Supermarket Check-Out System Analysis

BASE SIMULATION

Cashier service and self-service times were modelled using the probability profiles provided. This simulation models a "typical day" with customers adhering to an observed rate of arrival and reneging. There are three cashiers, six self-service tills and one assistant.

For simplicity's sake, the assistant requires the "Customer" resource which is also required by the self-service tills. This ensures that no more than 6 of the 7 tills can run concurrently and that the "Self Service Assistance" activity takes priority.

No warm-up time is utilized within the model, this is because we are assuming that when the store is opened at 8am to the general public that there are no existing work items in the system and therefore it would be more representative of the stores daily data for the model to reproduce this.

Fig. 1 show the frequency of average queue times over a 500 day simulation. We see from these graphs that the queue times for both self-service and cashier tills are approximately normally distributed with an average wait time of approximately 0.7 minutes each and these queue times currently range between 0 and 2 minutes. This data serves as a baseline to compare our variations against.

VARIATION A

Model A is designed to explore the impact of increasing the staff available for assisting customers using the self-service tills. This is represented using an extra replicate of the "Self Service Assistance" activity.

From **Fig. 2**, we see that there does not appear to be a discernable difference in queue times between our Base, and Variation A for either queue. This brings into question whether hiring an extra person to provide assistance at the self-checkouts is preferable, when customers will not notice a change in waiting time.

VARIATION B

Model B explores the impact of decreasing the number of staff working the tills throughout a day. Hence, a reduction to the number of replicates of the "Cashier Tills" activity to two. No other changes are made.

From **Fig. 3**, we see that we have a right skewed distribution for self-service queue times, with an average of 1.15 minutes approximately and times ranging between 0 and 4 minutes. We also see that we have a normal distribution, similar to our Base, however average wait times are around 3.1 minutes, and the range is from 0 to 5 minutes. These results show that reducing the number of cashiers working produces longer queues at these tills, and as a result, we put more stress on our self-service tills as people migrate from the longer cashier queues to the shorter self-service queues.

Whilst this considerably reduces operating costs, the resulting impact on customer waiting times (and, likely, satisfaction) would be significantly less manageable, especially considering fluctuations in arrival times, e.g. during local events; the store and queuing system could become overwhelmed.

Variation C

Model C explores the impact of decreasing the number of staff working the tills over a specified periods. This is represented by an additional resource, "Cashiers", of which there are two or three available, conditional to the time and these are required by the cashier tills.

Replicates were not used for the cashier tills in this variate as, due to the use of each being restricted to particular times of the day, it would be more accurate to collect each individual till results separately. No other changes are made.

From **Fig. 4**, we see a marginal increase in average queueing times across our 500 simulations compared to our base, and far lower queue times than Variation B. In comparison to Variation B, the cost reduction is not as substantial but certainly significant, yet the increase in queuing times is far less impacting.

Summary

Our goal with these simulations is to find the minimum operating costs for the supermarket, whilst also keeping customer satisfaction as high as possible. We believe that keeping queue times as short as possible is paramount to customer satisfaction and hence also to customer retention. We suggest that the data shows that implementing Variation A would be detrimental to the supermarket. There would be increasing operating costs at little to no benefit in terms of queuing times. Hence, there is no perceivable benefit to the company in its implementation.

The produced data for Variation B shows an increase of almost 350% in cashier queue times and 70% increase for self-service queue times **(Figs. 5 & 7)**. Hence a significant decrease in customer satisfaction. We also see from **Fig. 6** that this variation has far fewer people waiting in the queue for less than 4 minutes, causing reneging (and potentially customer loss in real terms) and further lowering customer satisfaction. However, it provides a large decrease in operating costs due to one less cashier employed. Assuming the standard 6 day week, 12 hour working day, that would be saving a total of 3744 paid working hours a year, which even at minimum wage is a significant decrease in costs to the company.

The data for Variation C, however shows that while the queuing times for cashier tills are almost 100% higher than our Base variation **(Figs. 5 & 7)**, the queuing times for self-service tills are only marginally worse ($\approx 6\%$). With Variation C we save 5 working hours per day, giving us a total saving of 1560 paid working hours over the whole year. We also find the number of customers waiting in queue for longer than 4 minutes is, while higher than our Base or Variation A, much more reasonable than Variation B **(Fig. 6)**. Whilst Variation B will save almost 2.5 times the amount of costs compared to Variation C, it increases cashier queue times 3.5 times more and self-services queue times almost 10 times more than Variation C.

CONCLUSION

Therefore we believe that Variation A offers no benefit to the company, and thus is pointless to implement. the large loss in customer retention due to longer queues offered by Variation B makes it inferior to Variation C, and hence is not a wise business decision to consider either. It is therefore our recommendation to implement Variation C at the store; having the cashiers work 3 different shifts across each day.
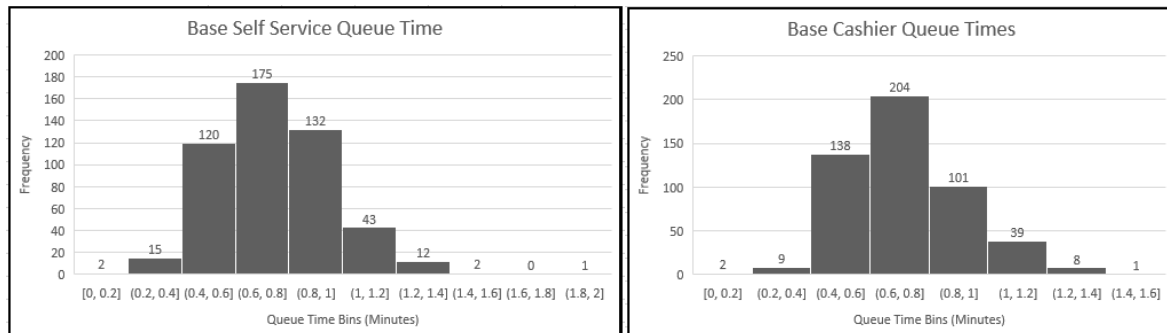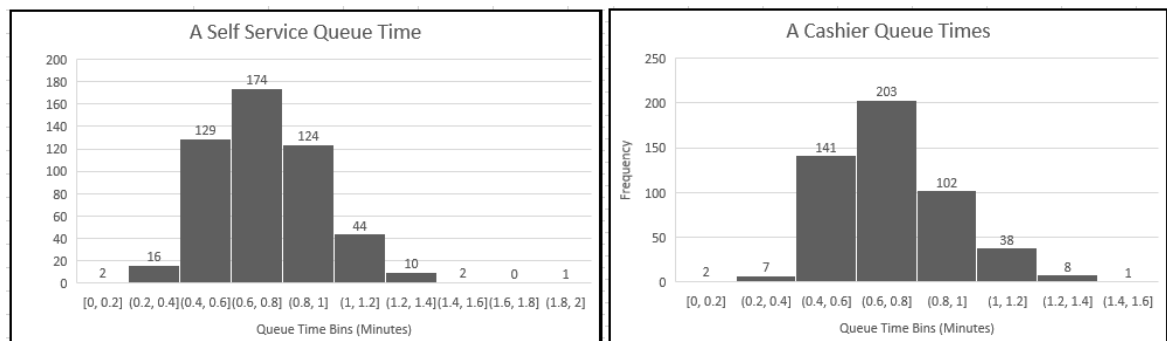
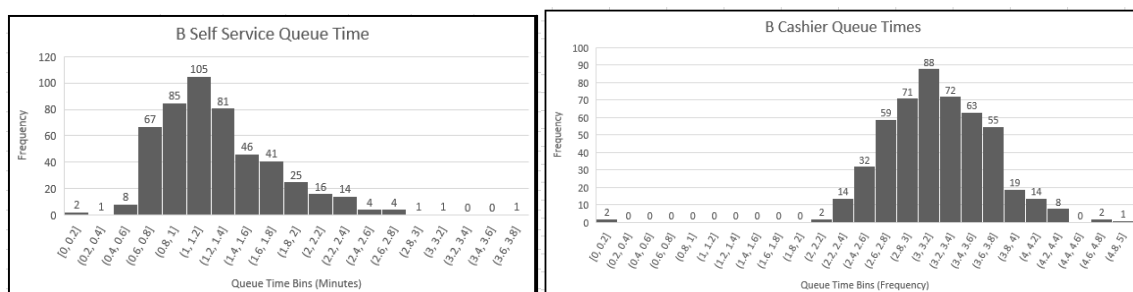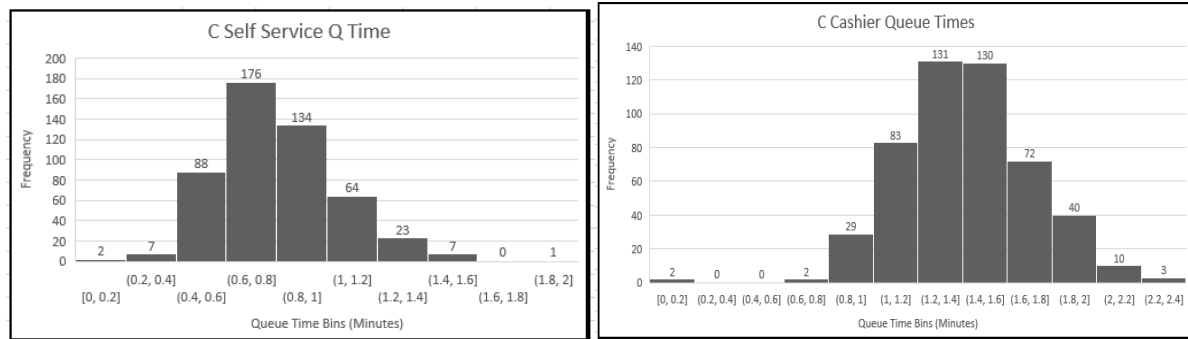# Index

Figure 1:

Figure 2:

Figure 3:

Figure 4:

Figure 5:
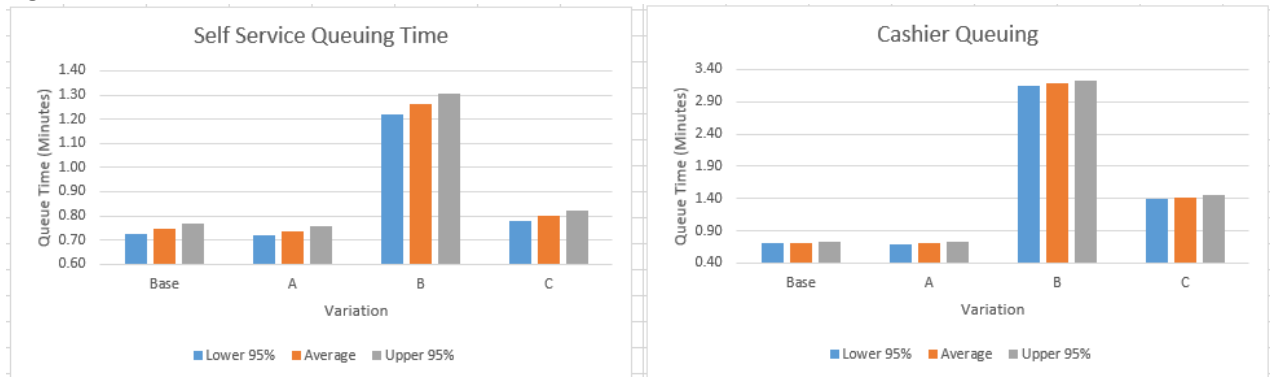
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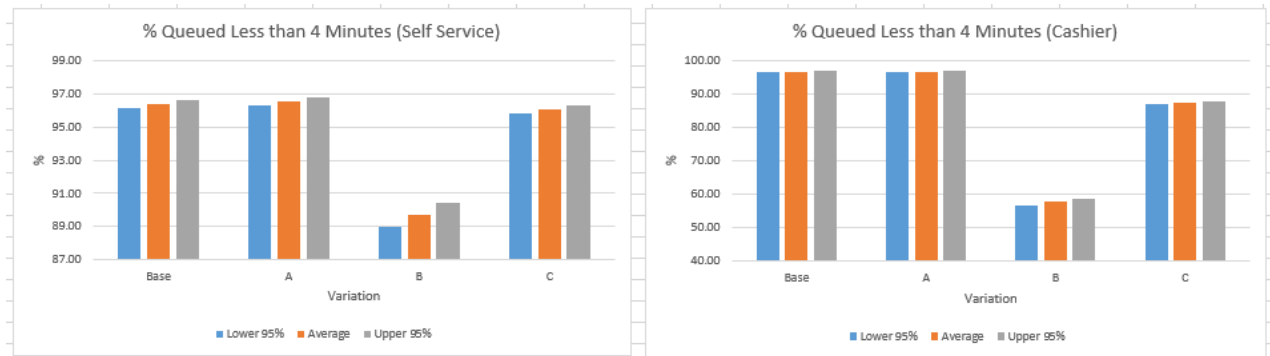
Figure 7:

% Greater Than Base		A	B	C
Cashier Tills	Average Use	0.06%	9.18%	67.22%
Self Service Tills	Average Use	0.90%	-6.30%	-1.58%
Queue for Self Service Tills	Average Queuing Time	1.44%	-68.97%	-6.99%
	% Queued Less Than Time Limit	-0.13%	6.96%	0.37%
Queue for Cashier Tills	Average Queuing Time	0.17%	-346.49%	-98.40%
	% Queued Less Than Time Limit	0.00%	40.45%	9.55%