# Executive Summary

XYZ café serves breakfast and lunch foods alongside coffee, tea, and specialty beverages. The café employs a single cashier, along with a barista for preparing specialty drinks (each at $16 per hour). Between the cashier and barista queues, congestion can become an issue. This leads to balking and lost revenue. The café wants to investigate business optimization through decreasing queue lengths and balking to maximize profits.

The objectives of this project were twofold. The first was to create a model that replicated the activities of a normal day given the data provided – three weeks of incoming business, Monday through Friday between 10:30 am and 1 pm. This model is necessary to simulate an average lunch rush with novel data generated by random variables. Secondly, a cost-benefit analysis was performed on this model alongside two potential modifications to the current employment strategy. These are:

- Adding a second cashier – "Second Cashier" model.
- The barista works as a second cashier when not making drinks – "Floating Barista" model.

Statistical analyses were performed in Excel to determine arrival rates of parties (sized one to four), party size frequencies, the probability of a party balking and whether balking correlates to cashier queue length, order type frequencies, order duration, average pricing of orders, and barista duration (for making drinks). A replication model (one cashier, one barista) was coded in C# to simulate a normal day using random variables to perform Monte Carlo simulations.

This model was run with 15,000 simulations to calculate the average parties served per day, balks, lost revenue from balking, and total profits. This model was validated using the original data. Then, 15,000 simulated days were run for the Second Cashier and Floating Barista models for comparison.

In comparison with the replication model, Second Cashier yielded:

- Decreased balking to 27.4% of the Base model, serving an additional 2.25 parties per day
- Decreased average profit earned during the 2.5-hour period by 1.5% (or $5.50)
- Increased the average maximum barista queue size by 1.17

The Floating Barista model:

- Decreased balking to 44.8% of the Base model, serving an additional 1.6 parties per day
- Increased average profit earned during the 2.5-hour period by 6.4% (or $25)
- Increased the average maximum barista queue size by 0.84

In either case, a second point of sale (POS) system will cost approximately $1,000. Perhaps, too, there will be training time for the barista to learn the duties of a cashier. Thus, there would be additional costs to implementing either the Second Cashier or Floating Barista model.

However, the additional $16 per hour for the Second Cashier renders average daily profits about $6 less than the replication model ($375.81 to $370.37). Simply, the expected average money gained by the reduction in balking doesn't offset the cost of an additional employee's wages. Coupled with the $1,000 POS cost, adding a second cashier would be a negative change. Moreover, rapid checkout causes greater congestion in the barista queue, which must also be considered.

On the other hand, even with the $1,000 for the new POS system, the Floating Barista model would be a significant improvement. The café would average more than $6,500 in additional profits annually, and not increase congestion in the barista queue as much as the Two Cashier model.

As such, it is highly recommended to implement the Floating Barista model.