

Analysis of Grocery Store Simulation Results

Intro

The purpose of this analysis is to provide a recommendation for both the amount and type of checkout lane a grocery store should use in order to maximize customer checkout speed, reduce wait time, and save money. All figures and tables provided are from my own grocery store simulation.

For purposes of the simulation, there can be no more than 12 total checkout lanes. I tested 2 different sets of data, for all combinations of lane types up to 12. I also will test a few cases with closed lanes, to determine the wait time cost of closing lanes, and lowest amount of lanes a store can have while keeping a reasonable wait time.

The main data file I will use is the large arrival text file, which has 3000 customers over a 13ish hour period. A majority of these customers (1733) have over 12 items and are not eligible for express lanes. There are 1267 customers that are eligible to use express lanes. The recommendation that I will be giving is based off of this ratio of express/normal customers, and I think my recommendation will stand with most situations where the amount of normal customers exceeds the amount of express eligible customers by about 15%. I think we can reasonably expect longer wait times when there aren't enough lanes for all the normal customers to flow through. I will be giving all measures in time in terms of minutes.

The Numbers

Based on my simulation, a 2:1 ratio of normal lanes:express lanes is the best combination of lanes for both arrival files. It yields the *lowest average wait time for both types of customers*, regardless of the amount of items they have. I found this to be true when testing combinations for 12 open lanes on the large arrival file, and combinations of 6 open lanes on the medium arrival file. On the large arrival file, this was 8 normal lanes and 4 express lanes. On the medium arrival file, it was 4 normal lanes and 2 express lanes. In an odd amount of total lanes, it was better to get rid of an express lane than a normal lane.

Changing the 2:1 ratio may yield a shorter *average* wait time, but will begin to disproportionately affect the wait time of one type of customer (express or normal) as a consequence. Considering there are less express customers than normal customers in these tests, it's important to look at the average wait time for *both* types of customer, since there will be more regular customers in the store at a time, according to the data files.

Conclusion

The cost of going from 12 lanes to 11 lanes is about .59 minutes of wait time, in the best case scenario, and you would want to close down one normal lane. If you were to go from 11 to 10 lanes, you would want to close an express lane, as it would only increase wait by .11 minutes. If you were to close down 3 or more lanes total, it would result in a jump in wait times and a 6x increase in average line length, even in the best case scenario.

Thus, my recommendation is to have 7 normal lanes and 3 express lanes. Attached are some tables from my simulation to support this.

Normal Lanes	Express Lanes	Average Wait Time	Average Line Length	>12 Items Wait Time	<= 12 Items Wait Time	Longest Line Length
1	11	57.904 minutes	8.659 customers	100.235 minutes	0.002 minutes	234
2	10	47.534 minutes	10.635 customers	82.284 minutes	0.004 minutes	116
3	9	25.577 minutes	7.337 customers	44.274 minutes	0.004 minutes	56
4	8	21.292 minutes	6.749 customers	36.851 minutes	0.009 minutes	38
5	7	17.908 minutes	5.969 customers	30.98 minutes	0.028 minutes	26
6	6	15.037 minutes	5.133 customers	25.972 minutes	0.08 minutes	19
7	5	.794 minutes	1.276 customers	1.257 minutes	0.159 minutes	4
8	4	.755 minutes	1.268 customers	1.117 minutes	0.26 minutes	3
9	3	.790 minutes	1.297 customers	1.07 minutes	0.408 minutes	3
10	2	.804 minutes	1.3 customers	0.989 minutes	0.552 minutes	3
11	1	.860 minutes	1.3 customers	0.924 minutes	0.771 minutes	0.924

Normal Lanes	Express Lanes	Average Wait Time	>12 Items Wait Time	<= 12 Items Wait Time
1	5	19.340	33.493	0.000
2	4	0.439	0.760	0.000
3	3	0.241	0.418	0.000
4	2	0.079	0.134	0.005
5	1	0.038	0.060	0.009

Arrival Big with Lane Restriction	normal	express	avg	normal	express
11 lanes	7	4	0.804	1.199	0.263
	8	3	0.85	1.166	0.418
	6	5	17.186	29.626	1.11
	9	2	0.879	1.056	0.89
10 lanes	8	2	0.939	1.17	0.624
	7	3	0.914	1.27	0.426
	8	2	0.939	1.561	0.874
	6	4	14.38	24/69	0.288
9 lanes	6	3	14.62	25.01	4.15
	5	4	22.07	38	0.292
	7	2	21.951	23.18	20.25
	8	1	16.193	17.233	14.77
	4	5	19.7	33.99	0.169
8 lanes	5	3	19.602	33.63	0.411
	6	2	23.01	24.89	20.41
	7	1	25.719	26.87	24.144
	4	4	23.48	40.43	0.296