Modelling and Simulation of a State University Cafeteria: A Case Study

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ABSTRACT

With the current shift toward a service prominent economy, there exists a necessity in continuous improvements of service provision. Hospitality services have emerged as a foremost service under these circumstances. A university cafeteria is among the most time intensive services within a university premise. The tight schedules of the students and the staff influence the rushed atmosphere at the cafeterias that leads to customer dissatisfaction and brand switching. The study identified the congession at a hostel cafeteria of a state university. The objective of the study was to improve performance by reducing in the waiting times. The cafeteria was studied and primary data were collected during the rushed hours of weekdays for two weeks. The obtained data were simulated with Rockwell ARENA 14.5 version. Existing system allowed a waiting time of 3.30 minutes in the queue. The total time in the system was 4.81 minutes. Two model developments of increasing the service provision and the addition of another counter were simulated on the software. The waiting times resulted in the simulations depicted the efficiency in the increment of the service provision by two-fold at the counter. The simulations for the data available depicted the addition of resources to the counter as the most efficient alternative. It obtained a reduction in waiting time by 74.84 percent and the service provision was increased by 67.54 percent in the system. The developments can be acheived by the standardization of the food serving and the payment handling at the counters.

KEYWORDS: ARENA Simulation, Performance Improvements, Queue, Waiting Times

1 INTRODUCTION

In an economy based on the services, the continous improvement in performance is essential. Hospitality services are essential in excelling at customer satisfaction. Thus, the service provision needs continual improvement. Psychology of waiting and the queues are among the factors that lead to customer dissatisfaction. Therefore queues are moderated by the service providers in enhancing customer satisfaction. Thus, a service provider seeks methods of reducing the waiting times of customers in queues.

State Universities are foremost service providers in the Sri Lankan educational industry. The State university cafeterias are among the most time intensive service providers with the large crowds being served. There are at least two cafetarias established within a university premise to serve the crowd. Yet, the tight schedule of the students and having common interval increases the congestion at the cafeterias.

The businesses of the customers have become less willing to stay in large waiting lines leading to high customer dissatisfaction.

The study was based on a state university where two cafeterias were present. The chosen premise was the hostel based cafeteria of the university, which serve both the resident student and the daily travelling customers of the university. It served its customers only on week days and Sundays. The three main meals were served at the premise along with other confectionary inquries. The cafeteria was allowing the dine in and the take away of the food for its customers.

The cafeteria used the First-in-First-Out (FIFO) discipline. The serving at the counter includes the providing of food and the payment handling for the customer. The service was provided for a variety of customers within the university premises. Although the students are prioritized. Thus,

the system had a finite population and a finite waiting room size.

The busy schedules of the students resulted in large queues at the cafeteria during the meal hours. Thus, the study was conducted in identifying available methods of optimizing the service provision of the system. The methods of reducing waiting times were made prominent in the study as a performance improvement of the system.

2 LITERATURE REVIEW

Queuing theory is the study of the waiting lines. Queue analysis allows the derivation of the expected queue length, expected waiting time and probability of balking customers. Thus it can be used in the analysis of a cafeteria where the service cannot be immediately provided for each customer.

Nosek & Wilson (2001) stated that queuing theory is a mathematical approach applied in operations management field for the waiting line analysis.

Dharmawirya et al. (2012) conducted a study for fast food restaurants to identify the difference in the expected waiting time and the actual waiting times. Authors identified that the customers identify the speed of service of the restaurants to be a major factor in choosing restaurants.

Church & Newman (2000) stated that customer queueing at the fast food facility is an inherent and a critical factor of the operations. Authors further stated that computer-based simulation packages are allowing rather thorough analysis rather than the conventional approaches. Their study was driven toward the optimization of the total product positioning of the fast food retail industry.

Kwan et al. (1988) conducted a study to identify the applicability of the steady state

solutions of the queuing theory for the worker scheduling.

The queuing systems can be simulated using ARENA platform. It allows the modelling of real-time systems on computer-based software. The software uses pre-defined modules for the modelling (Rockwell Automation, 2009).

3 METHODOLOGY

The study was conducted at the hostel cafeteria of a state university. Observation of the system was needed in identifying the system and the processes held.

3.1 Data Collection

Primary data for the arrival times and the served times were obtained at the cafeteria. The busy hours were mainly between 12.30 p.m - 1.30 p.m and 6.00 p.m – 8.00 p.m. Data were collected in the busy hours of the premises. Collected data were the times related to entering, getting served and waiting of the students in the queue.

3.2 Data Analysis

The data taken by direct observations were analysed and inter-arrival times and serice times were obtained. The Input Analyzer – an ARENA built –in tool - was used to identify the probability distribution for inter arrival time and service time (Table 1).

3.3 Modelling and Simulation

The exising system was modelled on ARENA 14.5 with the obtained probability distributions. The conceptual model was depicted in Figure 1 (M1). The animated model of the system was developed for the existing system (Figure 2).

3.4 Model Assumptions
• FIFO discipline was used

- No customer left the queue without being served.
- Customers arrived randomly and independently.

Table 1 : Distributions from Input Analyzer

|	Distribution	Expression
Inter-arrival times (Customers)	LOGNORMAL	-0.5+LOGN(24.4, 75.7)
Service Times (s)	LOGNORMAL	1.5+ LOGN(29.5, 33.2)

3.5 Model Validation and Verification

The modelled system was verified through running the system under different conditions. The obtained results were analysed for its logicality in the verification.

3.6 Model Developments

The study proposed two models for the performance improvement of the existing system. They suggested increasing the efficiency of the server by two-folds and adding another counter for the cafeteria. Increment of the service rate by two-folds was done without changing the orientation of the exisying system (M2).

Addition of another counter allowed a customer to go to the free conter to be served. It was also assumed that the counters would be seving at FIFS and the counters were free at a probability of 0.5. An hour replication of the existing counter was assumed in the second counter (M3).
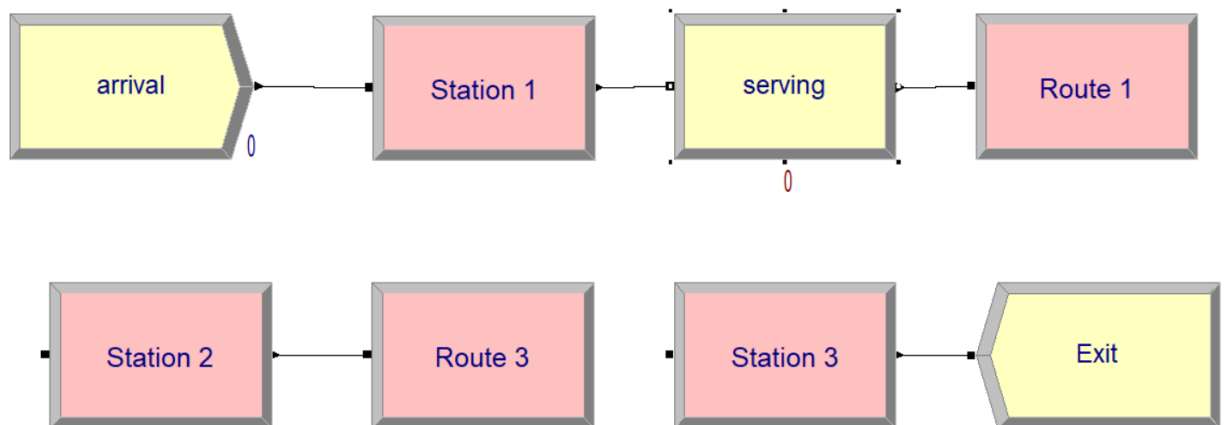
Figure 1: Conceptual Model of the existing System

Figure 2: Animated System

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4 RESULTS AND DISCUSSION

Table 2 illustrates the modelled cafeteria and it stipulated a 93.40 percent serving rate with the present conditions. The total waiting time in the system was modelled to be 4.81 minutes.

There were two models developed to imrpove the system performance of the cafeteria. Model where the service rate was increased showed a reduction in the waiting time and an increment in the number of customers served.

Addition of another counter did not derive the expected reduction in the waiting time of the customers. It increased the time of a customer being in the system and the waiting time at the counter two. This may be affected by the customers' switching the counters when they get free.

Accordingly, the study concluded that the the exisiting waiting time could be further reduced through the increment of the service efficiency of the server at the counter by a two-fold.

The simulated reduction in the waiting time was 74.84 percent of the existing system waiting time. Also an increment of the service provision could be seen by 67.54 percent.

5 CONCLUSIONS AND RECOMMENDATIONS

The system under the study, cafeteria at a State university was found to be efficient for the obtained primary data. The waiting time was simulated for a developed system. The development was to further increase the efficiency of the serving counter by two-fold.

The development reduced the waiting time by 74.84 percent and increased the service provision by 67.54 percent. Thus, the M2 model was selected as the optimal development over M3.

The study recommended the improvement of the service counter by standardizing the operations of the counter such that the food serving and the payment handling could be run smoothly in the same server.

The study can be advanced to simulate the optimal performance measures for the different days of the week causing the queue variations. Thus the accuracy of the model can be further validated.

Moreover, the study can consider identifying the critical operations of the system and simulating the most critical operation in performance improvements.

Table 2: The Simulated Results for the Cafeteria

	Existing Model (M1)	Model Development (M2)	Model Development (M3)
Number In	91	96	148
Number Out	85	96	100
% of serving	93.40	100.00	67.56
Average Waiting Time (Counter 1) (Minutes)	3.30	0.83	6.20
Average Waiting Time (Counter 2) (Minutes)	-	-	6.33
Total Waiting in the System (Minutes)	4.81	1.32	6.80

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