2,837
Thursday	2,650
Friday	1,962
Saturday	1,757



Dashboard: Jobs per Time Interval

Number of Completed and Failed Jobs per Time Interval

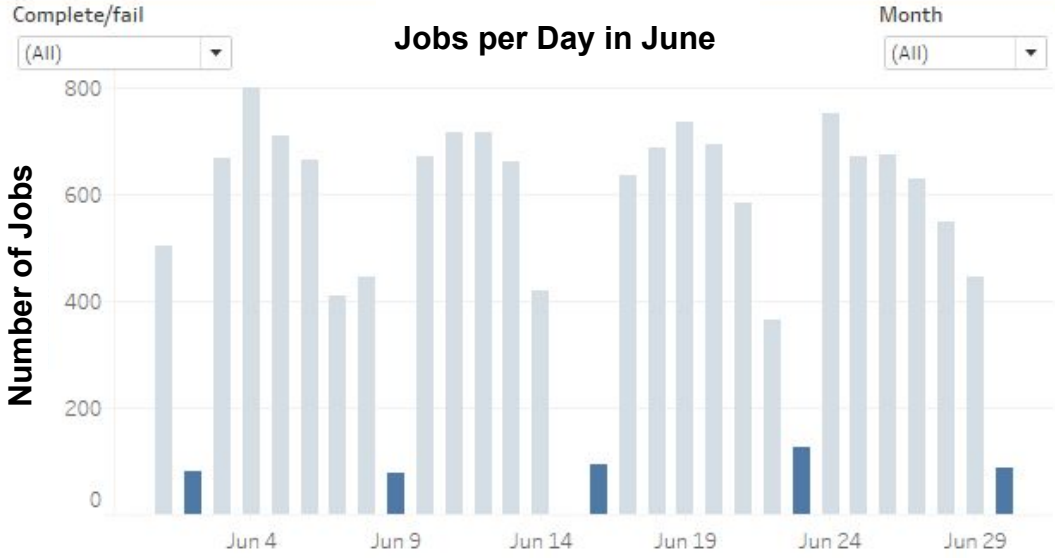


Total Jobs

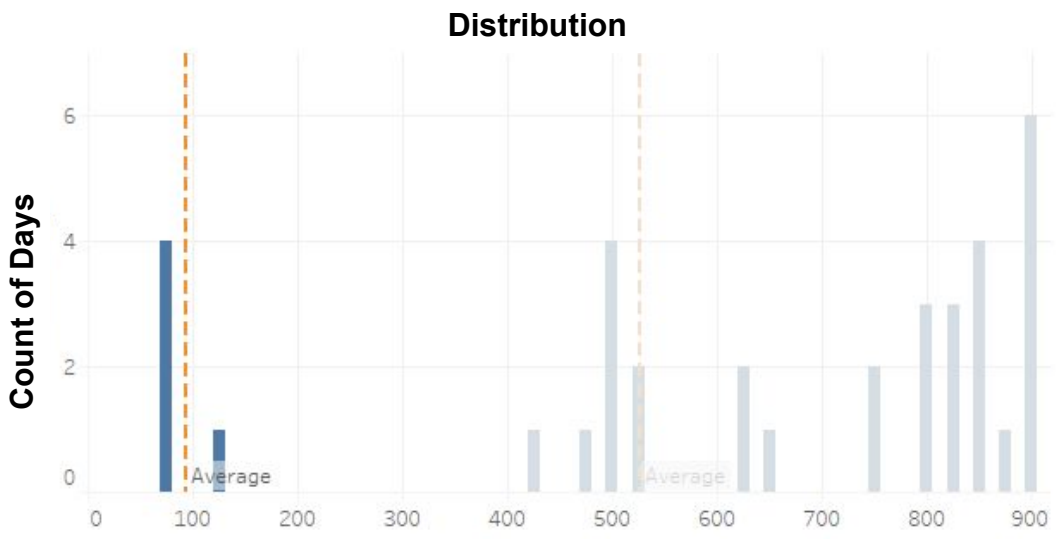
18,419

Failed Rate

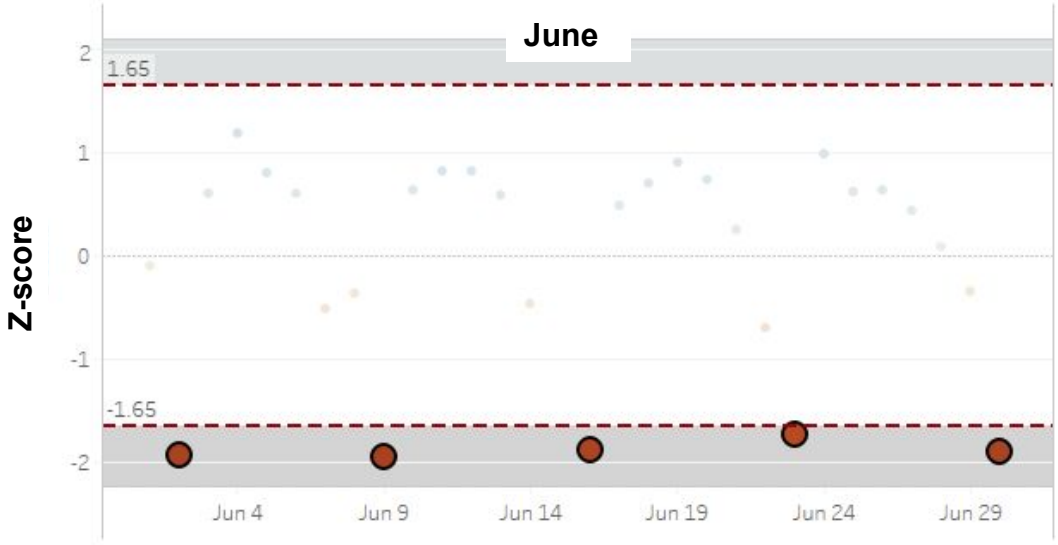
17.04%



Distribution & Outliers



Sunday	5
Monday	0
Tuesday	0
Wednesday	0
Thursday	0
Friday	0
Saturday	0



Example KPI

Panasonic

KPI 5

Compare number of picks between zones

KPI 6

Compare pick times between zones

Example KPI

Panasonic

KPI 6

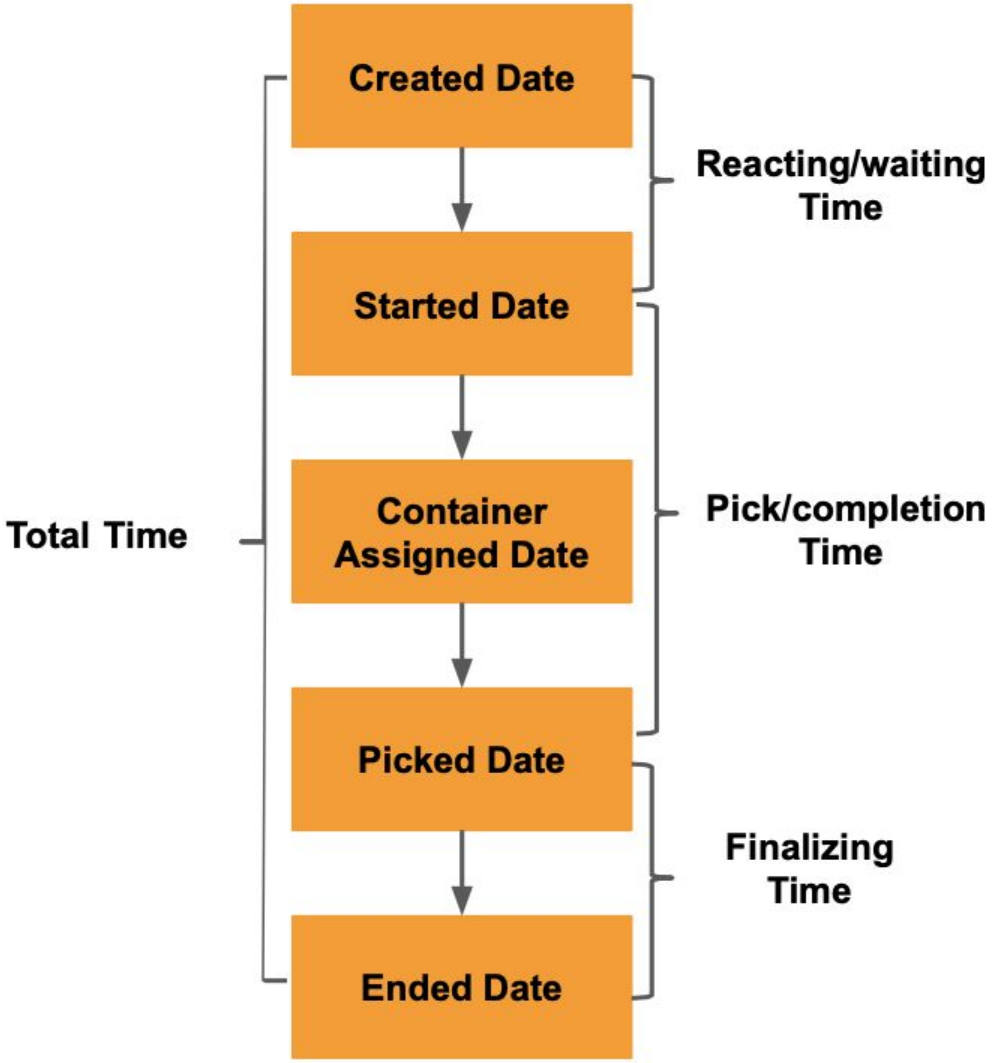
Compare pick times between zones

Area 1: Alpha (4 Zones)

Area 2: Head Rest (3 Zones)

Area 3: Trim and Foam (16 Zones)

KPI 6 Compare Time Between Zones



Reaction time = Started Date - Created Date

Pick time = Picked Date - Started Date

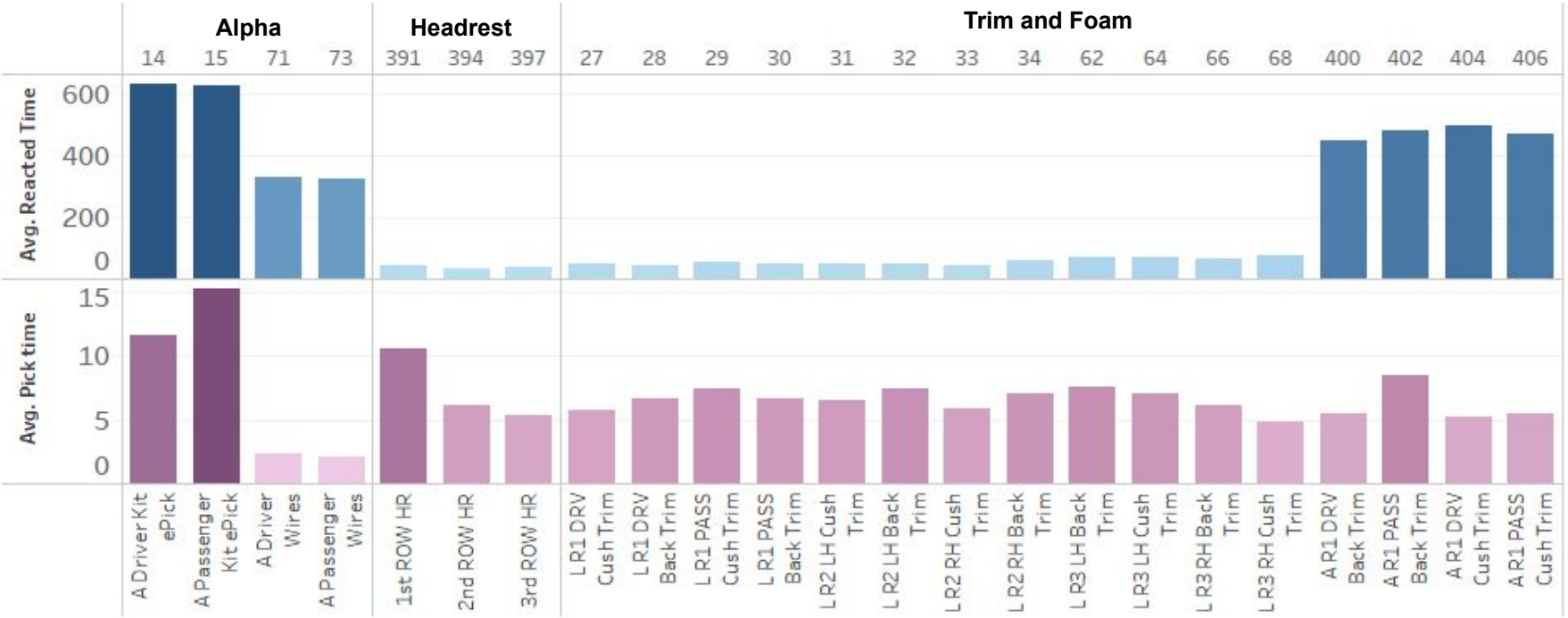
Total time = Ended Date - Created Date

Sample Dashboard: Location Analysis

Avg. Total Time	Avg. React Time	Avg. Pick Time	Avg. Finalzing Time
152 mins	123 mins	7 mins	4 mins

Completed and Failed Jobs per Area

Avg. Reaction Time and Avg. Pick Time per Zone



Failed Rate for Each Zone

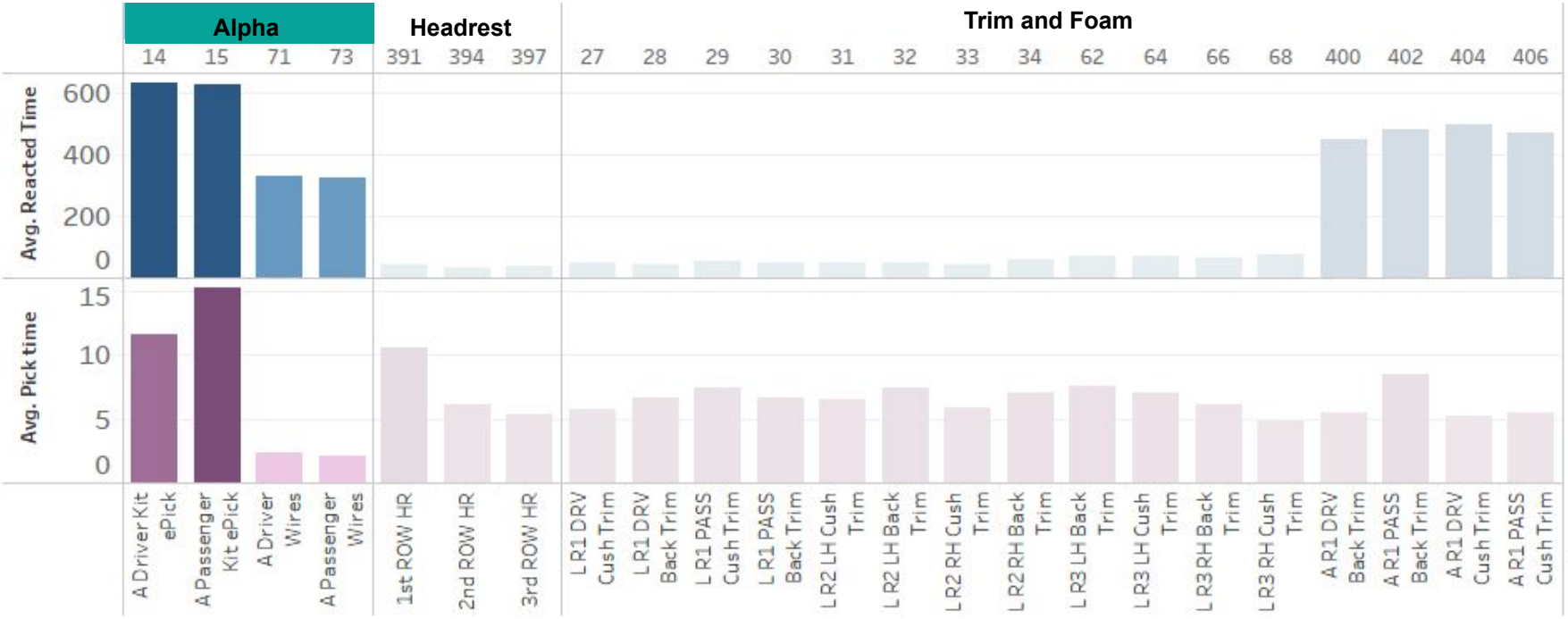
Description (..	Pick ..	Name	completed	failed
Alpha	14	A Driver Kit ePick	98.57%	1.43%
	15	A Passenger Kit ePick	97.05%	2.95%
	71	A Driver Wires	99.28%	0.72%
	73	A Passenger Wires	99.28%	0.72%
Headrest	391	1st ROW HR	95.26%	4.74%
	394	2nd ROW HR	95.19%	4.81%
	397	3rd ROW HR	95.69%	4.31%
Trim and Foam	27	L R1 DRV Cush Trim	92.39%	7.61%
	28	L R1 DRV Back Trim	84.90%	15.10%
	29	L R1 PASS Cush Trim	97.05%	2.95%
	30	L R1 PASS Back Trim	92.90%	7.10%
	31	L R2 LH Cush Trim	95.74%	4.26%
	32	L R2 LH Back Trim	96.73%	3.27%
	33	L R2 RH Cush Trim	89.93%	10.07%
	34	L R2 RH Back Trim	95.72%	4.28%
	62	L R3 LH Back Trim	73.10%	26.90%
	64	L R3 LH Cush Trim	81.46%	18.54%
	66	L R3 RH Back Trim	80.60%	19.40%
	68	L R3 RH Cush Trim	92.26%	7.74%
	400	A R1 DRV Back Trim	81.13%	18.87%
	402	A R1 PASS Back Trim	79.86%	20.14%
	404	A R1 DRV Cush Trim	69.50%	30.50%
	406	A R1 PASS Cush Trim	69.36%	30.64%

Sample Dashboard: Location Analysis

Avg. Total Time	Avg. React Time	Avg. Pick Time	Avg. Finalzing Time
486 mins	477 mins	8 mins	1 mins

Completed and Failed Jobs per Area

Avg. Reaction Time and Avg. Pick Time per Zone



Failed Rate for Each Zone

Description (..	Pick ..	Name	completed	failed
Alpha	14	A Driver Kit ePick	98.57%	1.43%
	15	A Passenger Kit ePick	97.05%	2.95%
	71	A Driver Wires	99.28%	0.72%
	73	A Passenger Wires	99.28%	0.72%
Headrest	391	1st ROW HR	95.26%	4.74%
	394	2nd ROW HR	95.19%	4.81%
	397	3rd ROW HR	95.69%	4.31%
Trim and Foam	27	L R1 DRV Cush Trim	92.39%	7.61%
	28	L R1 DRV Back Trim	84.90%	15.10%
	29	L R1 PASS Cush Trim	97.05%	2.95%
	30	L R1 PASS Back Trim	92.90%	7.10%
	31	L R2 LH Cush Trim	95.74%	4.26%
	32	L R2 LH Back Trim	96.73%	3.27%
	33	L R2 RH Cush Trim	89.93%	10.07%
	34	L R2 RH Back Trim	95.72%	4.28%
	62	L R3 LH Back Trim	73.10%	26.90%
	64	L R3 LH Cush Trim	81.46%	18.54%
	66	L R3 RH Back Trim	80.60%	19.40%
	68	L R3 RH Cush Trim	92.26%	7.74%
	400	A R1 DRV Back Trim	81.13%	18.87%
	402	A R1 PASS Back Trim	79.86%	20.14%
	404	A R1 DRV Cush Trim	69.50%	30.50%
	406	A R1 PASS Cush Trim	69.36%	30.64%

KPIs

Panasonic

KPI 11

General Job-In-Queue Time

- Reaction time
- Pick time

KPIs

Panasonic

KPI 9

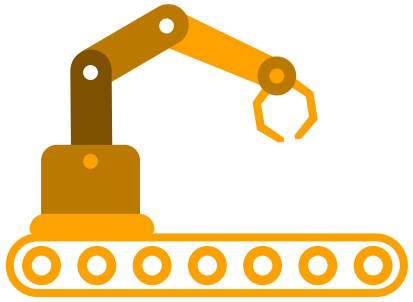
Compare number of parts (Time based)

KPI 10

Busiest zones - Compare number of parts (Zone based)

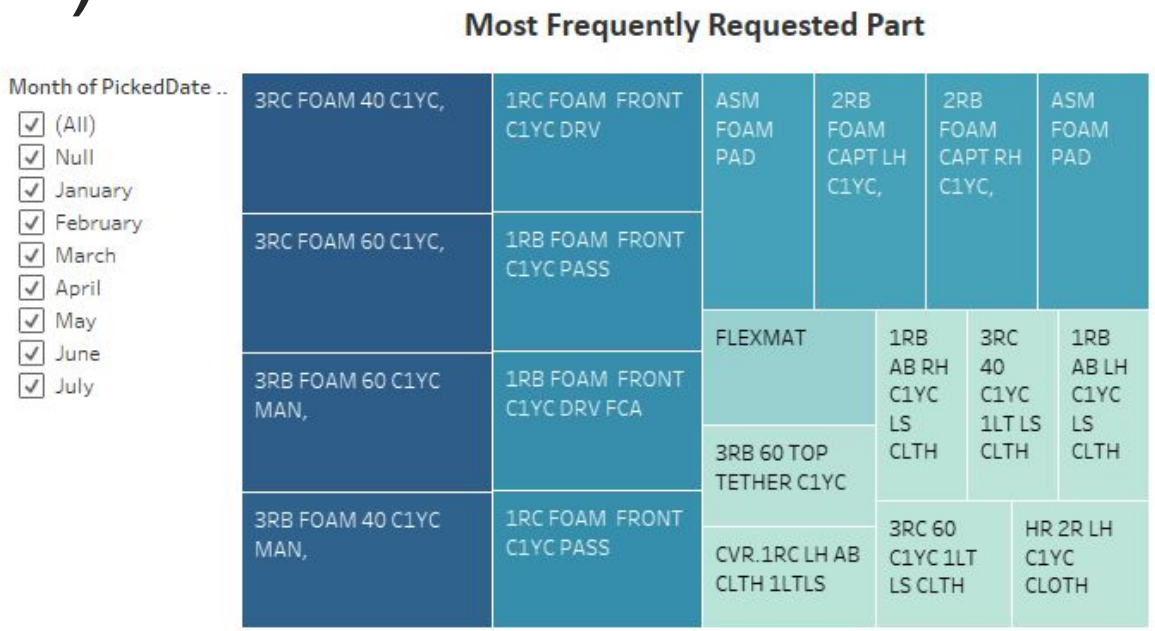
KPI 9: Requested and Picked Definition

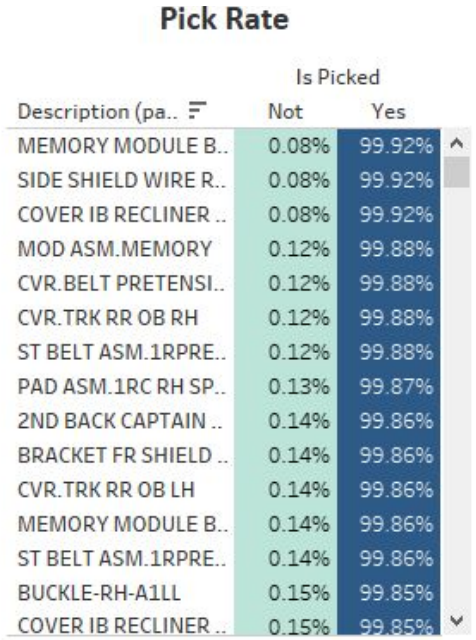
Requested Parts

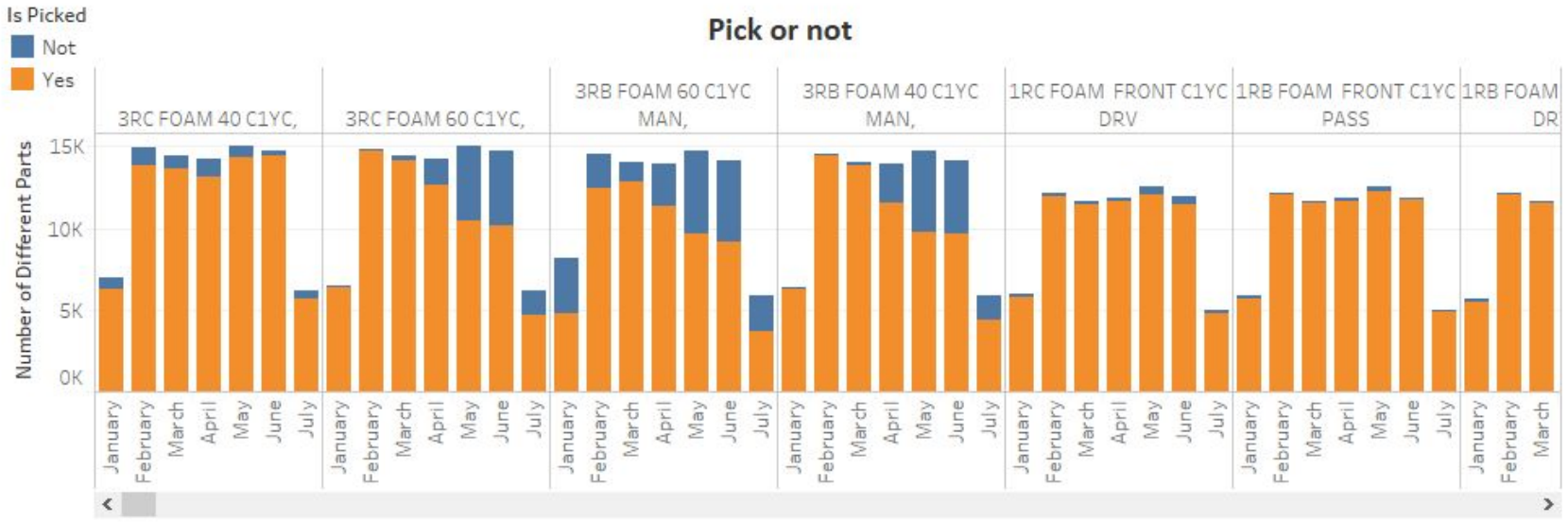


Picked Parts

Dashboard: Most Frequently Requested Parts and Picked Parts (KPI 9)

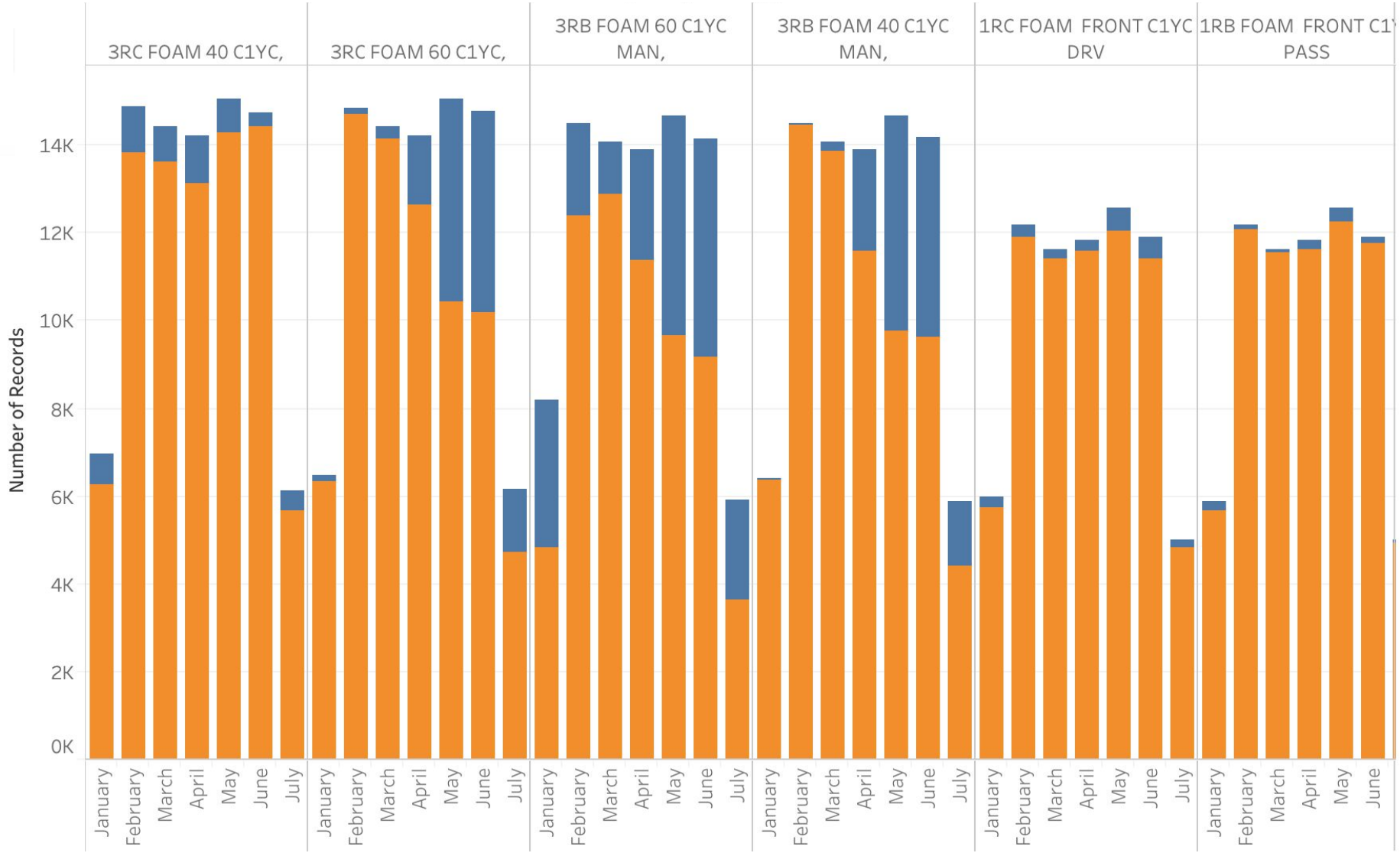






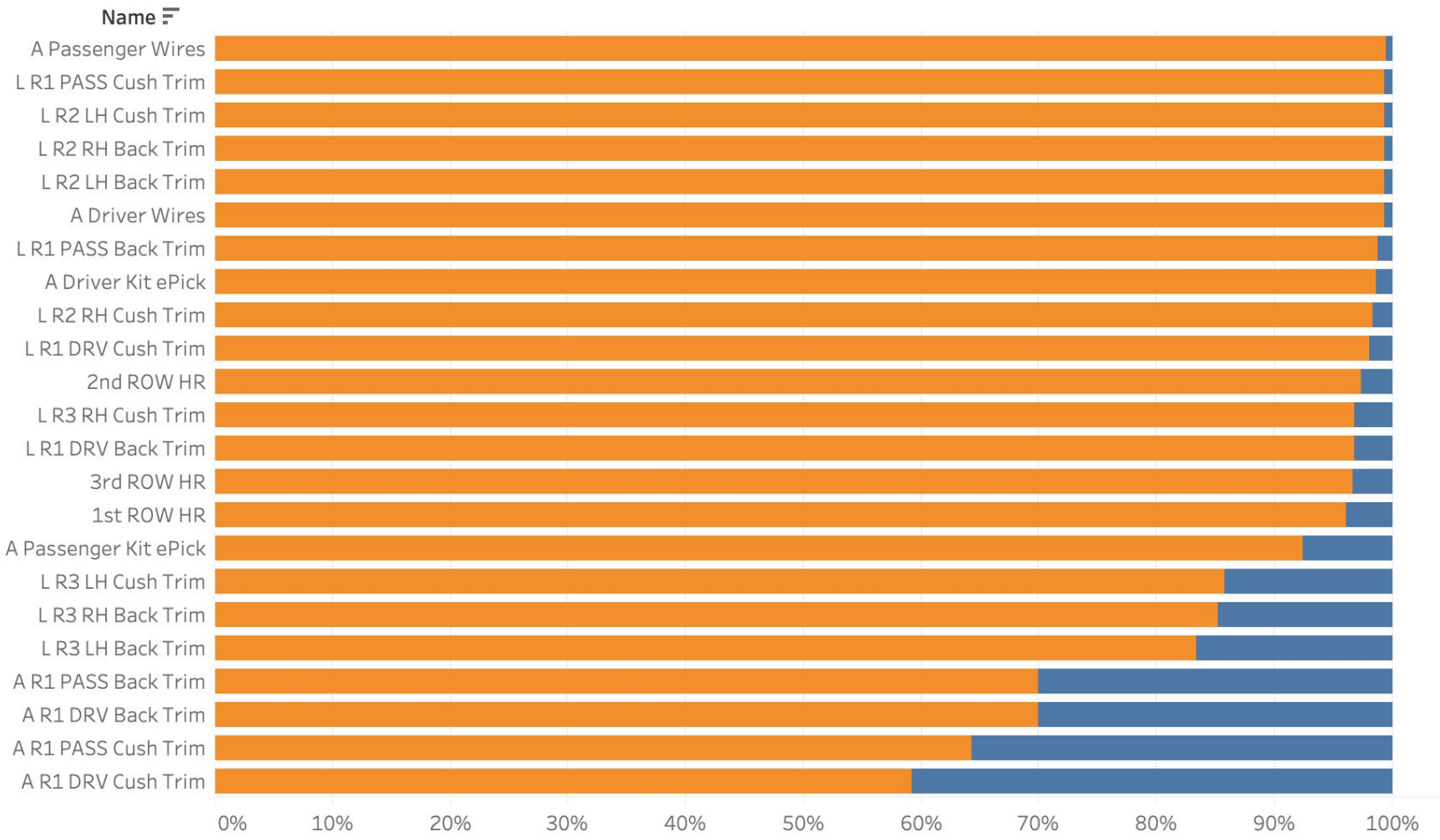
KPI 9: Most Frequently Picked Parts - Time Based

In general, May and June have the lowest pick rate, which matches our previous analysis on completion rate.



KPI 10: Busiest pick zone - pick rate

Pick Rate:



Location Gr..	Name	
Alpha	A Passenger Wires	0.9947
	A Driver Wires	0.9928
	A Driver Kit ePick	0.9869
	A Passenger Kit ePick	0.9236
Head Rest	2nd ROW HR	0.9730
	3rd ROW HR	0.9664
	1st ROW HR	0.9612
Trim and Foam	L R1 PASS Cush Trim	0.9937
	L R2 LH Cush Trim	0.9933
	L R2 RH Back Trim	0.9931
	L R2 LH Back Trim	0.9930
	L R1 PASS Back Trim	0.9878
	L R2 RH Cush Trim	0.9841
	L R1 DRV Cush Trim	0.9804
	L R3 RH Cush Trim	0.9680
	L R1 DRV Back Trim	0.9677
	L R3 LH Cush Trim	0.8584
	L R3 RH Back Trim	0.8519
	L R3 LH Back Trim	0.8336
	A R1 PASS Back Trim	0.7000
	A R1 DRV Back Trim	0.6994
	A R1 PASS Cush Trim	0.6427
	A R1 DRV Cush Trim	0.5920

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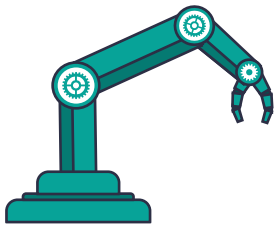
Predictive Analysis



Fit binary classification on *completion or failure* of Pickjob

Fit classification on *completion time* of Pickjob

Attributes Overview

Attributes	Description	Note
Number of Different Parts	How many different parts are in one job.	Defined different parts with ‘description’ in part table
Number of Different Orders	How many different orders are in on jobs	Calculated by counting order id.
Quantity	Total number of parts.	Different from Number of Different Parts. Quantity counts the number of same parts too.
Non-trackable Parts	If the job contains non-trackable parts or not.	Binary: 0 ‘doesn’t contain non-trackable parts’; 1 ‘contains at least one non-trackable parts’
Pick-zone-location-id	The zone the job belongs to	one-hot encoded: 14, 15, …, 400, 402, 404, 406 (23 locations)
Area	The area the job belongs to	one-hot encoded: ‘Trim and Foam’, ‘Head Rest’, ‘Alpha’
Shift	The shift time when the job is in queue	one-hot encoded: ‘Morning’, ‘Afternoon’, ‘Night’

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Dataset Overview

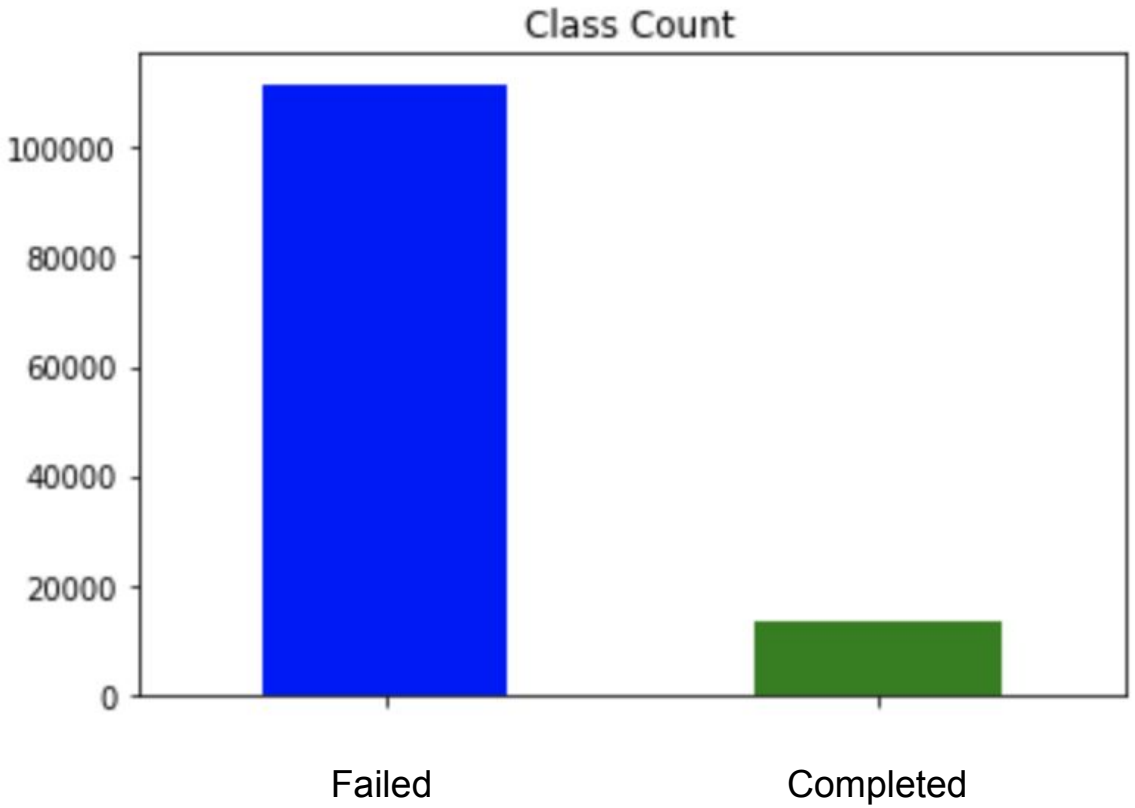
Number of Different Parts	Number of Different Orders	Quantity	Has Non Tracked Part	Pick Zone Location Id_14	Pick Zone Location Id_15	Pick Zone Location Id_27	Pick Zone Location Id_28	Pick Zone Location Id_29	...	Pick Zone Location Id_400	Pick Zone Location Id_402	Pick Zone Location Id_404	Pick Zone Location Id_406	shift_shift afternoon	shift_shift morning	shift_shift night	area_Alpha	area_Head Rest	area_Trim and Foam
11	20	40	0	0	0	0	0	0	...	0	0	0	0	0	1	0	0	0	1
7	20	40	0	0	0	0	0	0	...	0	0	0	0	0	1	0	0	0	1
9	20	40	0	0	0	0	0	0	...	0	0	0	0	0	1	0	0	0	1
10	20	40	0	0	0	0	0	0	...	0	0	0	0	0	1	0	0	0	1
7	20	40	0	0	0	0	0	0	...	0	0	0	0	0	1	0	0	0	1

Continuous

One-hot encoded

X : (125148 , 33)
Y : Complete : 0
Failed : 1

Imbalanced Dataset



Correlation

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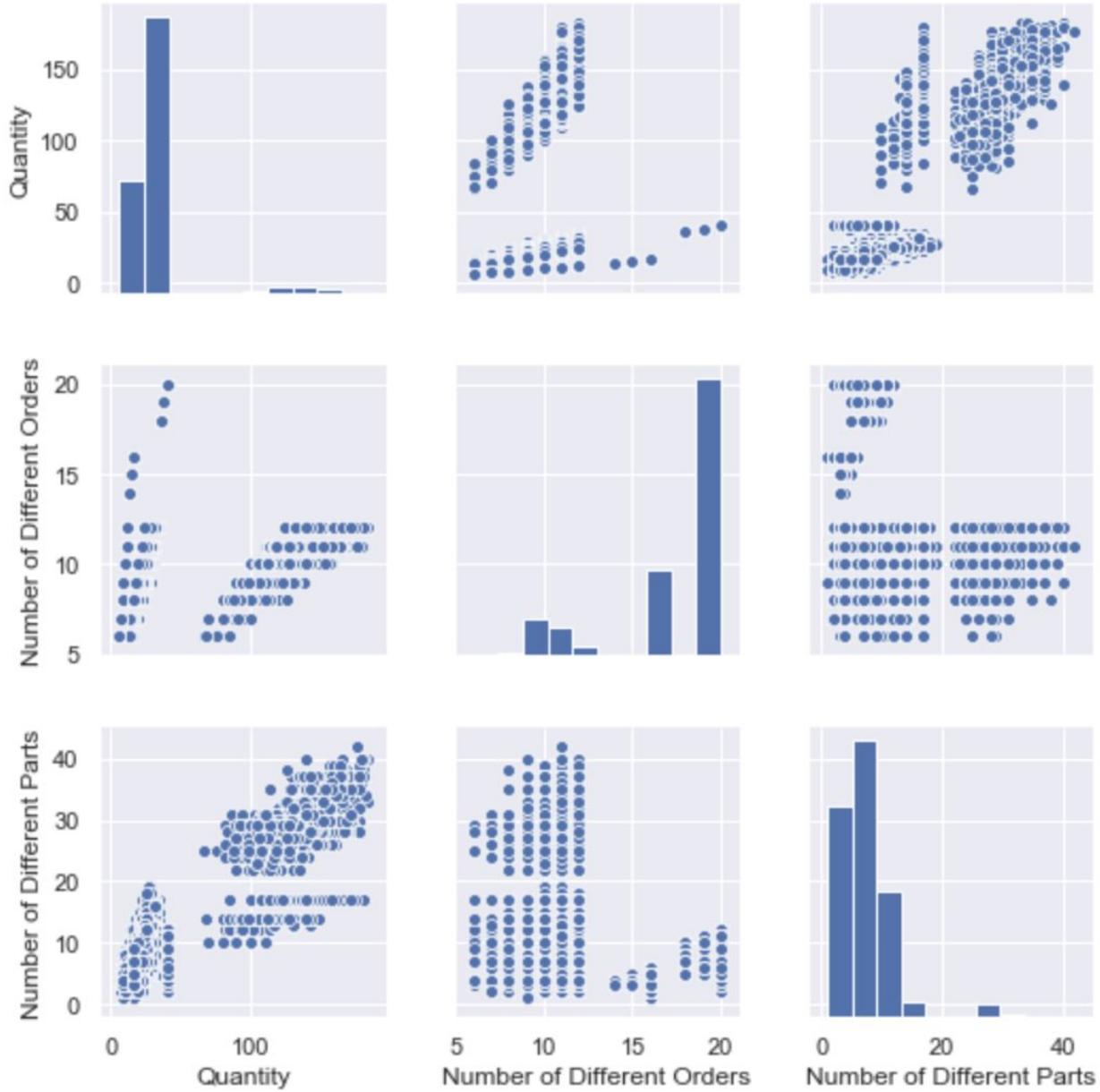
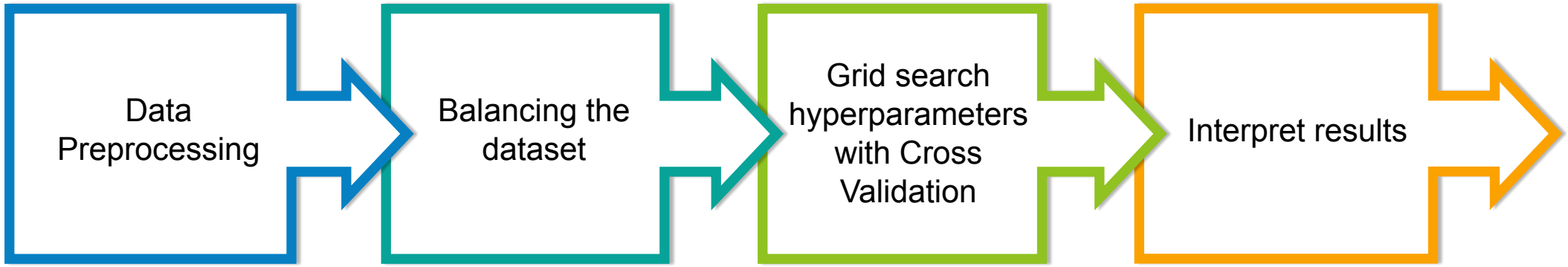


Predictive Analysis

Pipeline



1st

Data Preprocessing

Columns with continuous values are standardized with z-score normalization. Test dataset is scaled according to mean/std of training dataset

2nd

Deal with imbalanced dataset

Since the ratio of completed jobs and failed jobs is 9:1, undersampling without replacement was used to balance the training dataset

3rd

Grid search + CV

- To find the optimal and robust model, grid search on hyperparameters with 5-fold cross validation was used
- Due to data imbalance, model with the highest F-1 was chosen

4th

Interpret Results

Performed coefficient analysis on Logistic Regression and feature importance analysis on Random Forest, Decision Tree

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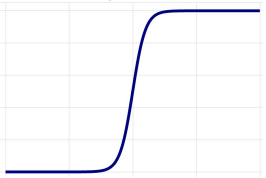
Modeling

Random Forest	Logistic Regression	Decision Tree
		
n_estimators: 50, 100, 150,1000 Criterion: Gini, Entropy Max_depth: 4, 6, 8	Penalty : none, l1, l2, elasticnet C: 0.5, 1, 100, 1e9 Iteration: 500, 1000	max_features: auto, sqrt, log2 Criterion: Gini, Entropy Max_depth: 4, 6, 8

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Modeling

Logistic Regression	Decision Tree	Random Forest
Penalty : l2 C: 0.5, 1, 100, 1e9 Iteration: 500, 1000	max_features: auto, sqrt, log2 Criterion: Gini, Entropy Max_depth: 4, 6, 8	n_estimators: 50, 100, 150,1000 Criterion: Gini, Entropy Max_depth: 4, 6, 8

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Failure/Completion Results

Logistic Regression	
TN: 16379	FP: 5954
FN: 799	TP: 1898
Precision: 0.24	
Recall: 0.70	
Accuracy: 0.78	
C: 0.5 Max_iter: 500	

Decision Tree	
TN: 19087	FP: 3246
FN: 1405	TP: 1292
Precision: 0.28	
Recall: 0.48	
Accuracy: 0.83	
max_feature: auto criterion: entropy max_depth: 8	

Random Forest	
TN: 20399	FP: 1934
FN: 1327	TP: 1370
Precision: 0.51	
Recall: 0.41	
Accuracy: 0.87	
n_estimators: 150 criterion: entropy max_depth: 4	

Positive: Fail
Negative: Complete

$$Recall = \frac{TP}{TP + FN} \qquad Precision = \frac{TP}{TP + FP}$$

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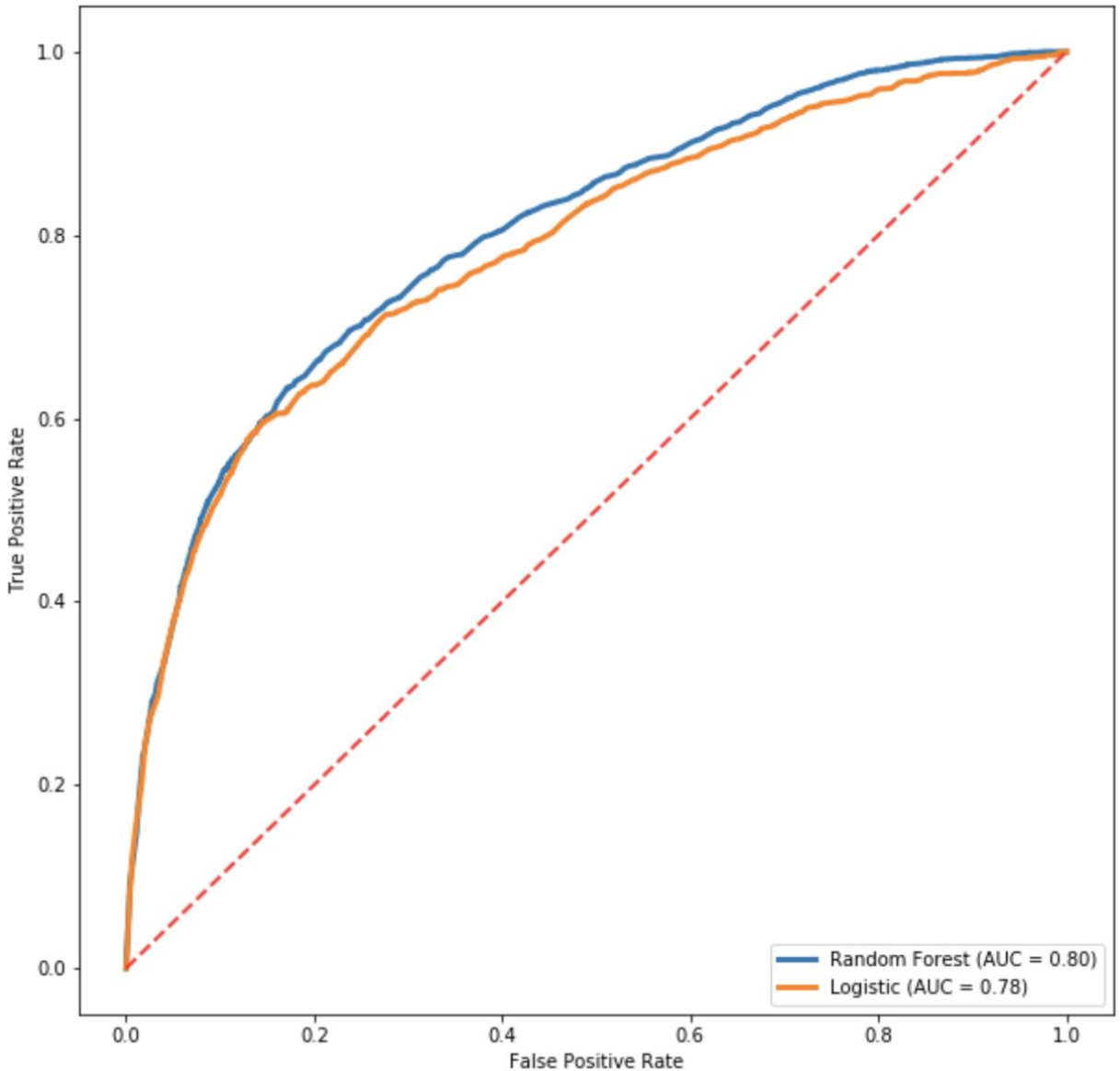
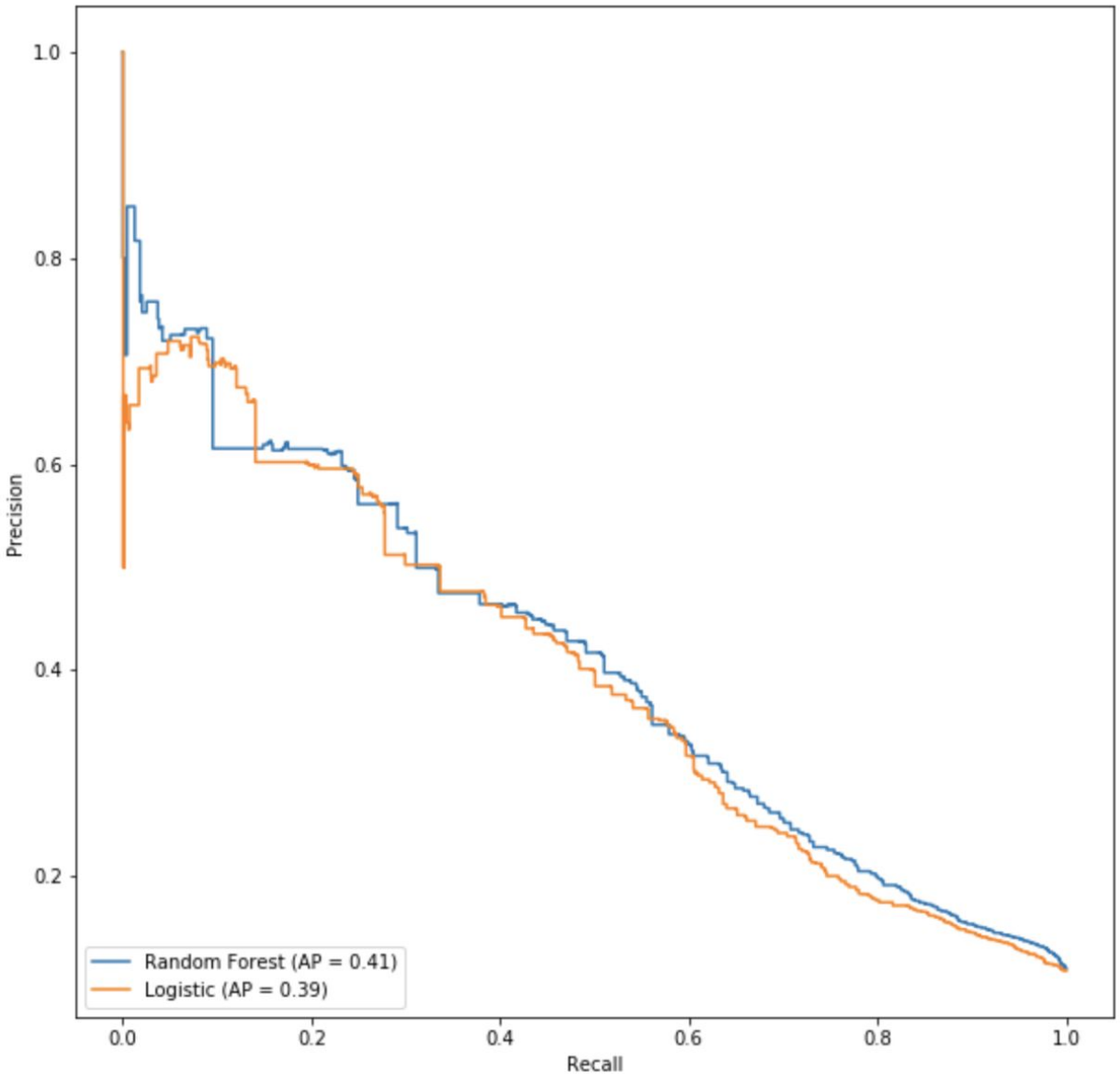
ROC Curve



Precision-Recall Curve



Weight / Feature importance

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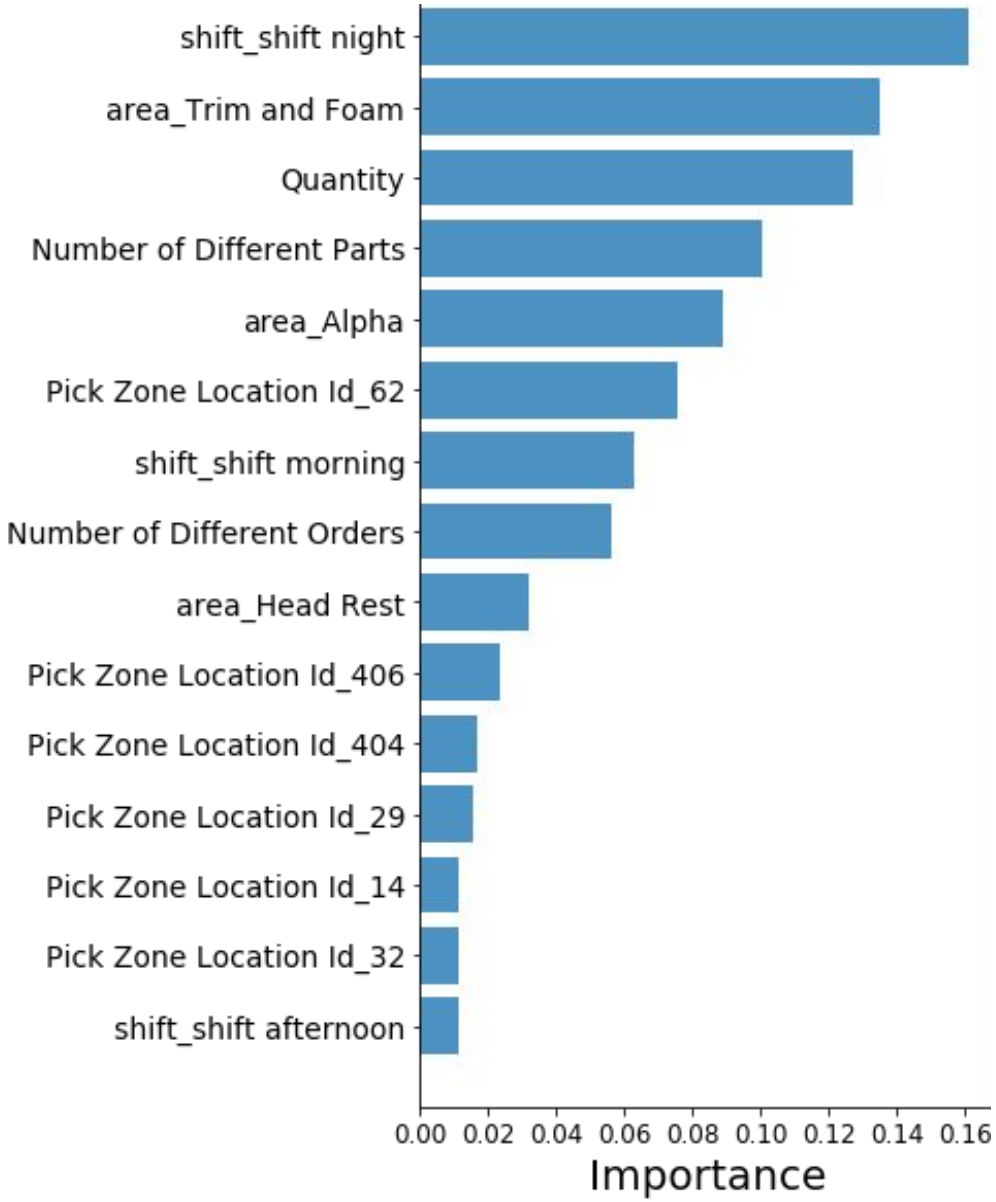
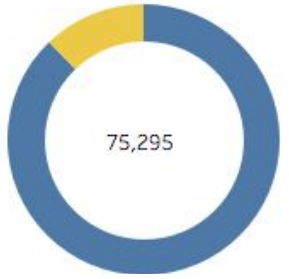


Alpha

Head Rest

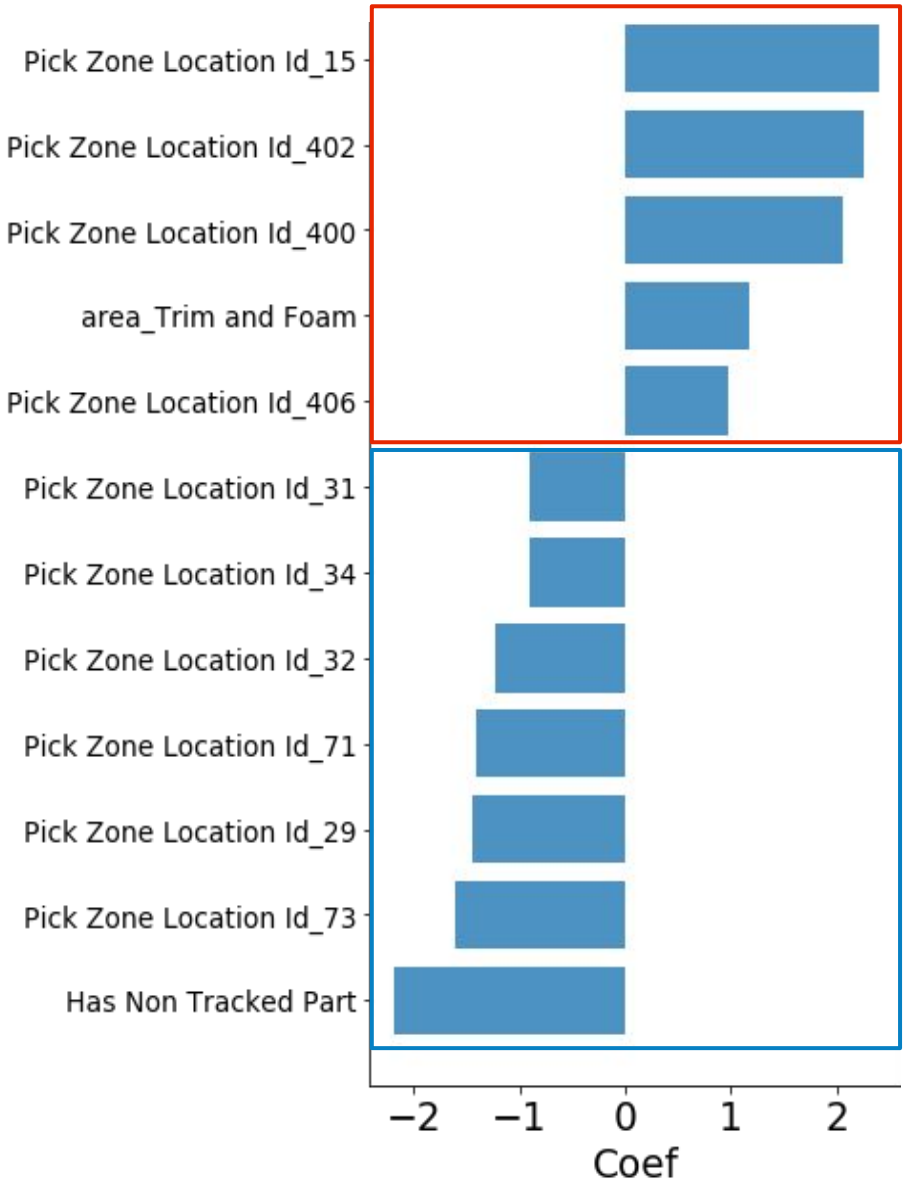


Trim and Foam

Shift	Completed	Failed
Shift Morning	86.70%	13.30%
Shift Afternoon	91.03%	8.97%
Shift Night	95.74%	4.26%

Weight / Feature importance

Panasonic

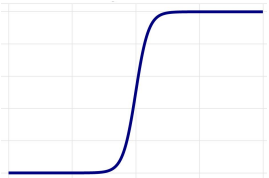


Failed Rate for Each Zone

Description (..	Pick ..	Name	completed	failed
Alpha	14	A Driver Kit ePick	98.57%	1.43%
	15	A Passenger Kit ePick	97.05%	2.95%
	71	A Driver Wires	99.28%	0.72%
	73	A Passenger Wires	99.28%	0.72%
Head Rest	391	1st ROW HR	95.26%	4.74%
	394	2nd ROW HR	95.19%	4.81%
	397	3rd ROW HR	95.69%	4.31%
Trim and Foam	27	L R1 DRV Cush Trim	92.39%	7.61%
	28	L R1 DRV Back Trim	84.90%	15.10%
	29	L R1 PASS Cush Trim	97.05%	2.95%
	30	L R1 PASS Back Trim	92.90%	7.10%
	31	L R2 LH Cush Trim	95.74%	4.26%
	32	L R2 LH Back Trim	96.73%	3.27%
	33	L R2 RH Cush Trim	89.93%	10.07%
	34	L R2 RH Back Trim	95.72%	4.28%
	62	L R3 LH Back Trim	73.10%	26.90%
	64	L R3 LH Cush Trim	81.46%	18.54%
	66	L R3 RH Back Trim	80.60%	19.40%
	68	L R3 RH Cush Trim	92.26%	7.74%
	400	A R1 DRV Back Trim	81.13%	18.87%
	402	A R1 PASS Back Trim	79.86%	20.14%
	404	A R1 DRV Cush Trim	69.50%	30.50%
	406	A R1 PASS Cush Trim	69.36%	30.64%

2. Slow/Fast Results

Random Forest	
TN: 2948	FP: 7132
FN: 104	TP: 958
Precision: 0.12	
Recall: 0.90	
Accuracy: 0.33	
n_estimators: 1000 criterion: entropy max_depth: 6	

Logistic Regression	
	
TN: 4629	FP: 5451
FN: 285	TP: 777
Precision: 0.12	
Recall: 0.73	
Accuracy: 0.49	
C: 1 Max_iter: 500	

XGBoost	
XGBoost	
TN: 3093	FP: 6987
FN: 121	TP: 941
Precision: 0.12	
Recall: 0.89	
Accuracy: 0.36	
Gamma: 5 subsample: 1 max_depth: 3	

Decision Tree	
TN: 3203	FP: 6877
FN: 164	TP: 898
Precision: 0.12	
Recall: 0.85	
Accuracy: 0.20	
max_feature: auto criterion: entropy max_depth: 4	

Positive: Slow
Negative: Fast

$$Recall = \frac{TP}{TP + FN} \qquad Precision = \frac{TP}{TP + FP}$$