Analyzing the Service Performance of a Post Office in Kurunegala District: A Case Study

MAN Perera, BMMT Bandaranayake, KHMSD Goonatillake, MASD Premarathne and BMAM Balasooriya#

Department of Industrial Management, Wayamba University of Sri Lanka, Sri Lanka

#amandabalasooriya0629@gmail.com

Abstract - The postal service is an essential service organization that provides a quality service leading to customer satisfaction. However, long queues were observed at a post office in the Kurunegala district. Since it affects the service quality, this study aims to suggest an improved configuration for the selected post office by analyzing its queuing performance. This study collected 300 data from two counters in the post office during three hours from 10.00 am on two consecutive weekdays. The system was modelled using the Rockwell ARENA 16 software. The queues for the observed registered post and speed post counters were named queue 01 and queue 02, respectively. The existing system resulted in 19.03 and 18.43 minutes of waiting time in queues 01 and 02. The number waiting in queues 01 and 02 were 25 and 24. The percentage of customers served by the system was 58.23 percent. Since the existing system showed a low performance rate, the study recommended doubling the staff at the counters. Therefore, three models were suggested as models 01, 02, and 03. The suggestions were to double the resources at counter 1, double the resources at counter 2, and double the resources at both counters. Compared to models 01 and 02, model 03 shows less waiting time and number waiting. Therefore, the study recommends model 03 as the best-fitted model. It reduced waiting times to 3.52 and 1.27 minutes, and the numbers waiting to 6 and 2 in queues 01 and 02. Moreover, the proposed system could increase its performance by 33.72 percent.

Keywords: computer-based, simulation model, post office, service quality

I. INTRODUCTION

The postal service is a major service of the central government that meets every citizen on a daily basis. It has done a great service from ancient times to the present (Crew & Kleindorfer, 1992). The service-providing organizations should provide quality customer service to survive in the field (Zalatar, 2012). Providing better services to the customers leads to high customer satisfaction and makes customers more loyal to the organization (Chen, 2008; Chou & Kim, 2009).

Moreover, services play a significant role in the economy of the country. Despite the technological advancements, the postal service is still vital in the transport sector. However, one of the reasons for the customers' dissatisfaction is the presence of more waiting time to obtain the service. Therefore, based on the necessity of the improvements in the postal service, modeling and simulation can be applied to regulate the service process and eliminate the complications.

Modeling and simulation are comprehensive concepts absorbed in engineering applications and other social sciences scenarios. The essence of the simulation method's contribution is capturing the dynamic side of the system and complicated probabilistic relationships (Achimsk, 2019). The simulation consists of knowledge-based dynamic modeling, real-time computer-aided simulation, online and offline identification of engineering systems (Mohamed, 2010). Moreover, simulation helps to create a real image of the organization's process with a dynamic analysis (Jun et al., 1999). This study provides the reader instances of using the simulation method to enrich the queuing system of a Post Office in the Kurunegala district.

The majority of people visit the post office to send postal goods through registered post and courier services. When observing the post office, it was found that the registered mail counter and the speed post counter have a long waiting line compared to other counters, and it has badly affected the overall performance of the post office. Therefore, to enhance the performance of the post office, a well-managed system should be executed for the two counters mentioned above. The psychological nature of the waiting time in the system has a high impact on customer satisfaction levels.

As per the author's knowledge, a performance evaluation study of a post office using Rockwell Arena has not been published for the Sri Lankan context. Therefore, the study's main objective is to minimize customer waiting time in queues and optimize the performance of a post office in the Kurunegala district by modeling a project to simulate the queues at the two observed counters. It is considered to describe that modeling and simulation satisfy the proposed project when tested with the real. Rockwell Arena software is capable of generating great deal of models through providing analytical models and graphic simulation patterns (Kelton et al., 2008). In this study, reduction of customer waiting time is specified as an effective method to increase productivity and efficiency of the post office.

II. METHODOLOGY

A. Theoretical Model

Determining the various waiting times and queue sizes for certain system components helps the management make judgments on how the system should proceed to have an improved configuration.

The average length of the queue (L) can be broken down as the average number of customers waiting in the queue (L_q) and the average number of customers waiting in the queuing system (L_s). In addition, the average time a customer spends in the system (W) can be broken down as the average amount of time spent in the queue (W_q) and the average amount of time spent in the queuing system (W_s).

According to Little's rule,

$$L = \lambda W$$

$$L_q = \lambda W_q$$

$$L_s = \lambda W_s$$

Here, λ is the arrival rate of units to the system.

According to Kendall's notation, a system that has exponential inter-arrival times, exponential service times, and one server can be written as (M/M/1) : (GD/∞/∞). Here, M stands for Markov, and GD stands for General Discipline.

$$\lambda_j = \lambda \text{ for } (j = 0.\ 1,\ 2, \ldots.)$$

$$\mu_j = \mu \text{ for } (j = 0.\ 1,\ 2, \ldots.)$$

Then the steady-state probability can be written as,

$$\pi_j = \lambda^j \pi_0 \,/\, \mu^j$$

The traffic intensity of the system can be written as,

$$p = \lambda / \mu$$

Since the sum of all the steady state probabilities is equal to one, the equation can be written as,

$$\pi_0(1 + p + p^2 + \ldots + p^j) = 1$$

Assuming $0 \le p \le 1$ and $S = (1 + p + p^2 + \ldots + p^j)$,

$$S = \frac{1}{1-p}\ ,\ \pi_0 = (1 - p)$$

This provides $\pi_0 = p^j(1 - p)$ as the steady-state probability of state j.

With the steady-state probability of the system, the average number of customers in the system (L) can be represented by,

$$L = \sum_{j=0}^{\infty} j\pi_j = (1 - p) \sum_{j=0}^{\infty} jp^j \qquad (1)$$

Let $S = \sum_{j=0}^{\infty} = p + 2p^2 + 3p^3 + \ldots.$

Then $pS = p^2 + 2p^3 + 3p^4 + \ldots.$

By substracting them,

$$S - pS = p + p^2 + p^3 \ldots = \frac{p}{1-p}$$

$$S = \frac{p}{(1-p)^2} \qquad (2)$$

Substituting equation 2 to equation 1,

$$L = (1 - p)\frac{p}{(1-p)^2} = \frac{p}{1-p} = \frac{\lambda}{\mu - \lambda}$$

To calculate L_s, the number of customers in service should be identified at any given moment. There will be only one customer in service except for when there are no customers in the queuing system. Therefore, the formula can be written as,

$$L_s = 0\pi_0 + 1(\pi_1 + \pi_2 + \pi_3 + \ldots)$$

$$= 1 - \pi_0 = 1 - (1 - p) = p$$

Since, $L = L_q + L_s$,

$$L_q = \frac{p^2}{1-p}$$

Using Little's rule, the formulas for W, W_s, W_q can also be derived.

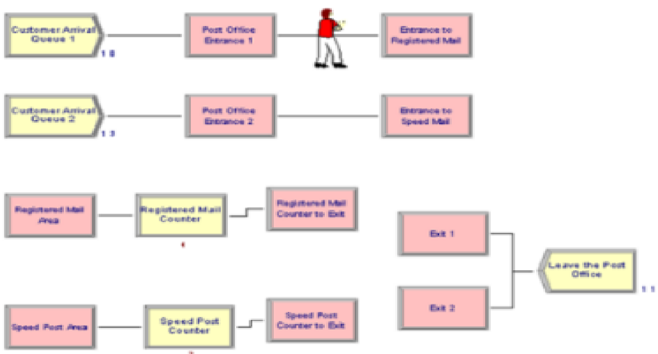
B. Survey Design

When observing the functionaries of a Post Office in Kurunegala district, it was found that two counters have more workload compared to other counters. Also, there were long waiting lines due to the heavy workload. Therefore, this study was done using those two counters of the Post Office. The registered mail counter and the speed post counter were the two observed counters of the Post Office. The study's sample size is 300, while the population is the customers who visit the Post Office. The population size was infinite, and queues were served on a First In First Out (FIFO) basis. The time period was considered as experienced by the post office functionaries.

Table 1. Identified Statistical Distributions

	Distribution	Expression
Customer Arrival Rate- Queue 1	Erlang	-0.001 + ERLA (22.3, 2)
Customer Arrival Rate- Queue 2	Erlang	-0.001 + ERLA (22.3, 2)
Service Rate (Counter 1)	Erlang	39 + ERLA (22.3, 2)
Service Rate (Counter 2)	Erlang	23 + ERLA (22.3, 2)

Source. Author's Calculations



Customer arrival time, service start time, and service end time were recorded as the data of the study. The inter-arrival time and the service time needed to build up the model were calculated using customer arrival time, service start time, and service end time. The data were recorded in seconds. The fitted statistical distributions for the inter-arrival rate and the service rate identified using the Arena Input Analyzer are shown in Table 01.

The identified statistical distributions were used as the input data of the model. The Rockwell ARENA software was used in modeling the study. The developed model was based on several assumptions, including the customer attaining each counter with equal probability, availability of identical counters, no work shifts between the workers, and no customer leaving the queue until the service is completed. Subsequently, the conceptual model of the post office was developed, as shown in Figure 01.

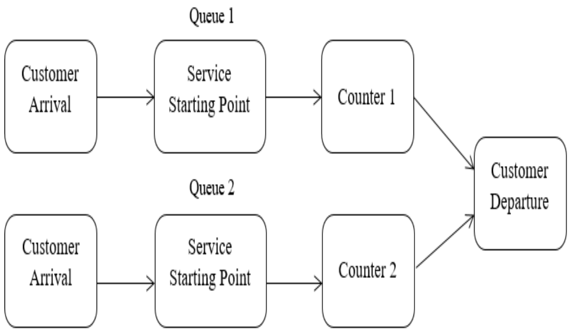


Figure 1. Conceptual Model for the Existing System

Source. Author's Calculations

III. DISCUSSION AND ANALYSIS

The results of the existing and proposed models are shown in Table 2. Observations suggested further

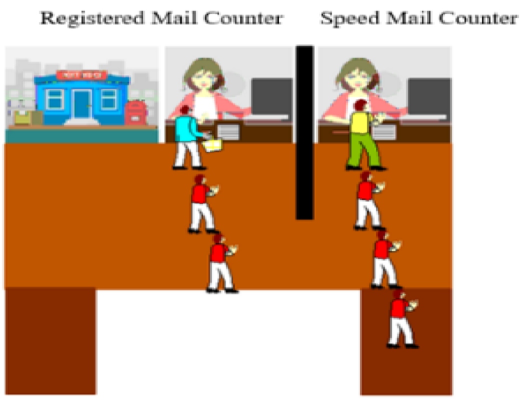


Figure 2. Animated ARENA Model for the Existing System

Source. Author's Calculations

developments for its optimal. The waiting time of the existing model was 19.03 minutes and 18.43 minutes for queue 1 and queue 2, respectively.

The study aimed to reduce the waiting time in queues. Accordingly, Model 01 and Model 03 of the proposed systems minimize customer waiting time compared to the existing system. Moreover, Proposed Model 01 and Model 03 reduced the number of waiting customers in queue 1 and queue 2 to 4 and 15, 6, and 2, respectively. However, in the Proposed Model 02, the waiting time and number waiting in queue 2 were reduced compared to the existing system and the other two proposed models while increasing the waiting time and number waiting in queue 1 considerably.

Table 2. Results of Existing and Modified Systems

	Existing Model		**Proposed Models**					
			Model 1		**Model 2**		**Model 3**	
Counter No:								
Waiting Time (min)	19.03	18.43	2.67	11.48	20.17	0.36	3.52	1.27
Number Waiting (min)	24.48	23.55	3.62	14.73	25.81	0.47	5.20	1.84
Number In	237		242		238		261	
Number Out	138		196		181		240	
Percentage of Customers Served	58.23		80.99		76.05		91.95	

Model 1 – Resources were doubled in registered mail counter (1)

Model 2 – Resources were doubled in speed post counter (2)

Model 3 – Resources were doubled in both counters

Source. Author's Calculations

This shows that when doubling the resources, the waiting time and number waiting decreases substantially in the respective counter.

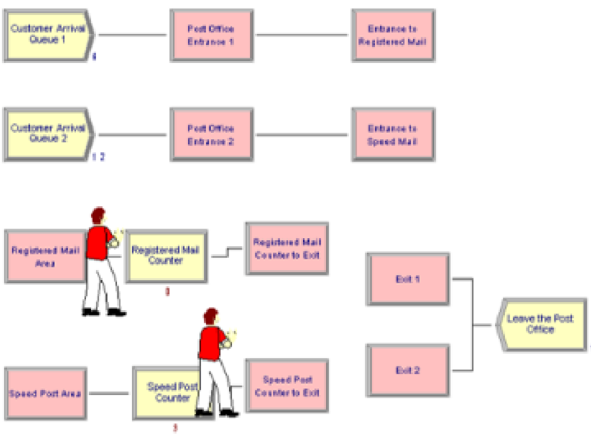


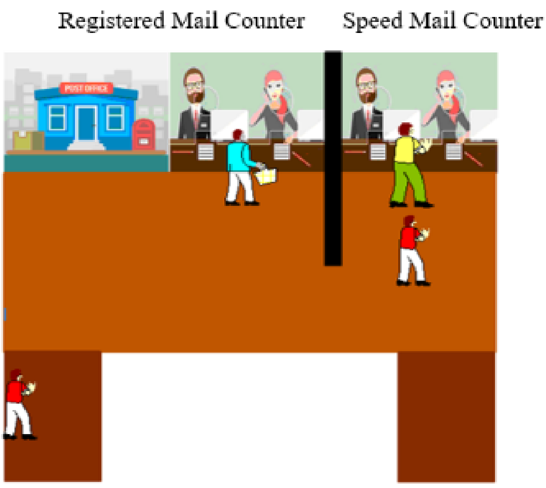
Figure 3. Animated ARENA Model for Proposed Model 03

Source. Author's Calculations

Moreover, it highlights that division of the workload among two staff members reduces the queue length of the two counters while increasing the system's overall performance. In addition, the customer served percentage of all the three proposed models was comparably higher than the existing model. However, this study aimed not to reduce the waiting time of one queue but for both queues in a counter.

IV. CONCLUSION

The study results concluded that the proposed Model 03 is the best-fitted model for the study requirements. Since the other two proposed models have high waiting times and number waiting atleast in one counter, compared to Model 03, Model 03 is the best-fitted model for the system. This adequate model displayed lower waiting time and number of waiting (queue size) in both counters. It decreased the waiting time in queue 01 and 02 to 3.52 and 1.27 minutes and decreased the number waiting in queue 01 and 02 to 6 and 2, respectively. Therefore, assigning two employees to each counter optimizes the process of the Post Office.



Limited time caused to collect only 300 amount of data. The data were collected only on two weekdays. Since analyzing more data increases the accuracy of the results, this can also be considered a limitation of the study.

REFERENCES

Achimsk K. (2019) Science Direct Simulation of Queuing System of Post Office Simulation of Queuing System of Post Office. 00.

Akhavian R. Behzadan AH, (2014) Evaluation of queuing systems for knowledge-based simulation of construction processes. Automation in Construction, 47, 37–49.

Al-Saleh KS. (2011) Productivity improvement of a motor vehicle inspection station using motion and time study techniques. Journal of King Saud University-Engineering Sciences, 23(1), 33-41.

Antoniol G. Cimitile A, Lucca GADi, Penta MDi, (2003) Assessing Staffing Needs for a Software Simulation. October, 1–36.

Chen CF. (2008) Investigating structural relationships between service quality, perceived value, satisfaction, and behavioral intentions for air passengers: Evidence from Taiwan. Transportation Research Part A: Policy and Practice, 42(4), 709-717.

Chou JS, Kim C. (2009) A structural equation analysis of the QSL relationship with passenger riding experience on high speed rail: An empirical study of Taiwan and Korea. Expert Systems with Applications, 36(3), 6945-6955.

Chung C. (2003) Simulation Modeling Hand Book: A Practical Approach, CRC Press.

Crew MA, Kleindorfe PR. (1992) The economics of postal service: a research study supported by WIK. Springer Science & Business Media.

Comas M, Castells X, Hoffmeister L, et al. (2008). Discrete-event simulation applied to analysis of waiting lists. evaluation of a prioritization system for cataract surgery. Value in health, 11(7), 1203-1213.

Elam J, Sviokla J. (1990) The Image Processing Project at USAA. Harvard Business School Case Study, (9), 190-155.

Jahn B, Theurl E, Siebert U, Pfeiffer KP. (2010) Tutorial in medical decision modeling incorporating waiting lines and queues using discrete event simulation. Value in Health, 13(4), 501-506.

Jun JB, Jacobson SH, Swisher JR. (1999) Application of discrete-event simulation in health care clinics: A survey. Journal of the operational research society, 50(2), 109-123.

Kelton WD, Sadowski RP, Sturrock DT. (2008) Simulation with Arena, 4th ed., The McGraw-Hill Companies, Incorporated, New York, NY.

Mohamed A. (2010) Modeling, simulation and identification.

Plesums CA, Bartels RW. (1990) Large-scale image systems: USAA case study. IBM systems journal,29(3), 343-355.

Profile SEE. (2020) Simulation of a Queuing System of a Post Office in Analogic Software Simulation Of A Queuing System Of A Post Office. May.

Sharifi S, Sajadi SM, Tavakoli MM. (2014) Simulation process of Isfahan post office using Arena. International Journal of Services and Operations Management, 17(1), 50-66.

Zalatar WF. (2012) Quantifying customers' gender effects on service quality perceptions of Philippine commercial banks. Procedia-Social and Behavioral Sciences, 57, 268-274.

Zare Mehrjardi Y, Hoboubati M, Safaee Nik F. (2011) Improvement of waiting time for patients referring to emergency room using discrete event simulation. SSU_Journals, 19(3), 302-312.

AUTHOR BIOGRAPHIES

MAN Perera is a final year undergraduate reading for the BSc (Special) degree in Industrial Management from Wayamba University of Sri Lanka and recently graduated with a Bachelor's in Information Technology (BIT) Degree (External) from UCSC of Colombo University of Sri Lanka. She was the Secretary of the IEEE Student Branch of Wayamba University of Sri Lanka for the 2019-2020 period. She is a volunteer, compere and an enthusiastic researcher.

BMAM Balasooriya is an instructor at Wayamba University of Sri Lanka, recently graduated with a BSc (Special) degree in Industrial Management from Wayamba University of Sri Lanka. She is also a researcher who has published several papers at international journals and conferences. She was the winner of Saman Kelegama Memorial Research Grant 2020 awarded by the Institute of Policy Studies of Sri Lanka.

ID 475