Increasing Cross-Dock Efficiency by Improving Door Assignments

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Initial Analysis

Why is Door Assignment so important?

"...dock productivity is measured by the 'bill/dock hour' metric. To me, this is the basis of dock operations as a whole. An inefficient layout can lead to longer unload and load times, causing the overall operation to suffer."

Chris Chrisanti, Lead Engineer

Statistical Testing Shows there is a Direct Correlation Between Average Walking Distance and Bills per Hour

Regression Analysis: BPH versus Walking Distance

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	1.0149	1.01491	47.38	0.000
Walking Distance	1	1.0149	1.01491	47.38	0.000
Error	10	0.2142	0.02142		
Total	11	1.2291			

Correlation: Walking Distance, BPH

Correlations

Pearson correlation	-0.909
P-value	0.000

Average Daily BPH vs Walking Distance per Person
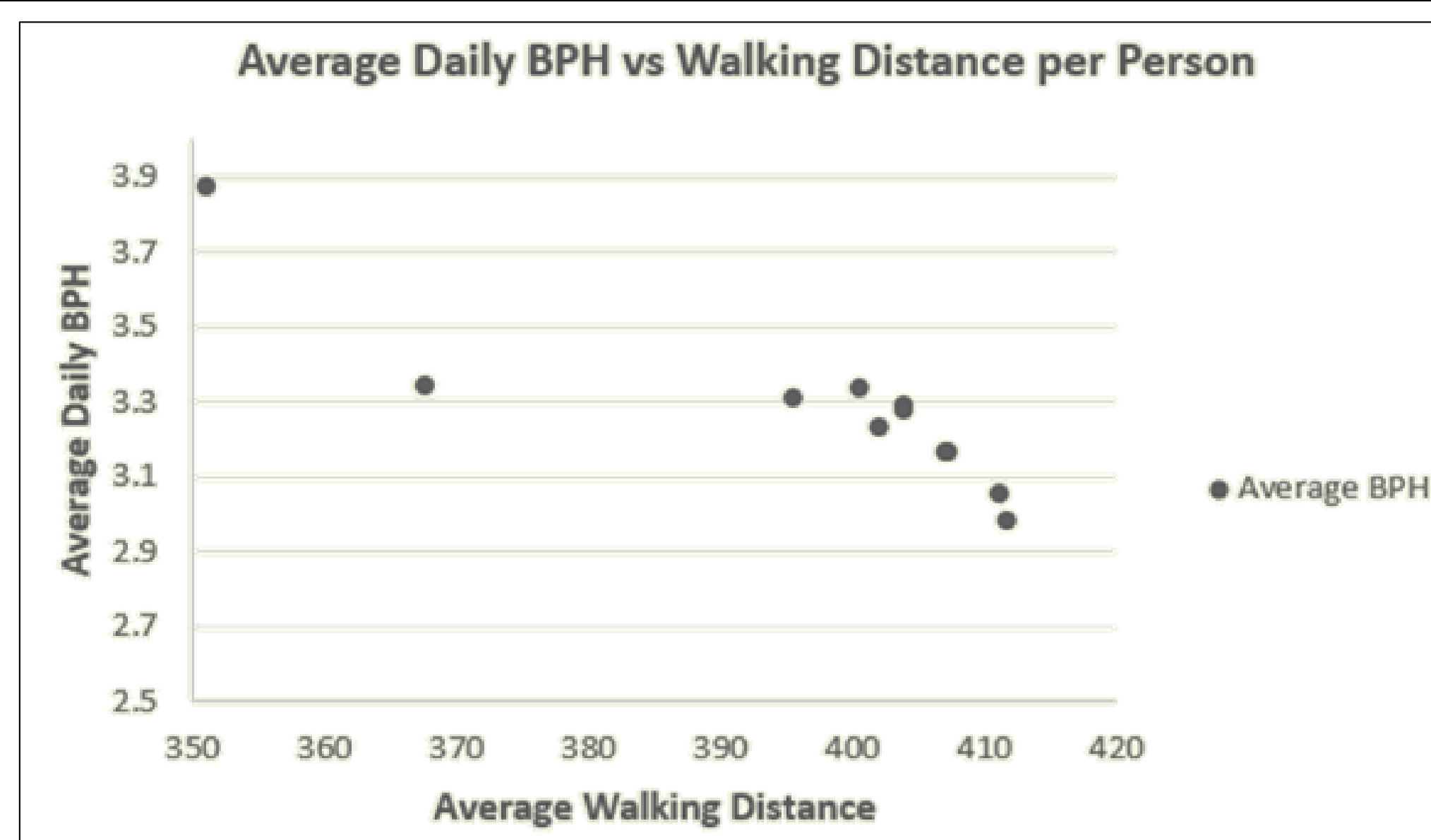
Project Objectives

|		Current Metrics
⬆	Increase cross-docked items	75.7% of items per day
⬇	Decrease travel distance per shipment	381.8 feet per shipment
⬆	Increase bills per dock hour	3.19 bills per dock hour

Model

Project Approach

We decided to use Arena simulation software to simulate the every-day processes that occur at the ABF Little Rock Service Center. These processes include the inbound trailers arriving at the lot, the item unloading process, the bay process, and the item loading process. Arena is a unique tool that allows the user to incorporate very specific details into the model so that the system can be accurately and precisely measured. Wit this tool, we can provide ArcBest with output such as the total travel distance, bills/dock hour, and the congestion of the facility.
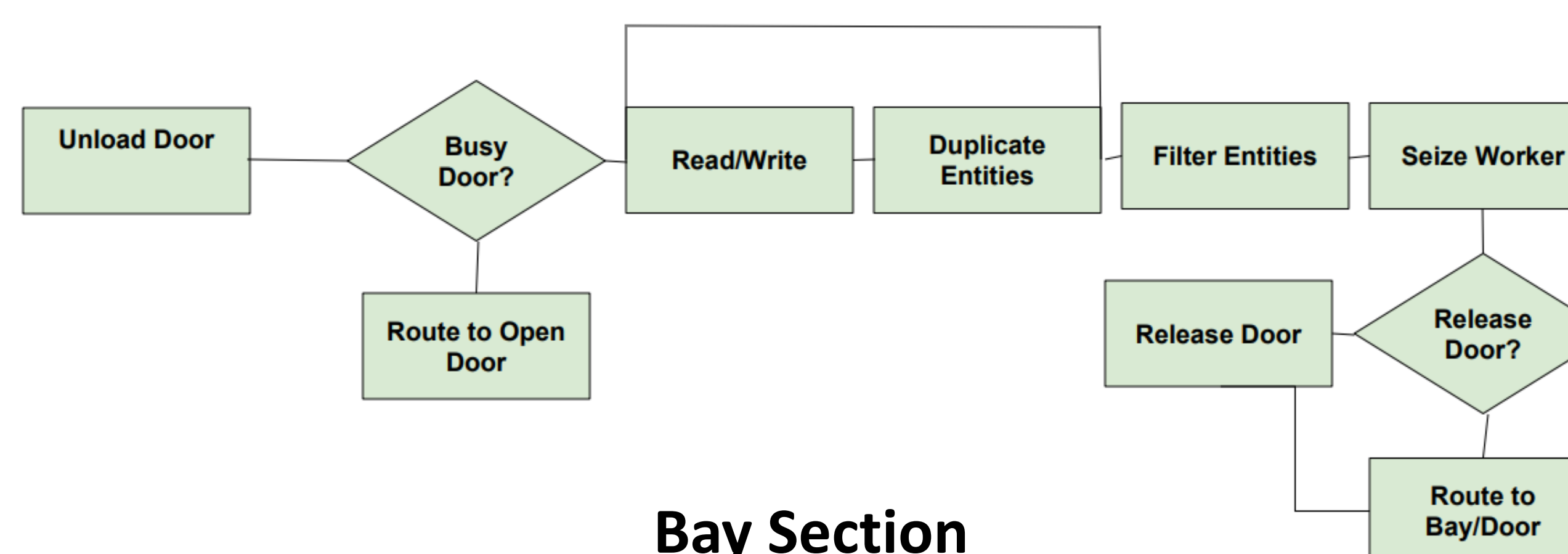
Inbound Trailers

The model simulates inbound trailers by creating one entity and then using a read/write module to read in information from excel to create an entity with assigned attributes for every row in the dataset. The entities are then sent to their assigned unload doors.

Created Entity → Read in Trucks → Create Duplicate → Hold Until Time → Send to Door
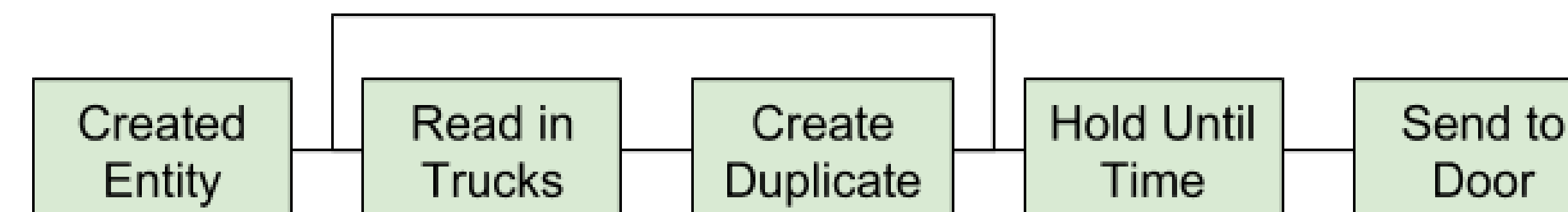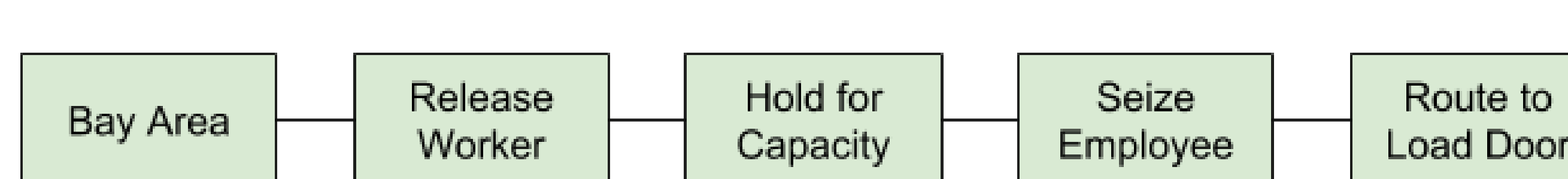
Unloading Process

When the entity arrives at the dock door, it runs through another read/write module to create the pieces that are moved in the system. It will then seize a worker and begin the process of items being pulled off the trailer to either be carried to a bay or an unload door.

Unload Door → Busy Door? → Route to Open Door / Read/Write → Duplicate Entities → Filter Entities → Seize Worker → Release Door? → Release Door / Route to Bay/Door
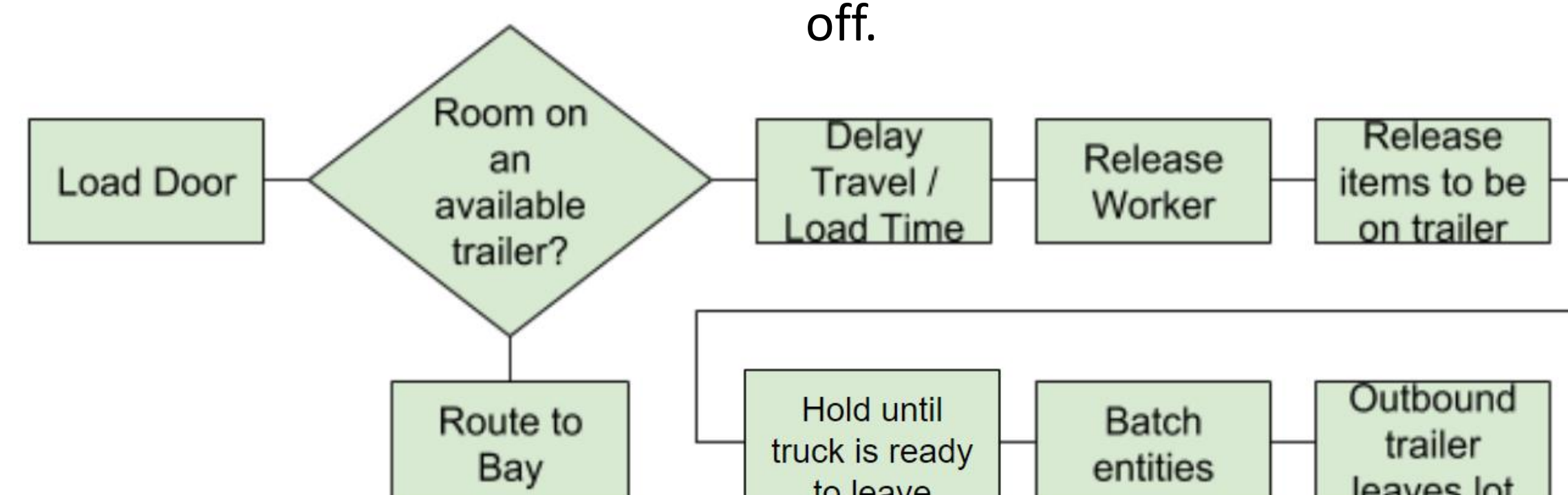
Bay Section

Items that are sent to the bay are held there until the capacity of the outbound trailer has reached 50%. Once this condition has been met, a signal is released for the items to be moved to the outbound door.

Bay Area → Release Worker → Hold for Capacity → Seize Employee → Route to Load Door

Loading Process

Pieces that arrive at the outbound door are loaded onto the trailer until a specified capacity is met, which in our project is between 50% and 80%. After the condition has been met, the pieces are batch into one entity and the truck is sent off.

Load Door → Room on an available trailer? → Delay Travel / Load Time → Release Worker → Release items to be on trailer → Route to Bay / Hold until truck is ready to leave → Batch entities → Outbound trailer leaves lot

Results

Current Layout Results

Number of bills: 6176
Number of Hours: 168

Employee	Bills	Travle Distance	Empty Blade Time
111507	11	9453	4726.5
123511	10	6366	3183
124501	42	30149	15074.5
127399	51	22878	11439
150207	1	460	230
155401	46	25862	12931
156362	29	19512	9756
157109	21	10372	5186

Door	Count of Items	Total Item Distance	Distance per Item
2	1	646	646
4	2	889	444.5
5	6	3110	518.3333333
6	4	1420	355
7	4	2365	591.25
8	5	2607	521.4
9	3	2143.5	714.5
11	7	3937.5	562.5
12	9	4802	533.5555556
13	3	2169.5	723.1666667
14	3	1490	496.6666667
15	1	923	923

We ran the model for one week or 168 hours and the service center produced 6,176 bills. The model also tracks the number of bills per employee, their travel distance, and their empty blade time. The model then tracks the number of items that go through each door, the total distance of every item for each door, and the distance per item per door. Above is a snapshot of the total results.

Changed Layout Results

Number of Bills: 5478
Number of Hours: 168

Employee	Bills	Distance Travled	Empty Blade Time
111507	5	2726	1363
123511	10	7664	3832
124501	42	33993	16996.5
127399	36	24075	12037.5
150207	1	336	168
155401	46	32650	16325
156362	22	17644	8822
157109	18	13185	6592.5
159275	140	109538	54769
163713	28	23351	11675.5
177533	5	5269	2634.5

Door	Count of Items	Total Item Distance	Distance per Item
2	1	648	648
4	12	7561	630.0833333
5	108	53930	499.3518519
6	105	67360	641.5238095
7	64	48617	759.640625
8	4	2497	624.25
9	5	777.5	155.5
11	104	70833.5	681.0913462
12	4	3389	847.25
13	2	993	496.5
14	100	46538	465.38
15	1	696	696
16	56	32384	578.2857143
17	39	19787	507.3589744
18	14	6236	445.4285714
19	1	685	685

The Model is Used to Compare Different Layouts

	Current Layout	Changed Layout	Difference	Percentage Change
Bills	6176	5478	698	13%
Total Travel Distance	3593751	4568171	974420	21%
Total Empty Blade Time	1796875.5	2284085.5	487210	21%
Total Distance per Item	55943.69451	61669.8857	5726.19119	9%

Cost/Profit Impact

	1 Week	1 Month	1 Year	5 Years
Bills	698	2792	33504	167520
Dollars	$69,800	$279,200	$3,350,400	$16,752,000
Total Travel Distance	974420	3897680	46772160	233860800
Total Empty Blade Time	487210	1948840	23386080	116930400
Total Distance per Item	5726.19119	22904.76476	274857.1771	1374285.886

Savings per Time