The Analysis of Queuing Theory Process for Customer Services Delivery: A Case Study of MUET Examination Department Jamshoro.

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Abstract

The application of Queuing models as technique of Queue solution in issuing the certificates like (pass certificates, marks certificates, transcript and Degree) in examination department MUET, Jamshoro. Specially this study attempts to look at the problem of long Queues in Examination department MUET Jamshoro. The variables measured include arrival rate (λ) and service rate. The were analyzed for the data of April 2017 to May 2018 and the efficiency in students satisfactory through the use of multichannel queuing models which were compare for a number of queue performance. It was discovered that using a 11- server channel system was better than a 9-serrver model,7-serrver model, 5-serrver model, 3-serrver model and 2-server model.

Keywords: students issuing certificates, multichannel Queuing Model, server efficiency, Queue Length, Queue Time.

Introduction

Queuing theory is a tool of mathematics which is used to analyze the probabilistic systems of customers and the servers.Queuing theory is also called as the theory of waiting line. Queuing theory is the branch of operational research that finds the connection between demand on a service system and the delays tolerated by the consumers of that system.

This is a branch of operations research because the conclusions can be utilized to make business decisions about the resources required to give service. This theory consists of many importantapplications, most of them are well-documented in the literature of probability, operations research, management science, and industrial engineering. Some instances are traffic flow (vehicles, aircraft, people, communications), scheduling (programs on a computer, jobs on machines, patients in hospitals), and facility design (banks, post offices, amusement parks, fast-food restaurants).

The situation of waiting line which are commonly experienced are; (i) cars waiting for green signal; (ii) students depositing fee at the counters; (iii) passengers waiting for bus/train; (iv) machines waiting for repairs; (v) work man waiting for tools. A group of people at some place to waiting for the service is known as queue.

In order to control the waiting time in the queue, the queuing theory can be implemented because the group of people do not like the wait of her/his to very notion of time loss, when the customers arrive too frequently they will have to wait for the service if they arrive the infrequently then the additional people arrives in the system the century ago A.K Erlang introduced the Queuing theory; A.K Erlang studied on telephone exchange congestion problem in the 20^{th} century. Nowadays the telephone exchange, traffic control, manufacture system, communication system, supermarket, patrol station, etc. use the queuing system. When an analyst has to design the performance of queuing system, then the queuing models prove to be as powerful tools. (A.H Hamdya, 2003).

Queuing theory based on probability concepts possible changes in its performance with modifications to the system. the mean system response time (waiting time in the queue plus service times), mean use of the service facility, distribution of the number of customers in the queue and in the system. Customers who are waiting for service is called queue discipline.

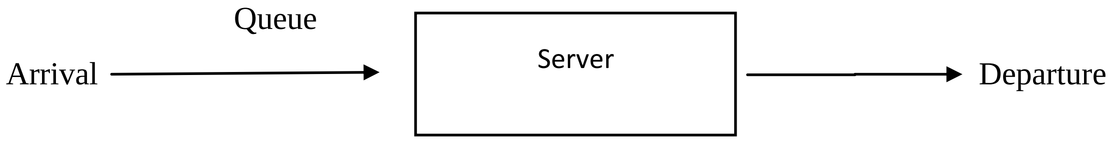
Queuing Discipline

(i) First in first out (FIFO)
(ii) Last in first out (LIFO)
(iii) Service in random order (SIRO)
(iv) Shortest processing time first (SPF)
(v) Service according to priority (PR)

Queuing Models:

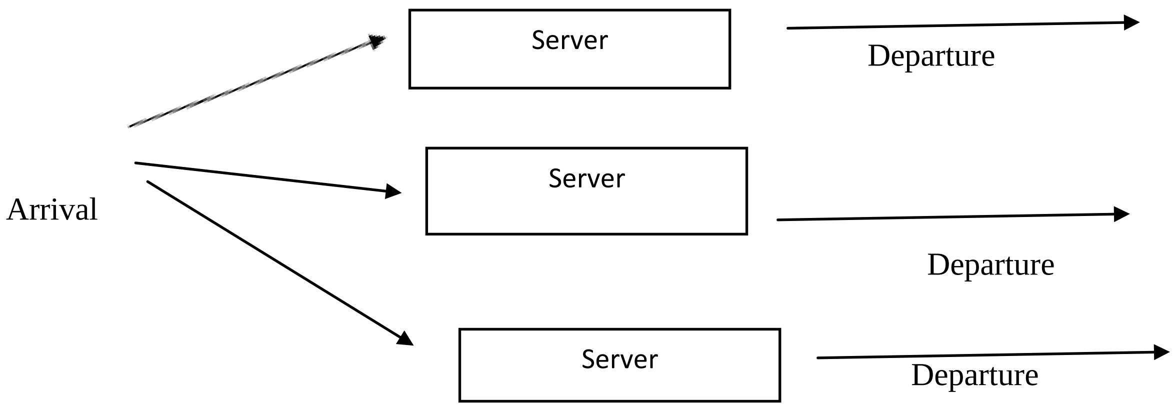
Some specific Waiting line models.

(1) Single-channel waiting line modelIn this model arrivals have single line and single server, Arrival are served on a first-in-first-out basis, every arrival waits to be served, service time vary from one customer to the next customer.



(2) Multiple-channels waiting line model

In this model arrival have single line and multiple channels, arrival is served on first come first served basis



(3) constant-service-time model

In this model service time is constant, when customers are processed according to a fixed cycle, as automatic car wash.

With the help of queuing models, we can change the behavior of queue and make a balanced between customers waiting time, and service capability and also their effect on the system.

Literature Review:

Cooray studied that the study of the sales checkout counter in supermarket checkout service and also the effectiveness of the models in term of utilization and queue length. in supermarket no anyone have to wait when servers in working (Cooray T.M.J.A, 2016).

I.M.Mankilik and H.N.Kana further studied that the mess system in Nigeria defense academy and analyzed the efficiency in mess system and also compare the six-channel is better than 4-channel,3-channel and 2-channel (I.M. Mankilik and H.N Kama, 2015).

Khalid Studied that the behavior and way of arrival of students in a university. They investigated student affairs department in many universities after investigating the result show that more than 70% students in university are unhappy. (M I Qureshi& Khalid Zaman, 2014)

Susila and Balambigai studied the analysis performance and staff planning in a telephone exchange and decide the various number of staffs achieve different management Queuing theory approach. (Susilamunisamy and Balambigai, 2007).

Rittu Mehandiratta studied on the heath care organization around the world and benefits required from the same. (Rittu Mehandiratta, 2011).

Ervin adi studied on the analysis of waiting time in fast food restaurants during the lunch time. (Ervin Adi,2012).

Tanzina studied on Bank ATM machine which is cannot provide the proper service to customers. than with help of queuing theory to solve this problem and maintain the customers' arrival and departure rate.(S.K. Dhar and Tanzina Rehman, 2013)

Methodology:

The present study is descriptive in nature. This study will be carried out on the process of student certificates similar to Mark sheet, Transcript and Degrees.

This data will be analyzed by queuing model *M/M/s* which involves a single-line with multiple servers in the system.

The condition for probability that a service channel is busy given by $\rho = \frac{\lambda}{M\mu} < 1$ where λmean arrival rate is, μ is mean service rate, M is the number of servers and ρ is called the service utilization factor that each server is busy. The totalservice rate must be greater than the arrival rate, that is $M\mu > \lambda$, and if $\lambda < M\mu$ the queue wouldeventually grow infinitely large.

M= number of servers
λ = Average arrival rate
μ =Average of departure rate at each server

(A) The possibility that there is no any customers in the system is

$$p_o = \frac{1}{\left(\left[\sum_{n=0}^{M-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n\right] + \frac{1}{M!}\left(\frac{\lambda}{\mu}\right)^M \frac{M\mu}{M\mu - \lambda}\right)} \quad \textbf{For } M\mu > \lambda$$

(B) The average number of customers in the system

$$L_s = \frac{\lambda\,\mu\left(\frac{\lambda}{\mu}\right)^M}{(M-1)!(M\mu-\lambda)^2}\,p_o + \frac{\lambda}{\mu}$$

(C) The average time a customer spends in the waiting line and being serviced is

$$W_s = \frac{\lambda\,\mu\left(\frac{\lambda}{\mu}\right)^M}{(M-1)!\,(M\mu-\lambda)^2}\,p_o + \frac{1}{\mu} = \frac{L_s}{\lambda}$$

(D) The average number of customers or units in line waiting for service is

$$L_q = L_s - \frac{\lambda}{\mu}$$

(E) The average time a customer spends in the queue waiting for service is

$$W_q = W_s - \frac{1}{\mu} = \frac{L_q}{\lambda}$$

Results and Discussion

This paper reviews a queuing model for multiple servers. The average queue length calculates by tora software at each hour. We have compared this average for six different model's **M/M/2, M/M3, M/M/5, M/M/7, M/M/9 and M/M/11,** used to estimate a queue length: a single-queue multi-server. The data was collected from the examination department MUET Jamshoro, it comprises the student's arrival date for issuing the certificates like Pass Certificates, Marks Certificates, Transcript and Degree.

Table 1 to Table 6 representing the Arrival rate(λ), Departure rate (µ), Service utilization factor (ρ), average no of students in system ($L_{s)}$, average no of students in Queue ($L_{q)}$, average time a student waiting in line ($W_{s)}$ and average time a student spends in queue ($W_{q)}$.

The examination department of MUET Jamshoro consist on M/M/11 model. (Table#6) indicating that the system is stable as compared to the other models. (Table#7) indicates that the maximum time spend by a customer in the queue is 16.559 for the model M/M/2. The result of our observation is that the queuing process of examination department MUET Jamshoro is 99.99% stable because no any student in queue.

Conclusion:

This paper has introduced the basic concepts of queuing models, and their application to student's arrival for getting certificates. Students facing problems especially during the time of getting the Degree. So both, students and staff of Examination department, face problems but in MUET the examination department is stable. For the smooth running of the system it is suggested during the months of April and May when the arrival rate increases which causes the work load and stress making the communication between staff and students so examination department can apply M/M/11 model in this situation to ease out the queue while during the other months when the work load is decrease or arrival rate is too short the M/M/7 model can be used to shift the surplus staff in any other departments.

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Table#01 **M/M/2 Model**

S:No	Arrival rate(λ)	Departure rate(μ)	Service utilization factor	Avg:no of students in system (L_s)	Avg:no of students in Queue (L_q)	Avg: time a student waiting in line (W_s)	Avg: time a student spends in queue (W_q)
April 2017	7.75000	7.69000	50.390%	1.35079	0.34299	0.17430	0.04426
May 2017	9.05000	8.88000	50.957%	1.37660	0.35745	0.15211	0.03950
June 2017	6.64000	6.32000	52.531%	1.45107	0.40043	0.21853	0.06031
July 2017	8.75000	8.16000	53.615%	1.50490	0.43260	0.17199	0.04944
August 2017	5.27000	4.57000	57.658%	1.72748	0.57430	0.32779	0.10898
September 2017	6.13000	5.20000	58.942%	1.80644	0.62759	0.29469	0.10238
October 2017	8.06000	7.17000	56.206%	1.64326	0.51913	0.20388	0.06441
November 2017	10.40000	7.25000	71.724%	2.95426	1.51977	0.28406	0.14613
December 2017	29.47000	22.80000	64.627%	2.21960	0.92705	0.07532	0.03146
January 2018	17.25000	11.93000	72.296%	3.02929	1.58335	0.17561	0.09179
February 2018	14.42000	8.07000	89.343%	8.85558	7.06871	0.61412	0.49020
March 2018	13.18000	7.11000	92.686%	13.15410	11.30037	0.99803	0.85739
April 2018	14.98000	7.61000	98.423%	62.91269	60.94423	4.19978	4.06837
May 2018	13.88000	6.97000	99.569%	231.83225	229.84086	16.70261	16.55914

Table#02 **M/M/3 Model**

S:No	Arrival rate(λ)	Departure rate(μ)	Service utilization factor	Avg:no of students in system (L_s)	Avg:no of students in Queue (L_q)	Avg: time a student waiting in line (W_s)	Avg: time a student spends in queue (W_q)
April 2017	7.75000	7.69000	33.59%	1.05468	0.04687	0.13609	0.00605
May 2017	9.05000	8.88000	33.97%	1.06814	0.04900	0.11803	0.00541
June 2017	6.64000	6.32000	35.02%	1.10592	0.05528	0.16655	0.00833
July 2017	8.75000	8.16000	35.743%	1.13226	0.05996	0.12940	0.00685
August 2017	5.27000	4.57000	38.44%	1.23335	0.08018	0.23403	0.01521
September 2017	6.13000	5.20000	39.29%	1.26645	0.08760	0.20660	0.01429
October 2017	8.06000	7.17000	37.47%	1.19651	0.07238	0.14845	0.00898
November 2017	10.40000	7.25000	47.81%	1.63054	0.19606	0.15678	0.01885
December 2017	29.47000	22.80000	43.08%	1.41985	0.12730	0.04818	0.00432
January 2018	17.25000	11.93000	48.19%	1.64866	0.20273	0.09557	0.01175
February 2018	14.42000	8.07000	59.56%	2.30114	0.51428	0.15958	0.03566
March 2018	13.18000	7.11000	61.79%	2.46504	0.61131	0.18703	0.04638
April 2018	14.98000	7.61000	65.61%	2.78854	0.82008	0.18615	0.05475
May 2018	13.88000	6.97000	66.37%	2.86094	0.86955	0.20612	0.06265

Table#03 **M/M/5 Model**

S:No	Arrival rate(λ)	Departure rate(μ)	Service utilization factor	Avg:no of students in system (L_s)	Avg:no of students in Queue (L_q)	Avg: time a student waiting in line (W_s)	Avg: time a student spends in queue (W_q)
April 2017	7.75000	7.69000	20.15%	1.00880	0.00100	0.13017	0.00013
May 2017	9.05000	8.88000	20.38%	1.02021	0.00106	0.11273	0.00022
June 2017	6.64000	6.32000	21.01%	1.05189	0.00126	0.15842	0.00019
July 2017	8.75000	8.16000	21.44%	1.07371	0.00140	0.12271	0.00016
August 2017	5.27000	4.57000	23.06%	1.15526	0.00209	0.21921	0.00040
September 2017	6.13000	5.20000	23.57%	1.18120	0.00235	0.19269	0.00038
October 2017	8.06000	7.17000	22.48%	1.12595	0.00182	0.13970	0.00023
November 2017	10.40000	7.25000	28.68%	1.44128	0.00679	0.13858	0.00065
December 2017	29.47000	22.80000	25.85%	1.29642	0.00388	0.04399	0.00013
January 2018	17.25000	11.93000	28.91%	1.45303	0.00709	0.08423	0.00041
February 2018	14.42000	8.07000	35.73%	1.80878	0.02191	0.12544	0.00152
March 2018	13.18000	7.11000	37.07%	1.88035	0.02662	0.14267	0.00202
April 2018	14.98000	7.61000	39.36%	2.00505	0.03659	0.13385	0.00244
May 2018	13.88000	6.97000	39.82%	2.03029	0.03890	0.14627	0.00280

Table#04 **M/M/7 Model**

S:No	Arrival rate(λ)	Departure rate(μ)	Service utilization factor	Avg:no of students in system (L_s)	Avg:no of students in Queue (L_q)	Avg: time a student waiting in line (W_s)	Avg: time a student spends in queue (W_q)
April 2017	7.75000	7.69000	14.39%	1.00782	0.00002	0.13004	0.00000
May 2017	9.05000	8.88000	14.55%	1.01916	0.00002	0.11261	0.00000
June 2017	6.64000	6.32000	15%	1.05065	0.00002	0.15823	0.00000
July 2017	8.75000	8.16000	15.31%	1.07233	0.00002	0.12255	0.00000
August 2017	5.27000	4.57000	16.47%	1.15321	0.00004	0.21883	0.00001
September 2017	6.13000	5.20000	16.84%	1.17889	0.00005	0.19232	0.00001
October 2017	8.06000	7.17000	16.05%	1.12416	0.00003	0.13947	0.00000
November 2017	10.40000	7.25000	20.49%	1.43467	0.00019	0.13795	0.00002
December 2017	29.47000	22.80000	18.46%	1.29264	0.00009	0.04386	0.00000
January 2018	17.25000	11.93000	20.65%	1.44614	0.00020	0.08383	0.00001
February 2018	14.42000	8.07000	25.52%	1.78775	0.00089	0.12398	0.00006
March 2018	13.18000	7.11000	20.48%	1.85487	0.00115	0.14073	0.00009
April 2018	14.98000	7.61000	28.12%	1.97019	0.00173	0.13152	0.00012
May 2018	13.88000	6.97000	28.44%	1.99326	0.00187	0.14361	0.00013

Table#5 **M/M/9 M0del**

S:No	Arrival rate(λ)	Departure rate(μ)	Service utilization factor	Avg:no of students in system (L_s)	Avg:no of students in Queue (L_q)	Avg: time a student waiting in line (W_s)	Avg: time a student spends in queue (W_q)
April 2017	7.75000	7.69000	11.19%	1.00780	0.00000	0.13004	0.00000
May 2017	9.05000	8.88000	11.32%	1.01914	0.00000	0.11261	0.00000
June 2017	6.64000	6.32000	11.67%	1.05063	0.00000	0.15823	0.00000
July 2017	8.75000	8.16000	11.91%	1.07230	0.00000	0.12255	0.00000
August 2017	5.27000	4.57000	12.81%	1.15317	0.00000	0.21882	0.00000
September 2017	6.13000	5.20000	13.09%	1.17885	0.00000	0.19231	0.00000
October 2017	8.06000	7.17000	12.49%	1.12413	0.00000	0.13947	0.00000
November 2017	10.40000	7.25000	15.93%	1.43449	0.00000	0.13793	0.00000
December 2017	29.47000	22.80000	14.36%	1.29254	0.00000	0.04386	0.00000
January 2018	17.25000	11.93000	16.06%	1.44594	0.00000	0.08382	0.00000
February 2018	14.42000	8.07000	19.85%	1.78689	0.00003	0.12392	0.00000
March 2018	13.18000	7.11000	20.59%	1.85376	0.00004	0.14065	0.00000
April 2018	14.98000	7.61000	21.87%	1.96852	0.00006	0.13141	0.00000
May 2018	13.88000	6.97000	22.12%	1.99146	0.00007	0.14348	0.00000

Table#06 **M/M/11**

S:No	Arrival rate(λ)	Departure rate(μ)	Service utilization factor	Avg:no of students in system (L_s)	Avg:no of students in Queue (L_q)	Avg: time a student waiting in line (W_s)	Avg: time a student spends in queue (W_q)
April 2017	7.75000	7.69000	9.16%	1.00780	0.00000	0.13004	0.00000
May 2017	9.05000	8.88000	9.26%	1.01914	0.00000	0.11261	0.00000
June 2017	6.64000	6.32000	9.55%	1.05063	0.00000	0.15823	0.00000
July 2017	8.75000	8.16000	9.74%	1.07230	0.00000	0.12255	0.00000
August 2017	5.27000	4.57000	10.48%	1.15317	0.00000	0.21882	0.00000
September 2017	6.13000	5.20000	10.71%	1.17885	0.00000	0.19231	0.00000
October 2017	8.06000	7.17000	10.21%	1.12413	0.00000	0.13947	0.00000
November 2017	10.40000	7.25000	13.04%	1.43448	0.00000	0.13793	0.00000
December 2017	29.47000	22.80000	11.75%	1.29254	0.00000	0.04386	0.00000
January 2018	17.25000	11.93000	13.14%	1.44593	0.00000	0.08382	0.00000
February 2018	14.42000	8.07000	16.24%	1.78686	0.00000	0.12392	0.00000
March 2018	13.18000	7.11000	16.85%	1.85373	0.00000	0.14065	0.00000
April 2018	14.98000	7.61000	17.89%	1.96846	0.00000	0.13141	0.00000
May 2018	13.88000	6.97000	18.10%	1.99139	0.00000	0.14347	0.00000

Table #07 Maximum and Minimum average time spends in queue for the six models.

MODEL	MAXIMUM TIME IN QUEUE		MINIMUM TIME IN QUEUE	
	Wq	Month	Wq	Month
M/M/2	16.55914	May	0.03146	December
M/M/3	0.06265	May	0.00432	December
M/M/5	0.0028	May	0.00013	December
M/M/7	0.00013	May	0.0000	December
M/M/9	0.0000	May	0.0000	December
M/M/11	0.0000	May	0.0000	December

References:

[1] Priyangika, J. S. K. C., &Cooray, T. M. J. A. (2016). Analysis of the Sales Checkout Operation in Supermarket Using Queuing Theory.*Universal Journal of Management*, *4*(7), 393-396.
[2] *Kaduna State, Nigeria 2015*, Application of queuing theory in cadet mess administration:A case study of Nigerian defense academy,Academy Journal of Science and Engineering 9 (1), 2015
[3] Chinwuko, E. C. E., & Daniel, E. C. (2014). Analysis of a queuing system in an organization (a case study of First Bank PLC, Nigeria).*American Journal of Engineering Research*, *3*(2).
[4] Yang, S., & Yang, X. (2014). The Application of the Queuing Theory in the Traffic Flow of Intersection.*International Journal of Mathematical, Computional, Physic, Electrical and Computer Engineering*, *8*(6).
[5] Qureshi, M. I., Bhatti, M., Khan, A., &Zaman, K. (2014). Measuring queuing system and time standards: A case study of student affairs in universities.*African Journal of Business Management*, *8*(2), 80.
[6] A. H. Taha,Operations Research: AnIntroduction, 8thEd. (Prentice Hall, India, 2003)
[7] Bakari, C., Chamalwa, H., & Baba, A. (2014). Queuing process and its application to customer service delivery (A case study of Fidelity Bank Plc, Maiduguri). *International Journal of Mathematics and Statistics Invention (IJMSI)*, *2*(1), 14-21.
[8] Dharmawirya, M., &Adi, E. (2011). Case study for restaurant queuing model.
[9] Temple, T. T. Round Table The Pilgrim's Progress: Operations Research in Queuing G Raghuram G Raghuram is Professor, Public Systems, at the Indian Institute of Management Ahmadabad.
[10] Nafees, A. (2007). Queuing Theory and Its Application: Analysis of the Sales Checkout Operation in ICA Supermarket‖. *Department of Economics and Society University of Dalarna*.
[11] Kabir, M. R. Solving Of Waiting Lines Models in the Bank Using Queuing Theory Model the Practice Case: Islami Bank Bangladesh Limited, Chawkbazar Branch, Chittagong.