Queuing Theory

Metro Cash and Carry

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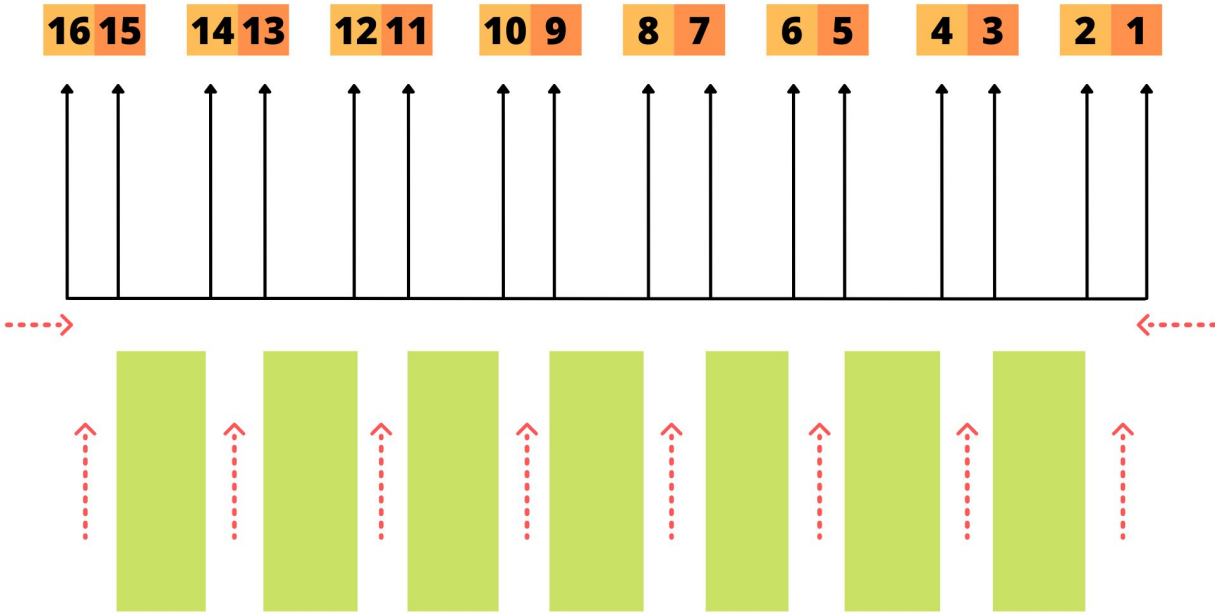
Problem

- Metro launched its “Electronic Gala” and expected an influx of more than usual customers
- Their counters had to be optimized to deal with the abnormal situation
- Key question: How many counters should be kept active?

Existing Counter Model



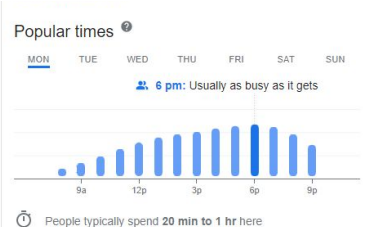
Weekend

- Morning - 6 active
- Evening - 6 active

Weekday

- Morning - 4 active
- Evening - 8 active

Data collection



- Verified ideal morning (11 am) and evening (6 pm) timings from **Google**
- Two members collected data of one counter each; then proceeded to next two counters when done; repeated till data of all active counters collected
- At least 20 mins of data collected at every counter
- **Arrival Time, Counter Time and Exit Time** noted for each customer

Counter 12

ACTUAL DATA

	Arrival Time	Inter arrival tim	Counter Time	Exit Time	Service Time	Total time in system	Wait time	Idle time
1	0:00:00	-	0:00:40	0:02:27	0:01:47	0:02:27	0:00:40	-
2	0:02:12	0:02:12	0:02:27	0:04:56	0:02:29	0:02:44	0:00:15	0:00:00
3	0:05:37	0:03:25	0:05:37	0:06:22	0:00:45	0:00:45	0:00:00	0:00:41
4	0:06:04	0:00:27	0:06:22	0:08:21	0:01:59	0:02:17	0:00:18	0:00:00
5	0:08:45	0:02:41	0:08:45	0:09:44	0:00:59	0:00:59	0:00:00	0:00:24
6	0:09:31	0:00:46	0:09:44	0:12:50	0:03:06	0:03:19	0:00:13	0:00:00
7	0:11:24	0:01:53	0:12:50	0:14:32	0:01:42	0:03:08	0:01:26	0:00:00
8	0:14:04	0:02:40	0:14:32	0:19:55	0:05:23	0:05:51	0:00:28	0:00:00

DATA FOR CALCULATION

	Arrival Time (mi	Service Time (mi	Exit time (mins)			
1	0.00	1.78	2.45	Arrival rate per person	0.401673640167	
2	2.20	2.48	4.93	**Arrival rate per person in 5 minutes**	**2.008368200837**	
3	5.62	0.75	6.37	Service rate per person	0.4403669725	
4	6.07	1.98	8.35	**Service rate per person in 5 minutes**	**2.201834862**	
5	8.75	0.98	9.73			
6	9.52	3.10	12.83			
7	11.40	1.70	14.53			
8	14.07	5.38	19.92			

Data Analysis

- Collected time for each customer using stopwatch; cause of **human error**
- Few customers balk, jockey, or renege; removed such cases; cause of **inaccuracies**
- Primary data collected by ourselves; ensures **authenticity**
- Low count of group members; could not observe all active counters simultaneously; collected data of 2 counters in each iteration; cause of **data inconsistency**

Mathematical Models

- M/M/s model of queueing theory implemented; FIFO queue behavior; infinite queue capacity; Arrival time follows poisson distribution; interarrival time and service time follow exponential distribution

Assumptions/ Constraints:

- Jockeying, balking, reneging customers: removed them from data on the spot
- Identification of counter time: when cashier starts scanning products
- Identification of exit time: when cashier hand over the receipt to the customer
- Imprecision in counter time: Exit time of previous customer = customer time of next customer

Results

- Arrival Rate and Service Rate for each counter averaged to generalize it for all counters ; Service rate came out to be > arrival time (as it should be)
- Poisson distribution of arrival times verified by creating 5 minute buckets of arrivals in each counter
- Used the lambda and mew values in M/M/s model

Findings:

- Adding or reducing counters has no major impact on Utilization, Expected time queue (Wq) and other factors
- M/M/s queueing model suggest that the queues are already optimized for all time periods

Recommendations

- Metro does not need to change the number of active counters
- Counters should not be scattered, rather they should be operated in a consecutive order
- Weight machines should be available on counter to weigh the mistakenly unweighted items
- A study should be carried out to observe the service time of each server, those performing below average should be enrolled in a training program