International Journal of
Science and Engineering Investigations vol. 10, issue 113, June 2021
Received on June 8, 2021 ISSN: 2251-8843

Improving the Performance of Reception and OPD by Using Multi-Server Queuing Model in Covid-19 Pandemic

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***Abstract*-**In Pakistan two sorts of healthcare facilities are offered i.e. private and public. Individuals who come from rural areas cannot afford the private healthcare because it is too pricey for them. At this point it is responsibility of the government to provide the health care service to them. Overcrowding scenario is observed to greater extent at the hospitals every day. Outpatients are delayed at the general public healthcare systems long before they are served by medical personnel. The queue is the major problem and that can be undoubtedly recognized that it results from poor management of queuing systems. Hereof, this research has been performed to bring the optimality in the service of patients. The objective of this research paper was to evaluate the performance of current queuing system plus propose the means to its optimum service level. The data was accumulated from the reception and OPD of the ABC public the hospital of Hyderabad. Data consisted of, the arrival times, service times of patients plus number of doctors and receptionist at the workplace in addition to their wages. Additionally, the waiting cost of outpatients was additionally gathered. Input evaluation of patients 'arrivals and service was performed by utilizing the input analyzer of Rockwell Arena software. Performance measures of mutli-server queuing model were computed in TORA optimization software. Costs of queuing system (service cost, waiting cost and total cost) were determined in MS Excel and the needed charts were likewise plotted in MS Excel. After the evaluation of the efficiency measures of the reception plus OPD, it was revealed that one more front desk staff and one doctor should be hired to bring optimality in the queuing system plus outpatients' flow. After this decision, waiting cost of outpatients lowered to higher level. It was suggested that this research study can be extended by including the time spent by the outpatients on the road to healthcare facility to ensure that the time cost can be computed in all ways. This research study was only carried out on the medical OPD; it can additionally be conducted in all the OPDs of hospital in order to improve the healthcare delivery at public healthcare. The seasonal analysis of queuing system of the OPDs can also be carried out.

Keywords- *Covid-19, Waiting Line, Multi-server Queuing Model, Pandemic, Public Hospital, Over Crowdedness, OPD*

I. INTRODUCTION

These days, the whole world is dealing with serious and very big health condition in the form of COVID pandemic [1]. The health sector is considered as one of the most important sectors in the service field due to its direct relationship with human health and life especially in this pandemic [2].These days, the biggest dilemma of hospitals is the over crowdedness of patients at the outpatient department (OPD), its corresponding receptions, emergency departments (EDs) and intensive care units. Waiting line is typical happening in our day to day lives [3]–[8]for example at the healthcare centers. When the number of doctors is less than that of patients then this scenario, yields the origination of queue or waiting line. EDs and OPDs are the most visited departments at any healthcare facility. It is also the very first meeting of the patients and the staff of the hospital when they go to consult with the doctor [9]. One of the most addressed issue that the patients face at the hospitals is long waiting lines. Even some of patients die while waiting to be seen by the doctor. Outpatient and emergency department play significant role in the healthcare delivery systems (HCDS). In the past decade, stress is put on the EDs in the developed countries in the context of congestion and its impact on the service delivery; thus, capacity of hospital to meet the demand was focused accordingly [10]. Because of non-rigid integration between the customer service and various operating departments at any healthcare facility, capacity planning of the specific department can be made complex in terms of fulfillment of service demand [11].In operations research, there are number of tools and techniques in order to solve the daily life problems [12]. The

reasonable approach or concept to resolve these kind of problems, queuing theory is one of the known approaches [13].

Queuing concept was formulated by the famous Danish telephone engineer Agner Krarup Erlang in 1913 [14],[15],[16]–[19]. Erlang was the first researchers in that era who solved the dilemma of congestion at the telephone exchange [7]. The essential aspects in the queuing theory include: number of people getting served, their service mechanism at the hospital, their waiting times in the queue and in the system at the various levels of service [20]. When the patients are asked or supposed to wait at the healthcare facility, the certain amount of cost is associated with that waiting and that cost is termed as waiting cost/opportunity cost [3]. Therefore, the patients at the hospitals or in any setting should be served in a manner so that the opportunity cost should be optimum. In order to solve these kinds of problems, queuing theory is the best option. In queuing theory, the waiting times, service times, optimum service level are calculated simultaneously [19]. This theory is known for enumerating the waiting lines` phenomenon by the calculation of performance measures i.e. average length of queue, average waiting time in the queue and the system and average utilization factor [17].

Queuing models are made use of to study queue methodically[21]–[24]. Because of managing the jammed circumstances, queuing concept is likewise known as the theory of overcrowding [17]. It is widely made use of in service companies for waiting lines to be analyzed as well as their procedures to be designed [13]. In recent times it has been the teething problem in health care solutions [25]. It is called for to raise the consumer endorsement by lowering the queue and making service distribution effective [26]. Hold-up is the distinction in between solution need and also the readily available capacity to meet the need [18]. Long waiting experience of the customers in the queue generally have unfavorable effect on the complete satisfaction of the person [5]. Due to the long queues doctors are propounded tension and also they attempt to get the customers totally free without detailed evaluation, which causes frustration of clients [5],[8], [27], [28]. Which incurs cost to organizations, which is called as expense of client discontentment [3], [6]. Poor health services are working as challenges against the overall advancement of Pakistan [29]. In this regard, the objective of this term paper was to evaluate the performance of current queuing system and suggest the means to its maximum service degree.

II. LITERATURE REVIEW

Public medical care system in Pakistan is large as well as dispersed and also is given in access to individuals with skilled medical professionals, personnel and also medicines; but there was the problem of unavailability medicines as well as medical professionals[22]. It was reasoned in the study that these both troubles were due to managerial constraints not due to economic restrictions [30]. An empirical study carried out to reveal the troubles dealt with by the patients in public health treatment healthcare facilities. Study showed that 36.4% individuals were poor who visited the healthcare facility, 41.8% sick people reported that staff is distressed towards the patients; furthermore, 72.7% respondents had common point of view that poor subjects are not well dealt with, whereas, 96.4% of subjects reported concerning the preference of physicians to relatives and also well-known individuals [31]. One more research was performed on public market hospitals of Pakistan, as well as it was exposed that mostly poor individuals paid a visit to the general public hospital for their health issues and also they encountered wide array of problems there in regards to therapy and also adeptness. The picture of public healthcare service delivery represents an even circulation of resources in between urban and country area. The poor in the backwoods go to evident downside in the context of key and also tertiary public healthcare facilities and they also fail to capitalize on immunization of their kids from the public programs [32]. Due to poor health services customers especially youngsters as well as ladies are suffering a lot. It be seen in the table 1 that the health indicators are badly lowering; after the period of twenty years, baby mortality is lowered from 95/1000 lives to 60/1000 lives. Exact same case is with the maternal mortality rate, it has lowered from 490 -260 lives per 100,000 lives. Kids` death under 5 years is reduced from 122-74 in twenty years.

It was suggested in the research that the Authorities ought to focus on healthcare in terms of appropriate medical tools as well as infrastructure keep check and also equilibrium, by doing this the issues can be reduced [33]. The personnel for health care are gradually boosting in Pakistan year by year. As reported by International Finance Corporation (IFC) in its article of 2011 that, 5000 medical graduates are generated by various universities as well as colleges. The present ratio of medical professional to individual is 1:1,183, which is rather below than the common suggested by World Health Organization (WHO) i.e. 1:1000 [34]. The requirement of clinical personnel i.e. physicians almost full; it is quite near to the common suggested by World Health and wellness Organization. Now, dynamic leadership and also governance is required desperately for creating and also imposing evidence-based policies, programs and the means to deal with the system [35]. Besides, above discussed problems the subjects in the public industry healthcare facilities face too many issues and delay is one of those significant issues. Customers wait too long in order to get offered in medical facilities, it's a prospective danger to health care services as well as is observed to a raising extent [36]. Health care sector is dealing with the issue of delays. Everybody await a visit relating to wellness issue at hospitals and after showing up the facility we are meant to wait even more to see the doctor. Delay is not unusual in hospitals, we always locate many people waiting for at different stages in the medical facilities i.e. individuals waiting on surgery, Analysis tests, OPDs, Emergencies etc. [37]. Hospitals are referred to as complex systems which are consisted of with some societal advantages and also bulk incurred prices. Those expenses are made to be sustained extra due to inefficacies of processes which take place because of congestion as well as hold-ups in the individuals` treatment systems. Literary works shows that forecast of degree of congestion and required capacity is difficult to be figured out without the help of queuing versions [37]. Consequently, in order to examine and also enhance individuals circulation, it is

suitable to check out the facility with the lens queuing network [38]. Queuing versions are needed to be placed in a little data as well as results can be computed by the assistance of straightforward formulae in regards to performance procedures; this is a much easier method to determine the maximum solutions as opposed to approximating the performance of the system in the supplied context [37]. Queuing theory was established by popular Danish telephone designer Agne Krarup Erlang in 1913 in order to figure out the capacity needs of the Danish telephone system [37][14],[15],[16]–[19]. He was the initial scientist in 20th century who dealt with the crowdedness trouble in the context of telephone exchange [7]. Ibrahim Ahmed and Abdelgadir (2021) conducted their research by applying the queuing models for the resolution of waiting line problems during Covid-19 pandemic at Al-Hikma hospital [2].

III. PROBLEM STATEMENT

This research is based upon the analysis of the queuing system of out-patient division (OPD) of public Hospital of Kotri. Patients have to wait prior to obtaining served. Because of the higher work, doctors may not be able to check out all the subjects properly. Subjects as well as doctors both are under stress and anxiety due to waiting on long in the OPD waiting area and also much heavier workloads respectively. It is needed to evaluate the present queuing system in the OPD. On the exact same time the actions of the patients/customers will be taken so that the influence of long waiting lines on the total satisfaction of outpatients can be measured.

IV. RESEARCH GAP

Number of researchers has worked on the optimization of queuing system and their work has been classified in terms of decision variable in table 1. A look at the table 1 indicates the clear understanding the research gap of present research work.

TABLE I. CONTRIBUTION TABLE FOR FINDING RESEARCH GAP

Author	MWTP	NRRDSS	BC	UR	TCWCSCH	OSND
[6]	X					
[39]	X					
[40]		X				
[41]	X					
[42]			X			
[11]	X					
[43]				X		
[9]	X					
[24]						X
Present Research					X	

MWTP = Minimization of Waiting time of patients
NRRDSS = Number of resources required at the different stages of service
BC = Bed Occupancy
UR = Utilization of resources
TCRPHD = Total cost, revenue and profit of the hospital and the doctor
TCWCSCH: total cost, waiting cost and service cost of the hospital

V. RESEARCH OBJECTIVES

The purpose of this research paper was to analyze the performance of current queuing system and suggest the way to its optimum service level in this Covid-19 pandemic.

- To analyze the performance of existing queuing system
- To suggest the increase or decrease (optimum) in the resources available at the current queuing system

VI. RESEARCH METHODOLOGY

A. Data Collection

The current data is gathered data from the OPD of the case medical facility in 2 actions. The first step was to collect the data from reception. Data included variables like arrival rate, service rate and wage of the front desk staff. 2nd step was to gather the data from OPD and the variables consisted of service times of the different customers concerning see different physicians sitting at the OPD. At the same time, the salary of appointed medical doctors and waiting cost of the patients were additionally gathered.

1) Service Cost

Incomes per hour of the numerous physicians operating at the OPD were accumulated as presented in the form of chart in figure 1. And after the estimation, it was shown that the average salary per hour at the OPD was Rs.614.60. In addition, income of receptionist was computed as Rs.155.56 per hour.

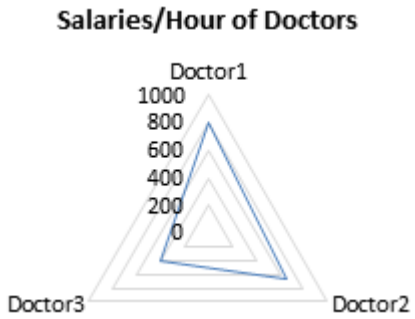


Figure 1. Doctors` service cost at the OPD of case hospital

2) Waiting Cost

The patients come from 14 different occupations/professions. Their waiting cost was collected and computed in MS Excel and it was outlined in bar chart as presented in figure 2. The typical waiting cost of the getting here patients was calculated as 185.2941/hour.

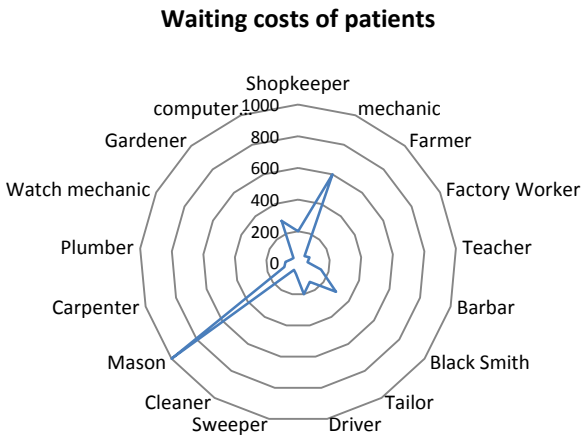


Figure 2. Waiting cost of patients arriving at civil hospital Hyderabad

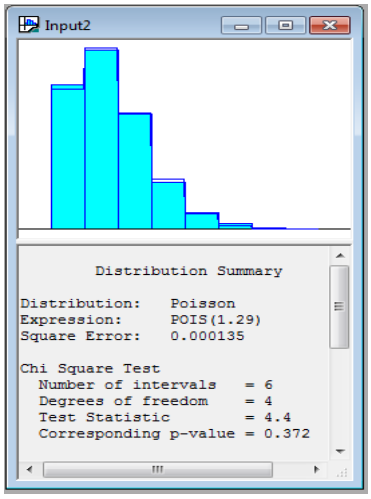


Figure 3. Distribution fit for the arrival of patient

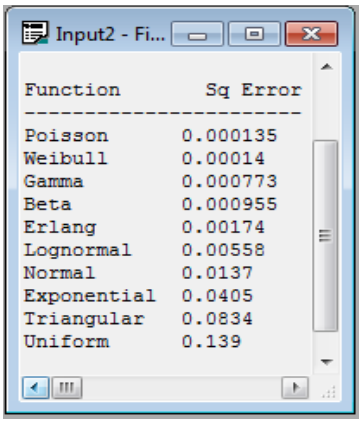


Figure 4. Summaries of square error of various Applied distribution functions

B. Data Analysis

Data analysis included the input evaluation of the collected data. The data was taken into the Rockwell Arena software in order to expose its distribution. When it was validated that arrival and service distribution of people followed the poison and exponential distribution respectively, then the ordinary arrival and service rate were put into TORA optimization software in addition to the variety of doctors. Performance measures were determined by the assistance of TORA optimization software application. In last the acquired performance measures were taken into MS succeed for estimation of cost and outlining graphs.

1) Model Assumptions

When the number of customers/patients goes beyond the quantity of physicians then the queue is created and multi-server queuing model is made use of in such situations to calculate the number of physicians to be assigned. Presumptions of multi-server queuing model are discussed listed below;

- The inter arrival times of patients should follow the poison distribution
- Service of patients should be exponentially distributed
- It was also assumed that all the doctors were operating at the same capacity

Agyei W., Asare-darko C. and Odilon F. 2015 also confirmed the poison arrival and exponential service in their research paper [6]. Kembe et al. 2012 did the same in their research before the calculation of performance measures [3].

2) Arrival Distribution

According to the assumptions of the multi-server queuing model that arrival of people should comply with the poison distribution; in this regard, the input analysis of arrival of people was conducted and it was suggested that arrival of patients adhered to the poison distribution (POIS (1.73)) as shown by figure 3 and 4 specifically.

3) Queue Discipline

The method through which awaiting clients are provided services to in the queuing system is called queuing discipline[14][28]. It deserves discovering that the particular discipline picked will have a terrific impact on the waiting time of the customers in the system [44]. In first come first-served (FCFS) technique, no preference is embedded in this discipline apart from serving those clients that are showing up in the system early. The application of this technique located to be mostly used service systems [28], due to its adequate justness. Last-come, first-served (LCFS) is one more queuing technique; in this technique, the people/ consumer get in the last time in the system and those customers are supposed to be served at the first preference. This technique is normally adhered to in the emergency situation and ICU (intensive care unit). There are other queuing techniques additionally i.e. service in random order (SIRO); in which the customers are provided services to randomly.

4) Service Distribution

Customers were being served at 2 stages i.e. when the people were getting themselves signed up at the reception and

when they go to see the doctor. The data for both phases was collected and its input analysis was additionally conducted.

a) Reception

As per second assumption of the multi-server queuing model, the service times of patients should be exponentially distributed. In this regard, the input analysis was conducted and it was revealed that the distribution of service times of patients being served at the reception were exponentially distributed (EXPO (0.45)) as presented in the figure 5 and 6.

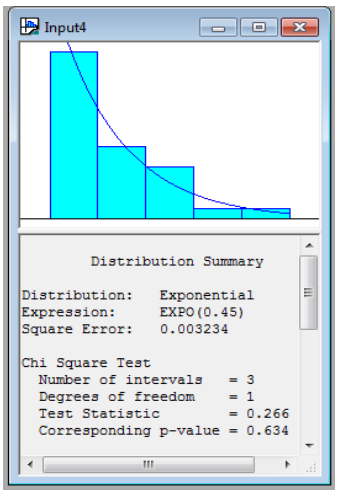


Figure 5. Distribution fit for the service of patients by the doctors

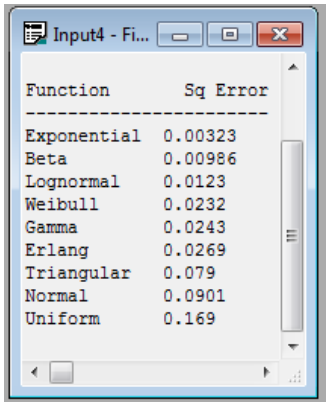


Figure 6. Summaries of square error of various Applied distribution functions

b) Service Distribution of Doctors

According to assumption of the multi-server queuing model, the service times of patients should be exponentially distributed. In this regard, the input analysis was conducted and it was revealed that the distribution of service times of patients being served at the reception were exponentially distributed (EXPO (2.8)) as presented in the figure 7 and 8.

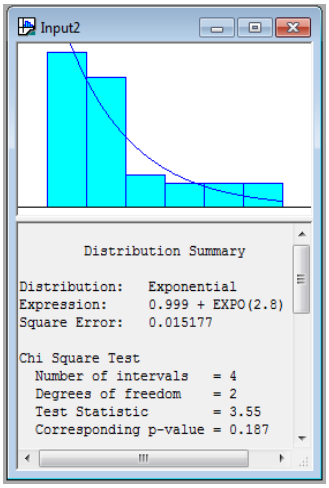


Figure 7. Distribution fit for the service of patients by the doctors

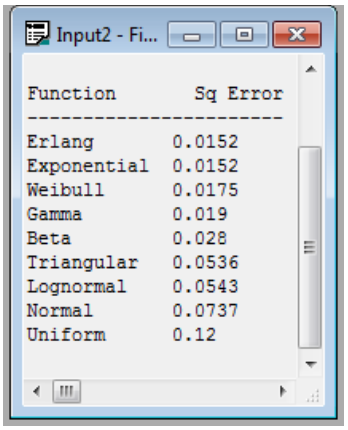


Figure 8. Summaries of square error for each Distribution fuction

5) Software

Three software applications were made use of in the present research paper at three different phases of the evaluation. Initially, MS excel was utilized for the data access and estimation of ordinary arrival and service rate. The entered data was then put into Rockwell Arena software program for the input evaluation of the data (arrival and service times) to ensure that the distribution of data could be exposed. In 3rd step the data was then put into the TORA optimization software program for the estimation of performance measures of multi-server queuing model. The performance measures were then taken into MS Excel for the plotting the graphs and cost calculations based on formulae presented in 6.3.

C. Formulae and Equations

The formulae by which the various costs were calculated are presented under this heading.

1) Notations

n = Number of doctors
Sa = Average salary of doctors

Wa = Average waiting cost
p = Number of patients
Sc = Estimated service cost
Wc = Estimated waiting cost
Tc = Estimated total system cost

$$Sc = nx(Sa) \quad (1)$$

$$Wc = (pxWs)Wa \quad (2)$$

$$Tc = Wc+Sc \quad (3)$$

D. Performance Measures of the Queuing System

Calculations of queuing system are represented some notations and they are known as performance measures. Definition of each of the performance measure is presented in below given table as adopted from Khaskheli S.A, 2018.

TABLE II. DESCRIPTION OF THE PERFORMANCE MEASURES OF THE QUEUING SYSTEM AS ADOPTED FROM KHASKHELI S.A. [45] (P. 13)

Symbol	Definition
μ	Service rate: Number of patients served per unit time
λ	Arrival rate: Rate at which the patients are served at the facility
S	Number of servers: Number of available service channels e.g. receptionists, nurses and doctors
n	Number of patients
P_o	Probability of the system to remain idle: This performance measure calculates the probability of the system that it gets free from the customers at the particular time period.
Lq	Number of patients in the queue: This performance measure calculates the number of awaiting patients customers/patients in the queues following doctors
Ls	Number of the patients in the system: This performance measure calculates the 'number of patients in the queue + number patients currently served by the doctor'
Wq	Time spent by patient in the queue: This performance measure calculates the amount of time the patient wait in the queue in order to see the doctor
Ws	Time spent by the patients in the system: This performance measure is the sum of 'waiting time of patients in the queue + service time of patients by the server'

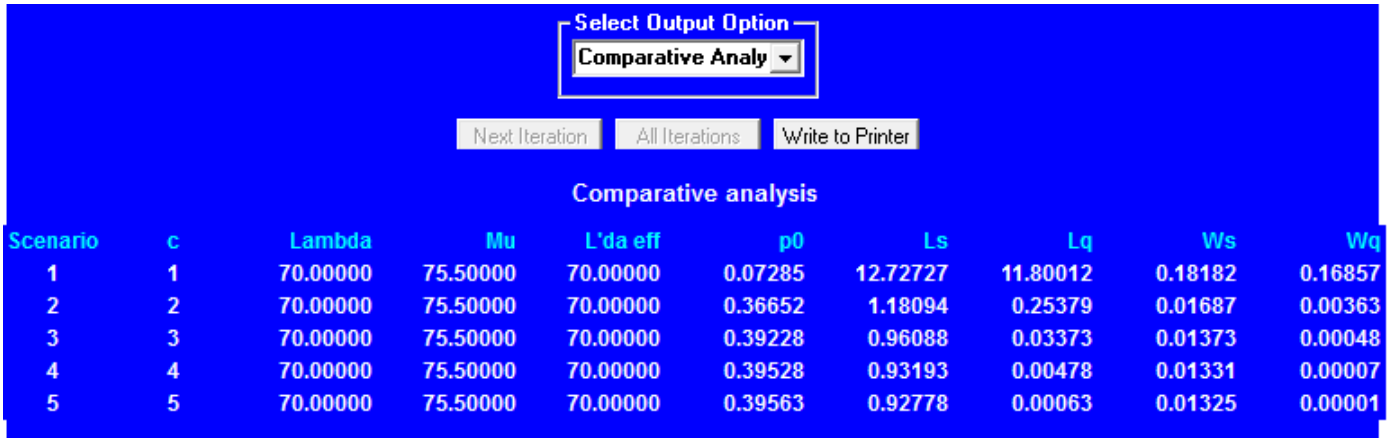
VII. RESULT AND DISCUSSIONS

In the present research paper, two queuing systems were analyzed i.e. reception and OPD. Thus, the results are split into two sections; in each section, the performance measures of the each queuing system are presented and elaborated.

A. Performance measures of the queuing system of Reception

Good health of the people is essential in order to develop and improve the economic state of country [22]. The top most objective of healthcare services is to improve the health of population [46]. Health care delivery system (HCDS) is the response of society to those activities and practices which determine health [22]. HCDS is the integration of people, agencies, organizations and numerous resources by the help of which it renders its services to the public [35], [47]. Number of frameworks are available which are used for the analysis of patients flow at the emergency departments; they are also used for the calculation of variables i.e. patients waiting times and service times; moreover, they also provide numerous other tools to analyze the factors having influence on the mentioned variables [48]. Among those frameworks, queuing theory is a famous concept to deal with solution of waiting line problems. Small piece of data is needed to be entered in queuing models and they gives their output in the form of performance measures and in the calculated result one optimal solution exist [37].

Only three inputs (arrival rate (lambda), service rate (Mu) and number of resources available (c)) are required for the calculation of performance measures in single phase multi-server queuing model. The mentioned details were put into the TORA optimization software along with the existing number of resources (receptionist) at the workplace. The analysis was conducted in five scenarios. The evaluation of current situation of the queuing system of reception indicated that the probability of the reception to be idle (p0) was 7.2%; number of patients at the reception (Ls) and reception queue (Lq) were calculated to be 12.72 and 11.80 respectively (see figure 9). Moreover, the time spent by the patients at the reception and in reception queue was calculated to be 0.18182 hours and 0.16857 hours respectively.



Scenario	c	Lambda	Mu	L'da eff	p0	Ls	Lq	Ws	Wq
1	1	70.00000	75.50000	70.00000	0.07285	12.72727	11.80012	0.18182	0.16857
2	2	70.00000	75.50000	70.00000	0.36652	1.18094	0.25379	0.01687	0.00363
3	3	70.00000	75.50000	70.00000	0.39228	0.96088	0.03373	0.01373	0.00048
4	4	70.00000	75.50000	70.00000	0.39528	0.93193	0.00478	0.01331	0.00007
5	5	70.00000	75.50000	70.00000	0.39563	0.92778	0.00063	0.01325	0.00001

Figure 9. Calculation of performance measures of the reception of OPD of case hospital

If one receptionist is supposed to be added in the first scenario the probability of the reception to remain idle increases 7.2% to 36.65% (see figure 9 and 10); number of patients at the reception and in the reception queue were calculated to be 1.18 and 0.25 respectively.

Systems which possess less capacity than demand, there exists an element of delay [18]. When patients wait for too long at the healthcare facility, it causes the customer dissatisfaction [5]. Therefore, the waiting time of patients to see the doctors should be decreased by process simplification; moreover, patients should be guided by the use of signboards for at the main locations of healthcare facility [46].

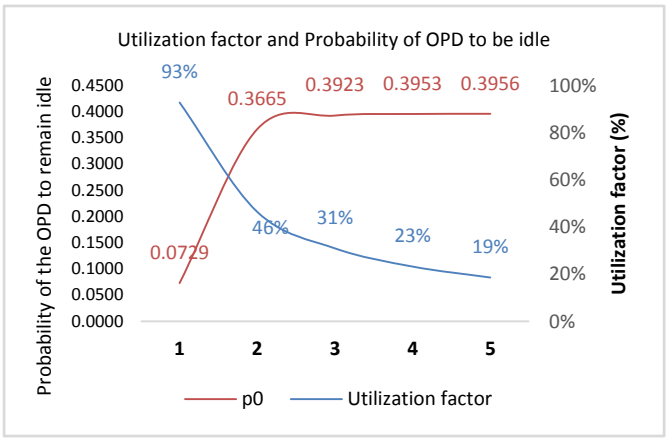


Figure 10. Utilization factor and the probability of the reception to remain idle

Furthermore, time spent by the patients at the reception and reception queue were calculated to be 0.0168 hours and 0.00363 hours respectively as shown in the figure 9.

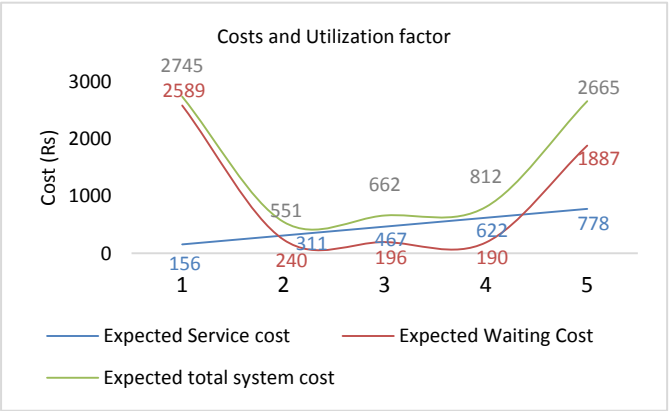


Figure 11. Costs of the queuing system of the reception

The costs of the queuing system were calculated in MS Excel and are presented in line chart given in figure 11. In first scenario, the expected service cost, waiting cost and total system cost were calculated to be Rs.156, Rs.2589 and Rs.2745 respectively. When only one receptionist is supposed to be increased the waiting cost decreases from Rs.2589 to Rs.311 as presented in the figure 11. Similarly, the total system cost also once decreases and then increases at one point (in second scenario); in this case, it is optimal decision to increase one reception at the OPD.

Kembe et al., 2012 used multi-server queuing model to calculate the optimum number of doctors at Riverside hospital; the number of existing doctors was 10; they calculated performance measures and cost analysis and the analysis revealed that 2 more doctors should be hired; by the mentioned decision, the system utilization came down from 86.6% to 72.2%, time spent by patients in the system reduce from 0.238 hours to 0.178 hours; and the probability of the system to remain idle increased from 1.2% to 1.6% [3].

B. Performance measures of the queuing system of OPD

Only three inputs (arrival rate (lambda), service rate (Mu) and number of resources available (c)) are required for the calculation of performance measures in single phase multi-server queuing model. The mentioned details were put into the TORA optimization software along with the existing number of resources (doctors) at the workplace. The analysis was conducted in five scenarios. The evaluation of current situation of the queuing system of reception indicated that the probability of the reception to be idle (p0) was 2.1%; number of patients at the reception (Ls) and reception queue (Lq) were calculated to be 11.83187 and 9.08617 respectively (see figure 12). Moreover, the time spent by the patients at the reception and in reception queue was calculated to be 0.16903 hours and 0.12981 hours respectively.

If one doctor is supposed to be added in the first scenario the probability of the OPD to remain idle increases 2.1% to 5.40% (see figure 12 and 13); number of patients at the OPD and in the its queue were calculated to be 3.63675 and 0.89165 respectively.

Furthermore, time spent by the patients at the OPD and in its queue was calculated to be 0.05195 hours and 0.01274 hours respectively as shown in the figure 12.

Kyoung W. C. et al. 2017 analyzed the variation in waiting times of patients prior and after the implementation of electronic medical record (EMR) system. They used queuing theory concepts for the calculation of patients` waiting times. After the implementation of EMR, they found that the patients` waiting times at the targeted public hospitals decrease within the range of 44%-78% [49].

Select Output Option

Comparative Analy

Next Iteration | All Iterations | Write to Printer

Comparative analysis

Scenario	c	Lambda	Mu	L'da eff	p0	Ls	Lq	Ws	Wq
1	3	70.00000	25.50000	70.00000	0.02079	11.83187	9.08677	0.16903	0.12981
2	4	70.00000	25.50000	70.00000	0.05405	3.63675	0.89165	0.05195	0.01274
3	5	70.00000	25.50000	70.00000	0.06170	2.96146	0.21636	0.04231	0.00309
4	6	70.00000	25.50000	70.00000	0.06361	2.80387	0.05877	0.04006	0.00084
5	7	70.00000	25.50000	70.00000	0.06409	2.76095	0.01585	0.03944	0.00023

Figure 12. Calculation of performance measures of the OPD of case hospital

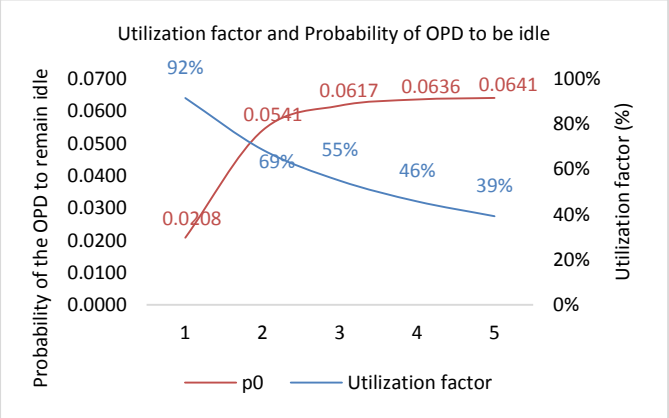


Figure 13. Utilization factor and the probability of the OPD to remain idle

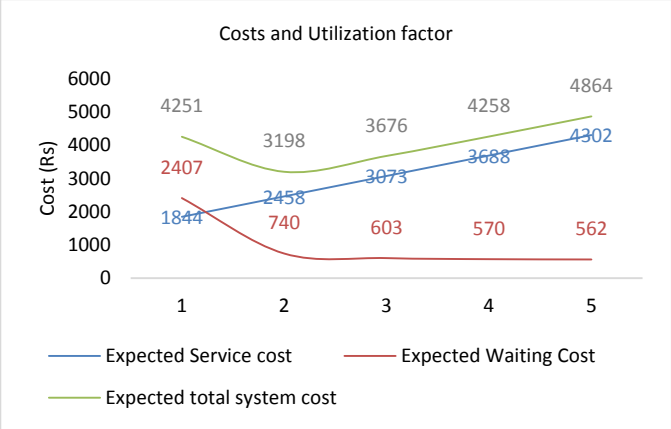


Figure 14. Costs of the queuing system of the OPD

The costs of the queuing system were calculated in MS Excel and are presented in line chart given in figure 14. In first scenario, the expected service cost, waiting cost and total system cost were calculated to be Rs.1844, Rs.2407 and Rs.4251 respectively. When only one doctor is supposed to be increased the waiting cost decreases from Rs.2407 to Rs.740 as presented in the figure 14. Similarly, the total system cost also once decreases and then increases at one point (in second scenario); in this case, it is optimal decision to increase one reception at the OPD.

Agyei W., Asare-darko C. and Odilon F. 2015worked on the queuing system of Ghana commercial bank, Kumasi. They made the total expected cost as the base of their final decision. They aimed to find the optimum number of teller points to minimize the congestion at the bank. The analysis indicated that by the installation of 5 teller points, the total waiting time of customers in the queue and system will reduce by 98.78% and 87.85% respectively. The total economic cost incurred by system would also reduce to GH¢631.69 as against the present GH¢1010.90 [6]. Ibrahim Ahmed and Abdelgadir suggested to increase the number of service providers by increasing the number of channels to become two channels at least, which leads to reducing waiting times for customers. This is explained by the second result that was reached on the assumption that there are two service providers instead of one service provider, as is the case now[2].

VIII. CONCLUSION

Pakistani public health care system promoted with the different facilities and sources which are definitely not nearly enough as well as the readily available facilities as well as sources go to the point of mismanagement. This is the factor people reaching public industry medical facilities encounter a great deal of issues. Queue is one of the major problems, several of the patients pass away awaiting their turn of service. Service is postponed when the solution need is greater than the offered capacity. When there is low capacity in comparison to the demand then the queue will develop in the system. For the analysis and also research study of queues, queuing theory is utilized. Queuing theory was formulated by Danish Engineer A.K Erlang in 1913. It is the mathematical device to address the troubles of queuing systems. The optimal solutions are figured out by the help of queuing theory in the form of performance measures. In the here and now research, after the

evaluation of the performance measures of the reception and also OPD, it was exposed that a person receptionist and one doctor need to be enhanced to bring optimality in the queuing system as well as people 'flow. After this decision, waiting cost of people reduced to higher extent.

IX. FUTURE IMPLICATIONS

It was suggested that this research study can be extended by including the time spent by the outpatients in the method to healthcare to ensure that the time cost can be computed in all ways. This research study was only carried out on the medical OPD; it can additionally be conducted in all the OPDs of hospital in order to bring the renovation in public healthcare. The seasonal analysis of queuing system of the affiliated OPD can also be carried out.

X. LIMITATIONS

The present research was conducted in small scope of only one OPD due to small span of time, in future research, the scope can be broadened.

ACKNOWLEDGEMENT

We want to thank the doctors, receptionist, and all other OPD staff of the case hospital for their immense support during the data collection; without them, it was not possible.

CONFLICT OF INTEREST

There was no conflict of interest among the authors of the present research paper.

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How to Cite this Article:

Khan, M. A., Khaskheli, S. A., Kalwar, H. A., Kalwar, M. A., Marri, H. B. & Nebhwani, M. (2021). Improving the Performance of Reception and OPD by Using Multi-Server Queuing Model in Covid-19 Pandemic. International Journal of Science and Engineering Investigations (IJSEI), 10(113), 20-29. http://www.ijsei.com/papers/ijsei-1011321-04.pdf