***MODULATION AND SIMULATIONS***

***PROJECT 3950***

***GROCERY STORE - QUEUING MODEL***

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On entering any grocery store one is sure to see at least one line. At peak operating hours, one is guaranteed to observe a line at each available cashier. At Massy Stores, St. Augustine six (6) cashiers were observed, five (5) regular cashiers and the express lane.

The following were recorded for each customer in each line at the grocery store:

* Arrival Time – the time at which the customer joined the queue
* Service Start Time – the time at which the cashier started servicing the customer
* Service End Time – the time at which the cashier finished servicing the customer
* Drop Time – the time at which the customer left the queue to join another
* Number of Items –the number of items processed by the cashier for the customer being serviced.
* Payment Method – whether the customer paid via a card, credit or debit, or cash.

While the grocery has multiple lines, each line is served by a single, designated cashier. This gives a ‘multiple single queue with a single server’ scenario. Each queue is considered individually based on its’ observed unique characteristics. The following examination of the queuing process uses values from the first observed queue.

Once a customer has finished browsing and acquired the items they wish to purchase they join a line. The time taken for customers to join the line varies with each pair of customers. However, using the arrival time of consecutive customers it is observed that a customer arrives, on average, every 1.08 minutes. This is the interarrival rate. The arrival rate, lambda , is  , 1 customer per minute.

Given the data captured for each customer a customer class was created, allowing the devised simulation to access the individual characteristics of each customer.

class Customer:

def \_\_init\_\_(self,arrival\_time,service\_start\_time,service\_time):

                       self.arrival\_time=arrival\_time

                       self.service\_start\_time=service\_start\_time

                       self.service\_time=service\_time

                       self.service\_end\_time=self.service\_start\_time+self.service\_time

                       self.wait=self.service\_start\_time-self.arrival\_time

Within Customer, wait represents the length of time the customer was in the queue and service\_time represents the time taken for the cashier to complete processing the customer’s goods.

These variables depend on primarily on the customers within the grocery and the cashier. The customer’s select the queue they wish to join, thereby increasing its length. Factors affecting the customer’s selection of a line include:

* Number of items in their cart.
* Number of customers in the queue.
* Number of items in the carts of customer already in the line.
* Perceived service rate of the cashier.

These factors will in turn affect the customer’s wait time and the service rate. It is expected that as the number of items increases the service time will increase, thus decreasing the service rate.

//add the camparison explanation here and see code for specifics

A comparative approach was taken to assessing the grocery’s system. A Simulation was created of the observed grocery and compared to a created grocery. The cost associated with the server, cashier is $15

Recommendations

It was observed that when the cashier had completed servicing a customer, at times, the next customer would be required to wait as the customer or cashier assisted in bagging the customer’s items, to make space available for the next customer’s items. This can be avoided by introducing a bagging wheel. This allows the attendant, or cashier where there is no attendant, to place the scanned items into bags before the service is completed.

Cashiers should also have an inventory list of all items for sale along with these items’ barcodes. This eliminates the need of finding the item if the barcode reader cannot detect the code or the corresponding numbers of the barcode are unreadable.

In the event a product is damaged at the cashier, the item should be scanned and a replacement requested. The customer would be able to complete the purchase of their items and simply wait for the arrival of their product without increasing the wait time of persons in the queue.