**Market To-go/Quick Zone Simulation**

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CS1538: Intro to Simulation

We decided to model the Market To-go/Quick Zone dinning service located in the base of the Towers complex. We simulated the real life environment by personally collecting observable data and implementing the system in the Java programming language. The actual location was interesting to us for multiple reasons. First, the central location on campus provides access to a service that the average student or faculty member has used during their time at the University of Pittsburgh. Next, the two types of services at the location provide a challenge in modeling the actual system and improving it while keeping the assumptions we make valid in relation to the real world environment. The location in particular contains the Quick Zone convince store and the take-out order Market To-go. Customers that are finished with either service locations bottleneck at the cashiers that service both locations. Finally, the Market To-Go/Quick Zone location provides a subject that follows the distributions—Poisson, Exponential, Normal—and Queuing models that we focused on for our class. The main problem that we are trying to solve by implementing the simulation of Market To-go/Quick Zone location is to increase server efficiency. Server efficiency is defined as improving server utilization with a minimum of servers without drastically increasing wait times in the queues. The main way we solved this problem was by experimenting with different configurations of servers placed throughout the location depending on the time of day. Our results of the experiments indicate that by XXXXXXXXXXXXXXXXXXXXX. The following report will go into details of the approach, experiments, and our final results.

The Market To-Go/ Quick Zone location has various different variables that contribute to the system itself. Until recently, Market To-Go used to have its own location that was located across the room from Quick Zone. The University expanded the main dining area, Market, to accommodate the influx of new Pitt students which in turn moved the original Market To-Go location. Market To-Go currently resides in the location that used to belong to Taco Bell. Market To-Go is now attached to the Quick Zone with its customers entering from that area. First, customers arrive by entering the doors that are located at the Quick Zone entrance. They then have the choice to continue shopping in the Quick Zone area or they can head over to the Market To-Go area. In the real life system they have the option to buy items from both locations while our simulation simplifies this option which we will discuss later in the report. The Quick Zone area contains many items that you would find in the average convenience store. These items include frozen goods, candy bars, soda, energy drinks, toothpaste, paper towels and various other items that the average Pitt student might need while enrolled. Along with these items, Quick Zone offers stations that provide salad selection and/or sushi selection. The main service area acts as a queueing model with an infinite server capacity as each customer serves themselves. Market To-Go has different a different setup entirely. There are different stations with premade food items and a take-out order area. The premade food items include onion rings, sandwiches and various other premade items. The take-out order area is the main focus for the Market To-Go portion of our simulation. The order area is serviced by one employee in the current real environment. A queue forms up at this point with one customer being serviced at a time. The customer has the option of picking two sides and one main item. The sides are usually consistent on a day to day basis with mac-and-cheese, mashed potatoes, or corn being examples. The main entrée varies throughout the week. Some examples would be a chicken breast or meatloaf. Once the customers are finished in either the Market To-Go area or the Quick Zone area, they proceed to the checkout location that is located at the entrance of Quick Zone. The checkout location has space for four active cashiers (servers) with queues forming at their relative location. The real life environment system usually only has two of the checkout locations open at a time. The customers form queues at each checkout location with the customer choosing the queue with the least amount of customers in it.

Before we go in depth on the implementation of our simulation, we would like to describe the assumptions we made for the model. First, we assume that customers in our model do not take any time to transition between stations or server areas. This assumption simplifies our model because the time between stations in the real life environment is negligible. Also keeping this time variable would have been difficult to observe. The next assumption is that when a customer arrives they can only choose one of the service locations: Market To-Go or Quick Zone. The reason for not allowing the option of going to both is that it greatly simplifies our model. This allowed for ease of tracking customers that just bought an item from either location. Another assumption is that if a customer enters the location that will not leave without buying an item. Again, this simplifies our model because it allowed us to ignore these outlier cases and because we are only interested in customers that purchased an item. Another assumption is that if customers seemed to arrive at the same time, they would be separated by a small amount of time. This allowed for greater transparency in calculating the arrival rates. Another assumption that we made is that servers—both Market To-Go and Check out area—do not need time to rest and there is no time between switching them out for shifts. This makes sense because it simplifies our model and allows us to focus on the actual server configurations and customer throughput. Finally, we assumed that customers going to the Market To-Go service location do not take any time to select the items they want to choose. Again, the reason for this assumption is to simplify our model further.

The figure 1 illustrates how we modeled the real life environment.

Fig. 1.

Arrivals

Market To-Go or Quick Zone?

Market To-Go Queue

Quick Zone Item Selection

Customer Exit

Checkout server

Market To-Go Server

Checkout queues

For our illustrated in Figure 1, we collected observable data in a few different ways. We observed the arrival times into the location by sitting out front and keeping note of the arrival times during a period of one hour. If a customer seemed to arrive at the same time as another we separated them by one second. We then calculated the arrival rate using the average number of arrivals in one minute periods. For the decision of either Market To-Go vs Quick Zone choice, we observed the choices customers made after entering the store. This was done by seeing if the items they purchased when leaving were from Quick Zone, items that were not in a white box, or Market To-go, items in a white box. The white box is the container the Market To-Go server places the food selected by the customer in the Market To-Go service area. Next, we observed the Market To-Go server service times. These times did not have any large differences so we simplified the service distribution to a constant value. Finally, we observed the Checkout counter service rates by keeping track of the time of the individual customers as they arrived at the server and the time they left the location. By subtracting the entrance time to the counter from the exit time, we calculated the individual service rates. We also observed the number of items each customer purchased by counting them as they left the Market To-go/ Quick Zone location but we ended up ignoring these because our final model does not account for the number of items purchased.

Conclusion:

After running our simulation with a variety of experiments, we believe that the right server configuration can keep a low customer wait time while keeping the servers occupied to max amount of time. The server configuration with the best decrease in wait from the base trial was having four servers but it also drop the server occupied percentage to an unreasonable level. When there is only one server, the occupied time is at an acceptable level but at the expense of a large increase in wait times. Based off of the peak time experiment results, the best solution would be to have 3 servers at the Cashier check out area during the high traffic times, lunch and dinner. Due to time constraints, we were not able to reliable check the effect of adding more servers to the MTG server area. In the future, we would have liked to run a set of experiments that accounted for the extra servers in this area and see if it made any noticeable difference on the overall throughput of the whole location. Another variable we would have liked to have kept track of was the monetary aspect of the whole store. Due to time constraints and lack of information on the price at which the store bought the goods at cost along with employee wages, we were not able to reliably account for these variables in our system and run experiments on them.