UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE of ENGINEERING

Warehouse Space Optimization (CAT_OPTO)
Senior Design II

Carolina CAT

Mentor:
Dr. Churlzu Lim

Supported by:
Carolina CAT

Project Overview

- Carolina CAT runs a large service, sales and repair operation. This project is related to the Warehouse optimization of CAT.
- Carolina CAT feels that the current layout is not conducive to the efficient operation and desires to use System Engineering tools to optimize the existing space and provide a new floorplan layout.
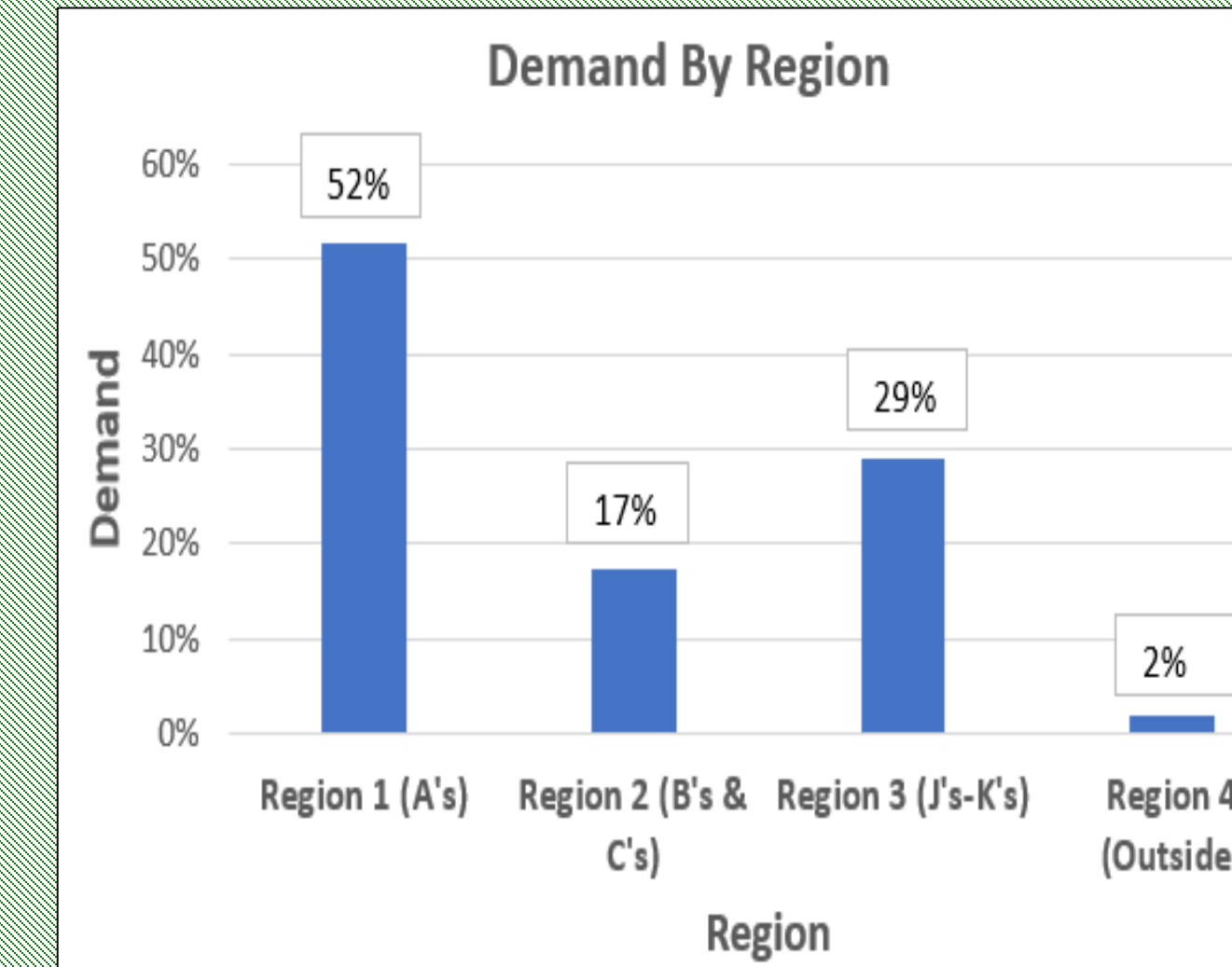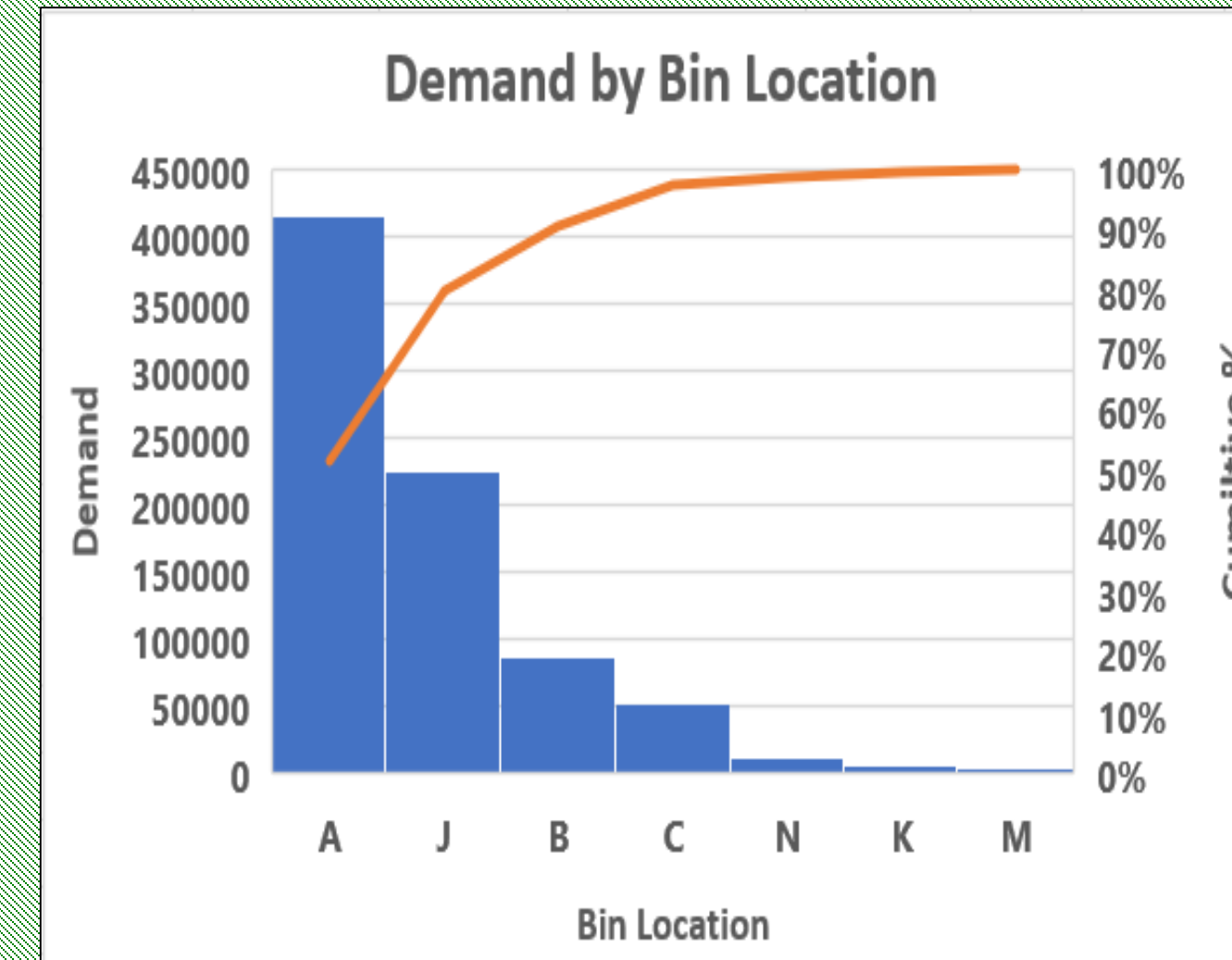
Deliverables

- The team used a DMAIC process for working through this project
- New layout design of the warehouse and quantification of improvements over the existing design
- Design recommendations the warehouse

AHP

- Surveying employees from Carolina CAT warehouse allowed the team to create an AHP and a decision tree, with monetary values, tailored to the employees opinions
- Taking into account the employees opinions will help CAT choose the recommendation that will be most likely endorsed and reinforced by the employees

Criteria Weights

Workable Volume	0.40
Storage Capacity	0.60
Minimal Picktime	0.00

Workable Volume

Move Shelving	0.22
Move Parts	0.28
Replace Door	0.14
Replace Cantilevers	0.36

Storage Capacity

Move Shelving	0.19
Move Parts	0.26
Replace Door	0.15
Replace Cantilevers	0.40

Minimal Picktime

Move Shelving	0.25
Move Parts	0.30
Replace Door	0.16
Replace Cantilevers	0.29

Overall Winning Recommendation

Criteria	Criteria Weights	Alternatives			
		Move Shelving	Move Parts	Replace Door	Replace Cantilevers
Workable Volume	0.40	0.22	0.28	0.14	0.36
Storage Capacity	0.60	0.19	0.26	0.15	0.40
Picktime	0.00	0.25	0.30	0.16	0.29
Final Score		0.20	0.27	0.15	0.38
Selected Recommendation					Replace Cantilevers
Worst Recommendation				Replace Door	

Measure – Data Analytics

Demand by Bin Location

Demand By Region

Location	# of Items	Demand
A	20852	414615
B	2155	87853
C	139	51568
J	2425	224788
K	117	6613
M	241	4595
N	541	11196
Total	26470	801228

- Demand for 26,470 items was divided into groups of their locations and further divided into the 4 regions for our Simulation

# of Items in an Order	# of Orders	% of Total	Cumulative
1	31641	53%	53%
2	10808	18%	71%
3	5191	9%	80%
4	3139	5%	85%
5	2212	4%	89%
6	1555	3%	91%
7	1063	2%	93%
8	796	1%	94%
9	593	1%	95%
10	500	1%	96%
11+	2354	4%	100%
Total Orders	59852		

- A total of 59,852 orders were analyzed to help decide how many items would be in an order

# of Items in an Order

Hourly Order Arrival with Line of Best Fit

MSE For Weekdays
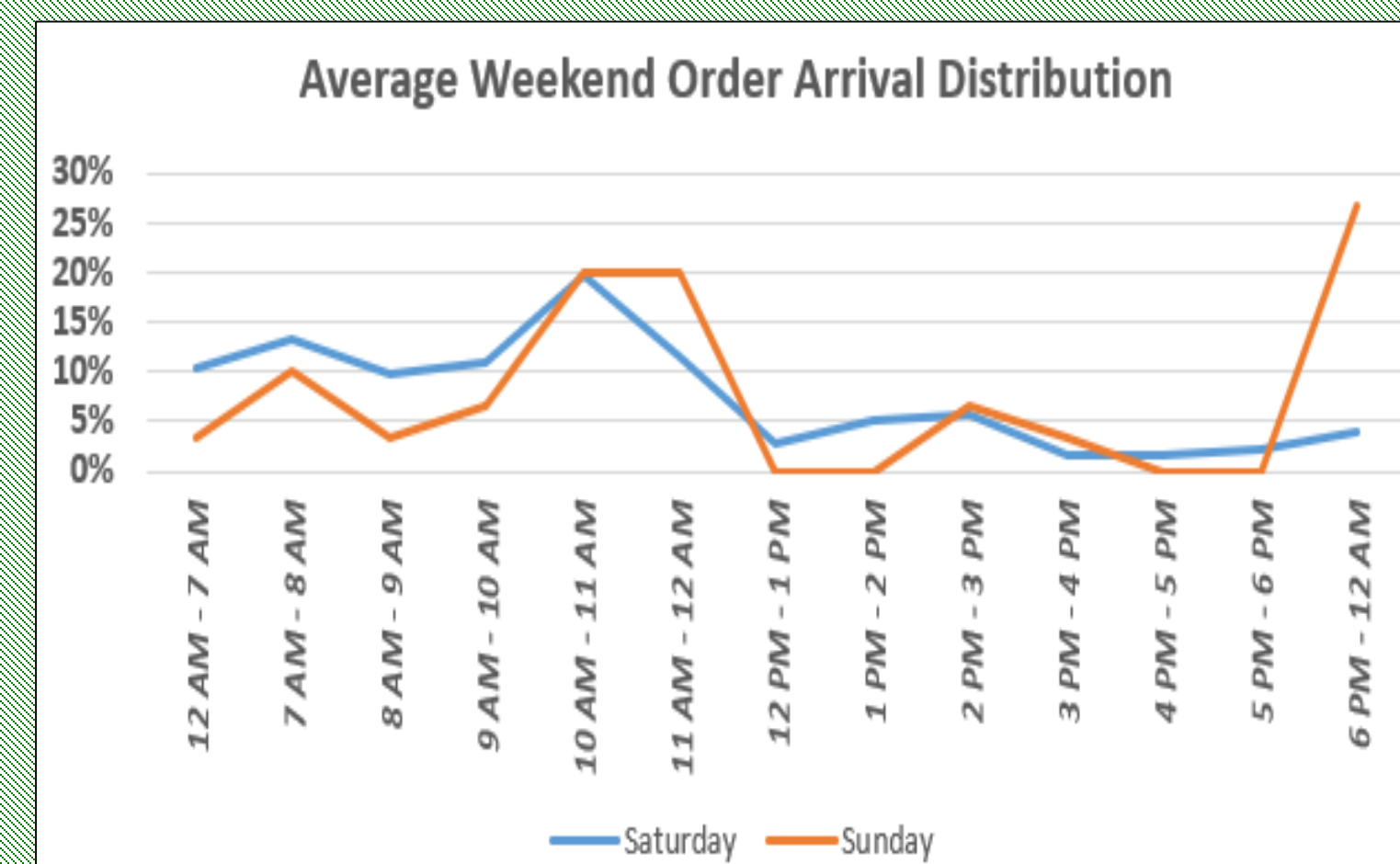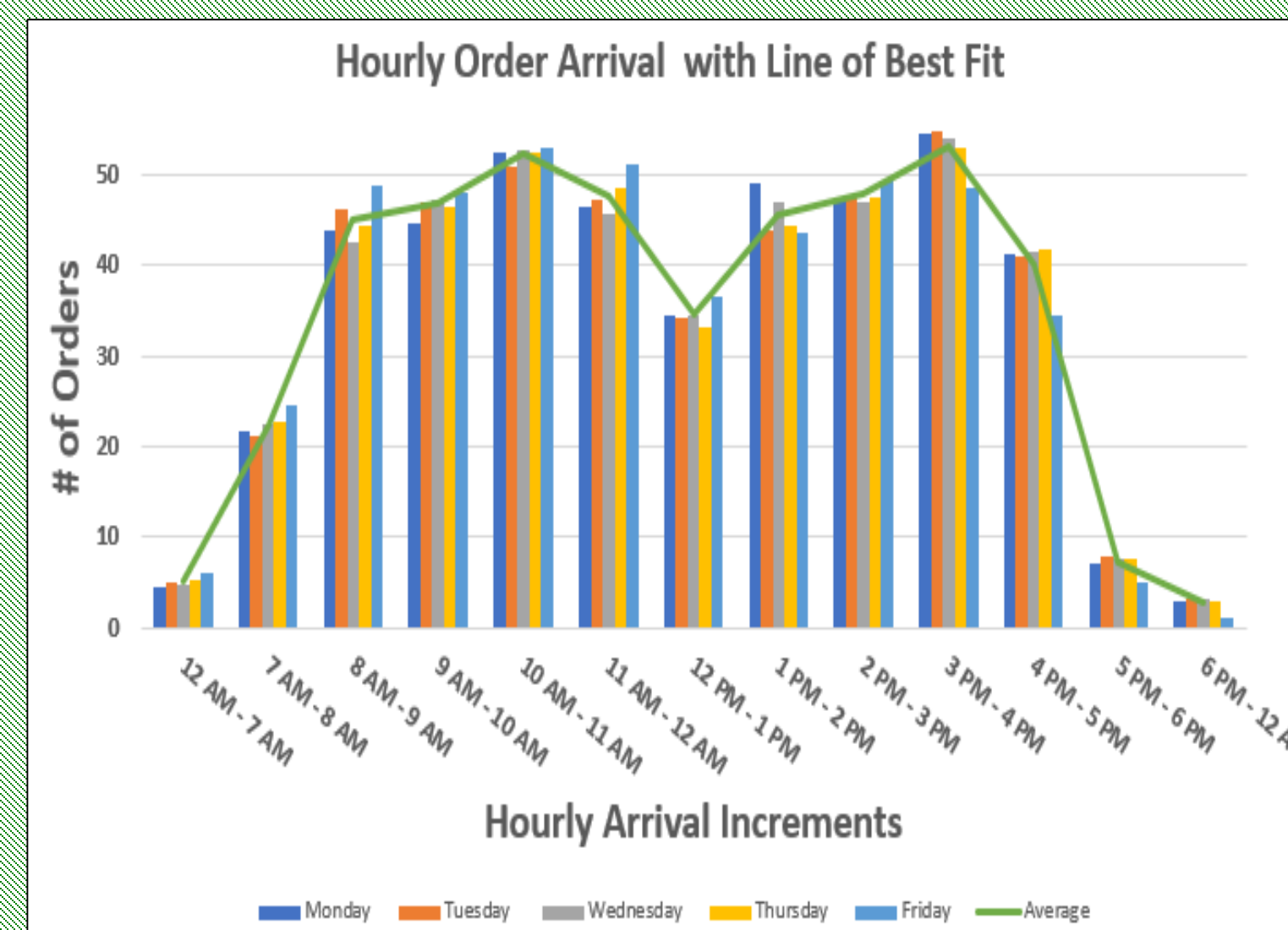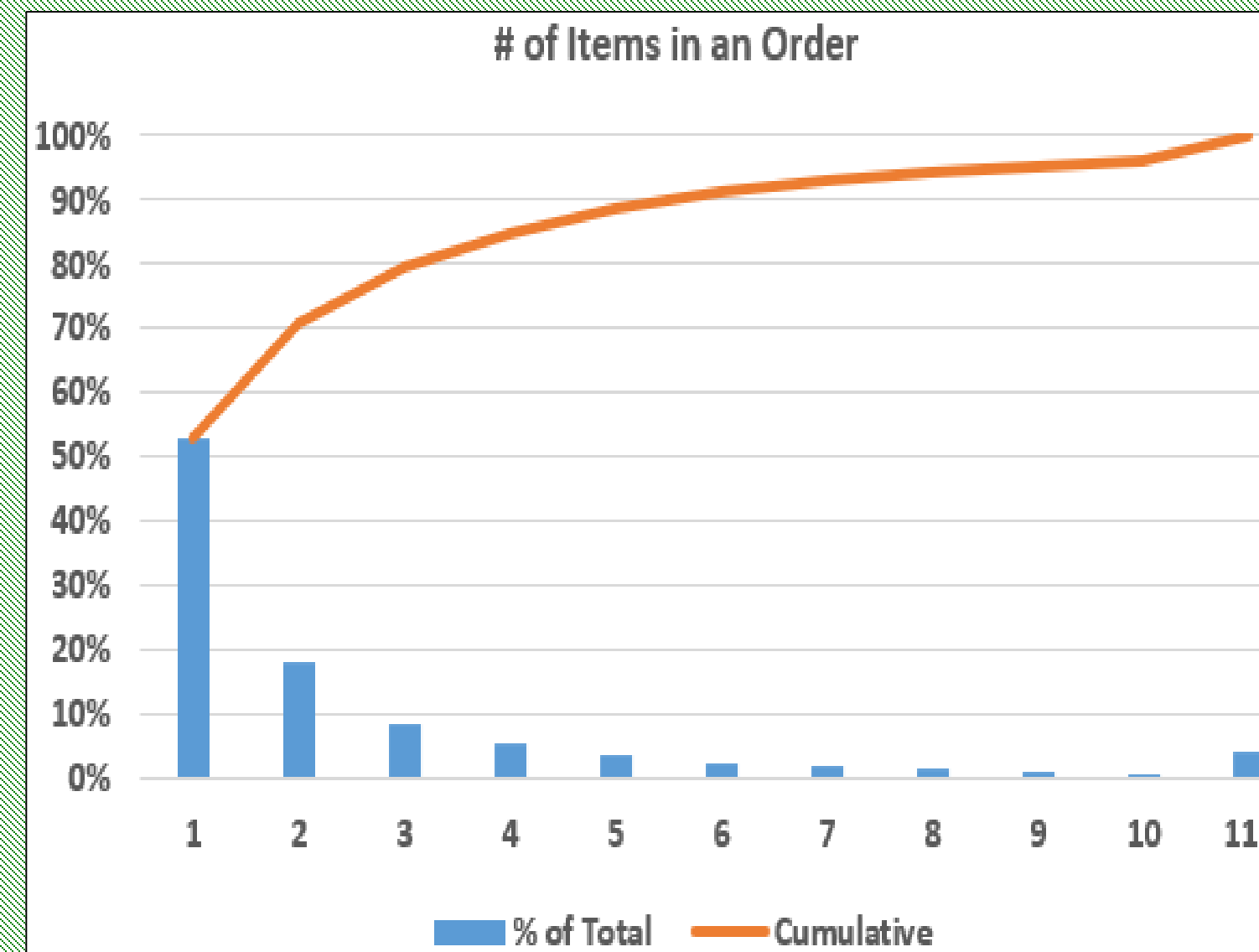
Time Interval	Monday	Tuesday	Wednesday	Thursday	Friday	MSE
12 AM - 7 AM	0.295	0.003	0.183	0.008	0.806	0.259
7 AM - 8 AM	0.720	1.827	0.002	0.133	4.565	1.450
8 AM - 9 AM	1.681	1.368	6.105	0.677	14.168	4.800
9 AM - 10 AM	4.123	0.088	0.320	0.060	1.637	1.245
10 AM - 11 AM	0.108	2.019	0.154	0.049	0.452	0.556
11 AM - 12 AM	1.964	0.184	3.974	0.626	11.776	3.705
12 PM - 1 PM	0.001	0.119	0.001	1.684	3.703	1.102
1 PM - 2 PM	13.131	3.059	2.222	1.369	4.030	4.762
2 PM - 3 PM	0.318	0.003	0.580	0.051	2.760	0.742
3 PM - 4 PM	1.975	3.200	0.884	0.058	19.683	5.160
4 PM - 5 PM	1.175	0.874	1.702	2.676	31.464	7.578
5 PM - 6 PM	0.001	0.412	0.342	0.352	4.705	1.162
6 PM - 12 AM	0.056	0.126	0.201	0.093	2.386	0.572
MSE	1.965	1.022	1.282	0.603	7.857	

Average Weekend Order Arrival Distribution

Total Orders	529
Total Satudays	38
Average	13.92105
Max	34
Min	1

Total Orders	139
Total Sundays	33
Average	3.75
Max	18
Min	1

- Strong correlation between order arrivals during the weekdays allowed us to use a line of best fit and MSE was calculated to ensure accuracy with there being an average of 450 orders per weekday
- Orders also arrived during the weekend which were transferred over to the Weekdays and were arriving inconsistently according to the graphs to the right so a triangular order arrival rate was made

Analyze - ARENA Simulation Explanation

- Please see demonstration

Economic Analysis

Which Door is Better?

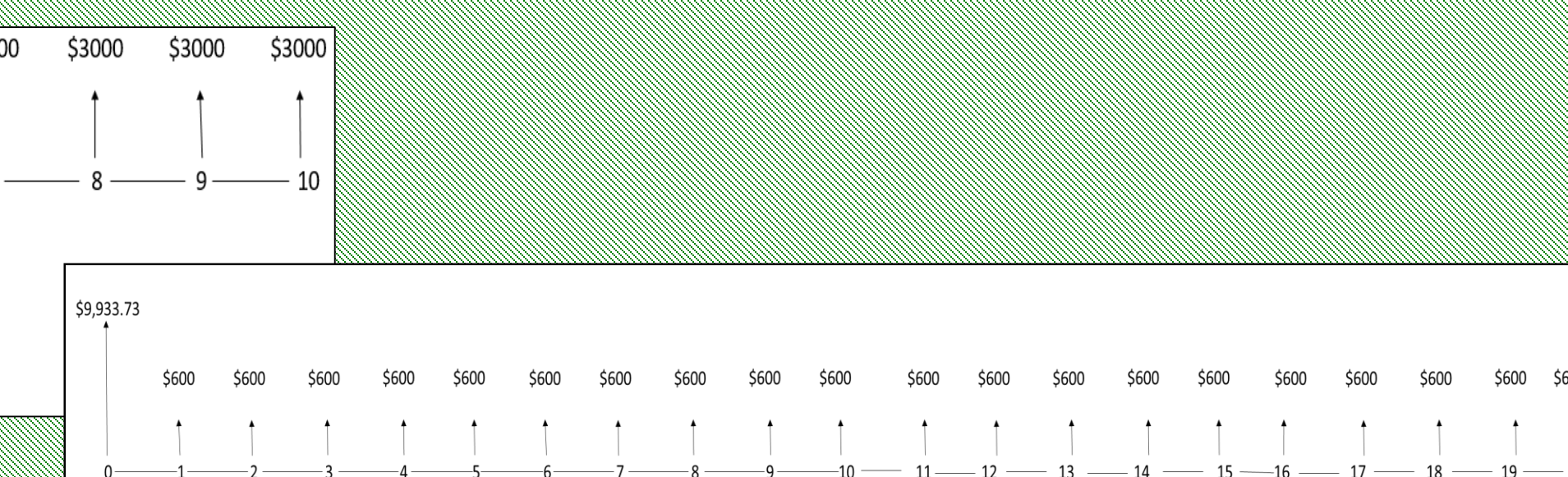| Alternatives	Current Door	New Doors
First Cost	x	9933.75
Uniform Annual Cost	-3000	-600
Salvage Value	0	0
Useful Life (years)	10	20

NPVcurrent	-18433.70
NPVnew	-15041.89
Difference	-3391.81

- For the current loading dock doors to be better than the new doors Carolina CAT would have had to make a profit of $3,391.81 instead of a first cost
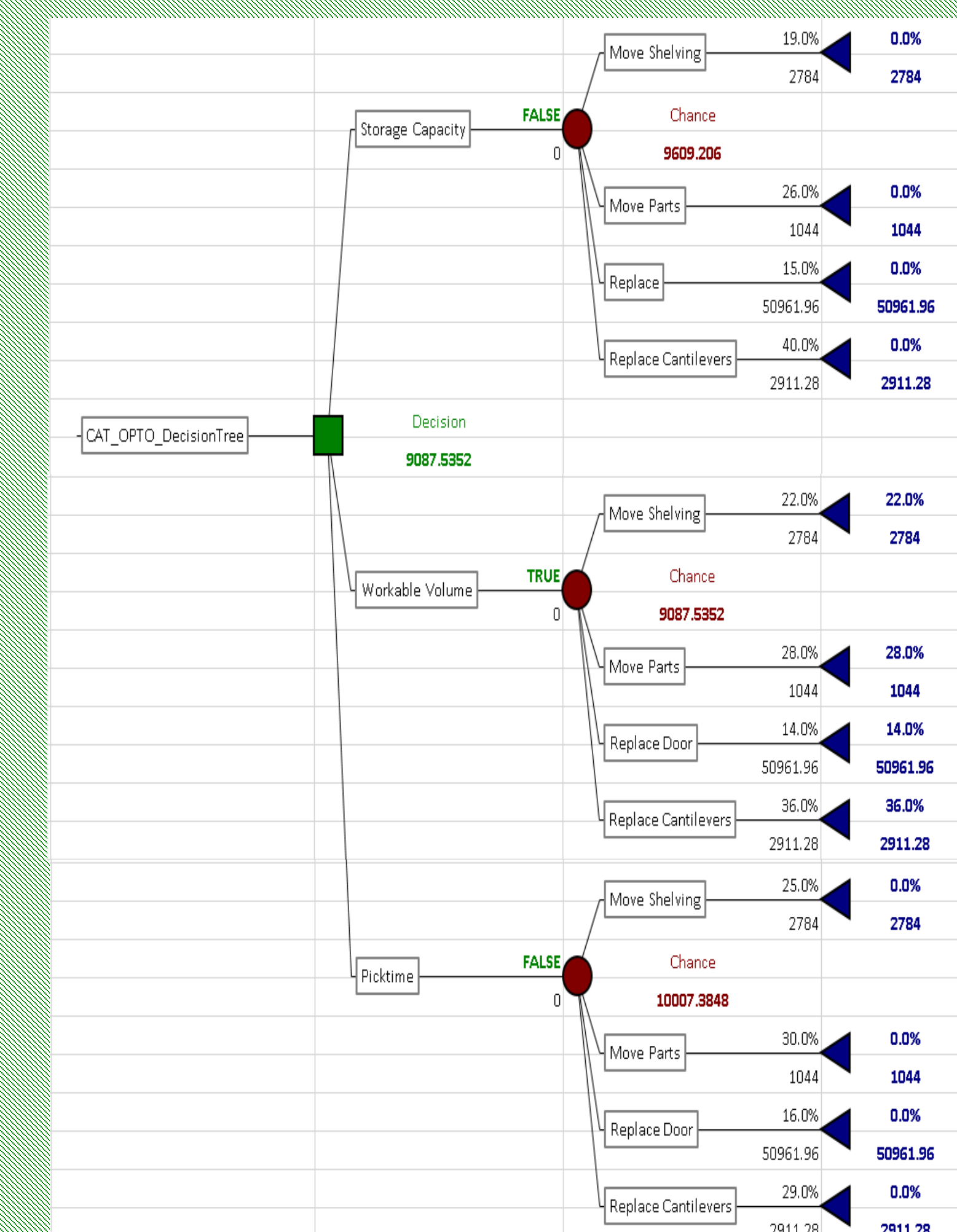
Cash Flow for Old Doors

$3000 $3000 $3000 $3000 $3000 $3000 $3000 $3000 $3000 $3000
0 1 2 3 4 5 6 7 8 9 10

Cash Flow for New Doors

$9,933.75
$3,391.81
$600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600 $600
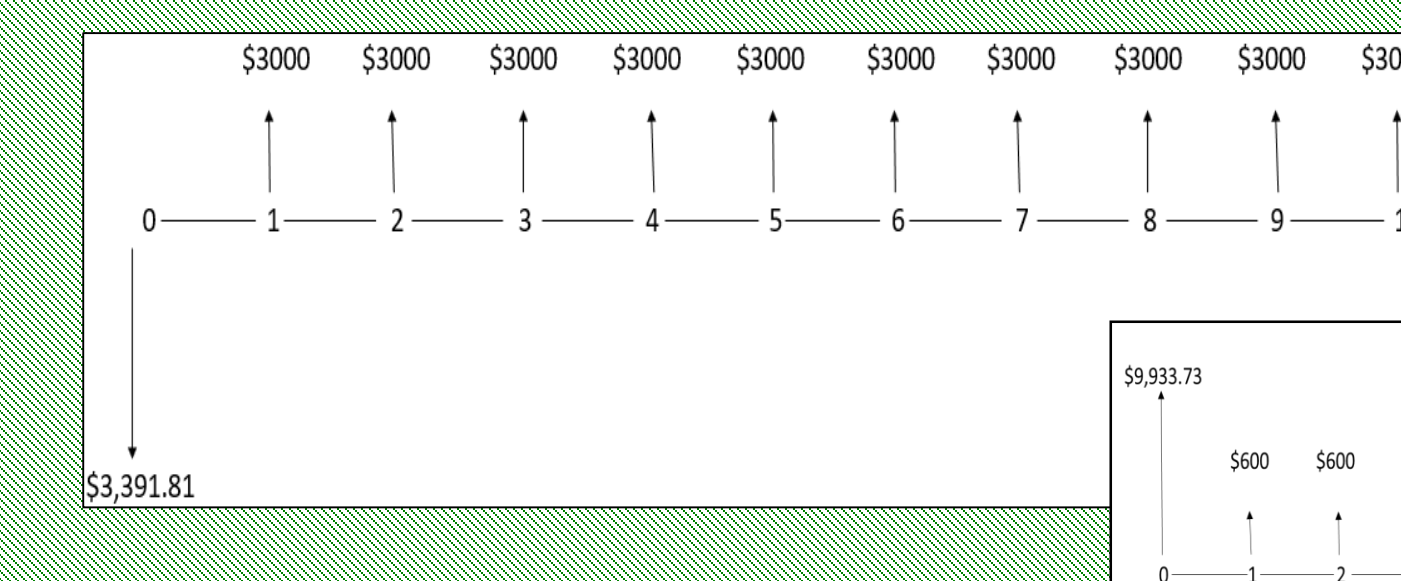
Decision Tree

CAT_OPTO_DecisionTree

- The decision tree determines that the best option is to follow the option to optimize the workable volume by implementing new shelving where the cantilevers are currently placed.
- Although there is a cost to implementing this recommendation, this will be the most acceptable option from the employees point of view.

Visual Representations of Recommendations

- Please see external displays