

Analysis of Delays Due to Waiting Lines in Healthcare Delivery for Sustainability

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Abstract

Due to the increasing population and the rise in the infectious as well as chronic degenerative diseases, healthcare industry is growing at very fast. In healthcare services, it is generally observed that, it is difficult to manage system due to overcrowding and waiting lines. Therefore it is very important to resolve this waiting line problem, to avoid further major problems like loss of human life and havoc in the operations. Waiting line analysis (Queuing theory) is the mathematical and scientific approach to the system. The queue are formed due to the arrival rate of patients is faster than the hospital system can handle. It is applicable to healthcare settings where the systems have excess capacity to accommodate random variations. Also it suggests the system about the best solution to the system which is workable and reduce the long queues and bring optimization in the operations.

Keywords: Healthcare Delivery, Operations Research, Patients, Waiting Line (Queue), Waiting Line Analysis (Queuing Theory)

1. Introduction

1.1 Background

Due to the increasing population and the rise in the infectious as well as chronic degenerative diseases, healthcare industry is growing at very fast pace. Healthcare System in India and around the world has witnessed a phenomenal growth during last three decades. The basic reason behind raising this industry is the increasing rate of population and their demand for the healthcare service. So, health care systems have been challenged in recent years to deliver services to all the patient and high quality services with limited resources without delay. This issue for healthcare industry is a bottleneck issue because delay in service may result in death of a patient and congestion results into mismanagement of resource distribution and allocation to patient or staff members of the hospital as well. Health care resources are becoming increasingly limited and expensive, thereby placing greater emphasis on the efficient utilization of the resources and the corresponding level of service provided to patients. (Kiran Soni, June 2011).

“Patient satisfaction and quality care are important indicators for the success of any health care enterprise. To sustain growth and competency, it is necessary for a hospital to focus its attention on quality and efficiency of its services in a continuous manner” (Buhaug).

Operations Research (OR), also termed as Management Science, and it is in use since 1930s.

Definition By : Churchman, Ackoff, Arnoff –“It is characterized as the application of scientific methods, tools and techniques to problems involving the operations of system so as to provide those in control of the operations with optimum solutions to the problem”. (Vohra, 01-Jul-2006)

Queuing theory deals with the study of waiting lines which arise in case of faster arrival rate than service system rate. Queuing theory is applicable in many situations and in different industries like telecommunication to Bank, where number of customers are in queue and waiting to get served.

In a hospital emergency department patients arrive with various kinds of injuries and medical issues that require urgent treatment. How many nurses and doctors

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need to be on staff to provide patients with proper care in a timely manner? How many intensive care units are needed to hospitalize patients? (Resing, March 26, 2015)

Healthcare executives and managers are always searching for better ways to improve production capacity for medical treatment and thereby improving operational efficiency. Variability in service demand is quite unpredictable. These variations of service demand create periods when the servers are idle and, on other times, patients have to wait. Because of some of these reasons, it is more challenging to plan for capacity in services than in manufacturing.

Generally patients scheduling is done by administrative personnel in the hospital by considering the availability of resources. These resources mainly are the personnel i.e. Doctors, Nurses, ward boys, support staffs and secondly its modalities (material or equipments) like machines. In any hospital, resources are generally limited and it is so essential to find the optimal way to treat the patients in order to maximize efficiency and productivity, and thereby, patient throughput time. While doing so, they have to make sure that the quality of the services offered are not getting compromised. If waiting lines are not managed properly, then it leads to inefficiency of the system and low bed occupancy level.

This paper focuses on how waiting line analysis which is one of the prominent OR techniques will help hospitals to reduce long waiting lines and thereby in managing patients' flow in the healthcare system. This analysis also helps management for facility management, resource planning, capacity analysis etc.

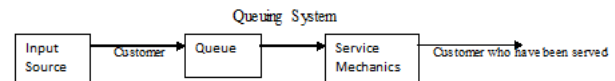
Patients arrival is expected through: Walk-in patients, emergency patients, appointments through phone calls, and patients referred by other physicians, outpatient clinics and outpatient surgeries etc.

1.2 Definition of Terms

- **Queue:** Is an aggregation of items waiting for a service function
- **Arrival Rate:** Is the mean rate of arrivals per unit of time and it is often denoted by the Greek letter lambda (λ)
- **Service Rate:** Is the average number of service rendered per unit of time. It is always represented by the Greek letter Mu (μ) (Nkeiruka Ameh B. S., 2013)

In the hospital setting, the group of individuals from

which arrivals come is referred to as the call-in population. Variations occur in this population's size. Total customer demand requiring service from time to time constitutes the size of it. The group of customers waiting for admission or healthcare service is known as the queue. According to Queuing theory queues are formed due to more arrival rate of the patients than the rate of the system at which patients are served. The process shows typical system where input source is the arrival of patients through appointments through phone calls/ online, prior appointments, emergency, walk-in patients etc. They will be given chance to get treatment through the system on FIFO basis or based on rules set by their system like how to handle emergency cases and what priority is given to walk in patients and so on. If the arrival rate is more than servicing rate then there is scope of formation of queues.



(Cheng-Hua Wang, March 2006)

Pile-up of queue will exert unnecessary pressure on the system called as Doctor, who has to increase the speed of operations or patients have to wait indefinitely. This leads to either Poor service quality rendered by the doctor or unsatisfied patients (health of the patients who keep waiting till long for the treatment). This situation has to be handled differently unlike the case of manufacturing or retail or any other service industry other than the health care. Here patients have ideally very less scope to switch the Doctor or Hospital unlike other service industry.

The need for application of queuing theory in healthcare settings is very important because the well being and life of someone is concerned. The time spent by a patient while waiting to be attended to by a doctor is critical to the patient and to the image of the hospital before the public. (Nkeiruka Ameh B. S., 2013 Jan-Feb)

The improvement on health care services can be achieved only when these waiting lines issue is addressed. The aim of this paper is to analyze queuing system at the outpatient small hospitals and clinics and also evaluate different ways by which these long queues can be controlled. The finding should be helpful in improving services at the clinic.

One way in which hospital capacity can be increased is by directing minor and medium injury class patients to short-stay walk-in clinics dedicated to such injuries. This

separates low-risk patients from the more heterogeneous major injury class patients, while continuously de-bottlenecking the health care process stream. Additional staff must also be scheduled to deal with sporadic patient arrival to help enhance patient flow. Using value stream maps, the bottleneck in the process can be identified. Although there will invariably be one stage of the process that moves slower than the others, the goal is to even the flow by reducing variation and planning the bottleneck to occur where it can be most effectively controlled with the addition of new resources. (Rajeev Chadha, 2012) “waiting for something to happen”; in turn, these delays and the corresponding queues signal inefficiencies. Hospitals thus present a propitious ground for research in Queuing Theory and, more generally, Applied Probability (AP), Operations Research (OR) and Service Engineering (SE). Such research would ideally culminate in reduced congestion (crowding) and its accompanying important benefits: clinical, financial, psychological and societal. (Mor Armony, 2015)

2. Rationale

- To know whether waiting line is a serious issue faced by all small hospitals or not.
- To understand the methodology adopted by hospitals to tackle the waiting lines problem.
- To study the different challenges faced by the hospitals while implementing queuing models (waiting lines analysis) in the hospitals.

3. Research Methodology

The cross-sectional study was carried out at small Private outpatient hospitals having small bed size (Below 50 beds). These Multi-Specialty and Super-specialty Hospitals in Thane and Kalyan city are visited during June-September 2016. Random and convenient sampling is used to choose the Hospitals in the given region. Few doctors, administrators, employees, were interviewed for collecting relevant information at the outpatient clinics and hospitals during the study period.

The questionnaire sought the Hospital/Doctor's demographic characteristics. The questionnaire is prepared to know the detailed information about the

hospitals including average arrival rate of the patients, average waiting time of the patients, and average number of patients in the queue. This will help in knowing the entire healthcare system of that hospital. The questionnaire also focuses on whether the stakeholders of the hospital think that the waiting line problem is a serious issue and waiting line analysis will help in smoothing the operations in health care system. Questionnaire is designed to find out different ways and method opted by the hospitals to tackle the problem of waiting lines and while doing so what are the challenges they are facing.

In this study personnel from the hospitals were asked the methodology adopted by them for tackling the waiting line problem. The major reasons behind these queues are more demand than the supply, which means either rate of arrival has to be restricted or servicing rate should be increased. The servicing rate is increased by adding extra resources like keeping assistant Doctor or adding to the modalities etc.

Average utilization = ρ (rho) = λ / μ = Traffic intensity

Where λ is rate of arrival and μ is the rate of servicing. If λ is greater than μ then there is formation of queues and so the aim of hospitals setting s is to balance between the two.

The emphasis of this study is not to burden the system and its achieved by taking measures discussed above. The condition of hospital industry in India is bleak and its always over burdening on the system. This leads to compromise on the quality of health delivery services and keeping patients unsatisfied due to long waiting hours. This is generally handled by hospitals either controlling the rate of arrival or speeding the operations by raising the resources.

4. Findings and Observations

The information is collected from small private hospitals in Thane city having bed size below 50 beds. Out of total 64 questionnaires, 56 were considered for the study. Hospitals are categorized as up to 10 Hospitals, 10-20 hospitals, 20-30 hospitals and above 30 but less than 50 hospitals.

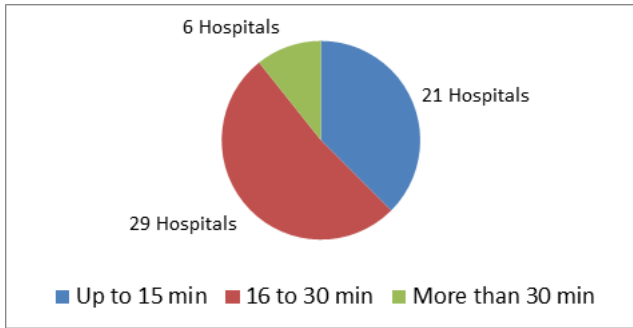


Figure 1. Average Waiting period in minutes for hospitals.

As shown in figure. 2, the queue length is found to be varying from 1 patient to 25 patient at different hospitals. Similarly, waiting time of the patients is varying from 10 min to 45 min and average arrival rate (λ) of patients observed to be from 10 -100 patients in different hospitals.

Table 1. Distribution of waiting time

	Frequency	Per- cent	Valid Percent	Cumu- lative Percent
Valid 16 to 30 min	29	51.8	51.8	51.8
More than 30 min	6	10.7	10.7	62.5
Up to 15 min	21	37.5	37.5	100.0
Total	56	100.0	100.0	

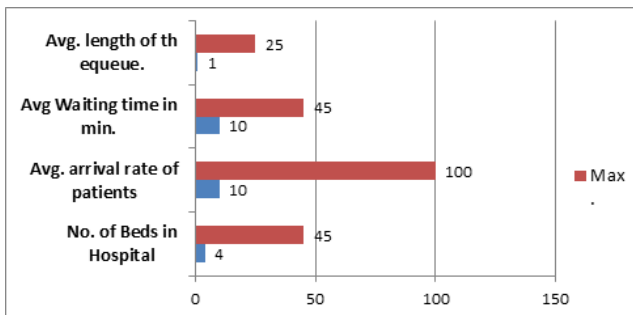


Figure 2. Minimum and Maximum range for different parameters.

From the study it has been observed that 71% of the respondents feel that waiting lines (queuing problem) is the serious issue their hospital is facing (Table. 4) and 93 % respondents think that waiting line analysis is important and helps in operating hospitals smoothly and optimally (Table. 5).

Table 3. Mean of different parameters

Size_of_Hospital	Avg arriv- al rate (λ)	Avg. waiting time of patient in min (W)	Avg. length of queue (L)
11 to 20 beds	40.3200	21.3600	10.7200
21 to 30 beds	56.6667	27.0833	9.7500
More than 30 beds	63.6364	23.1818	13.0000
Up to 10 beds	30.0000	15.6250	5.8750
Total	46.9286	22.1250	10.2679

Table 4. Response of the hospital to Que. 8 about different methods used to avoid waiting lines

	Frequen- cy	Per- cent	Valid Percent	Cumulative Percent
Valid YES	40	71.4	71.4	71.4
Valid NO	16	28.6	28.6	100.0
Total	56	100.0	100.0	

Table 5. Response of the hospital to Que.9 about the challenges they are facing to implement waiting lines analysis

	Fre- quency	Per- cent	Valid Percent	Cumulative Percent
Valid YES	52	92.9	92.9	92.9
Valid NO	4	7.1	7.1	100.0
Total	56	100.0	100.0	

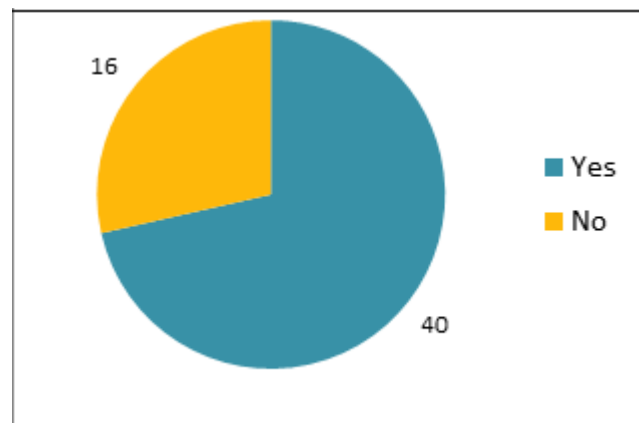


Figure 3. Waiting line (Queuing Problem) is the serious issue our hospital is facing.

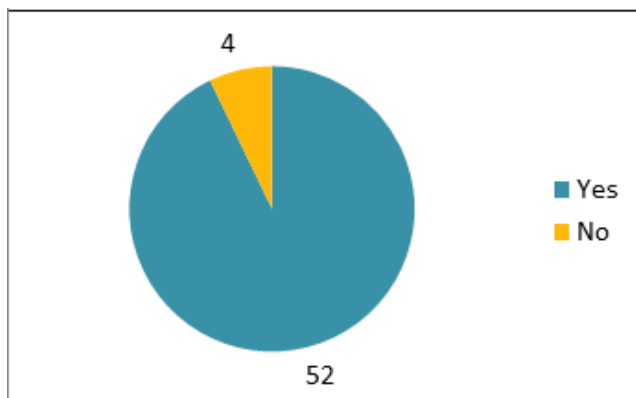


Figure 4. Waiting line analysis is important and helps in operating hospitals smoothly and optimally.

Study also focuses on understanding the methods used by hospitals for eliminating long queues. Very commonly used methods are as follows (see Table. 6):

- Keeping an assistant doctor to the senior doctor for attending the patients to minimize waiting time
- Discharging non-critical patients before expected date of discharge to serve the patients in waiting queue in case of IPD

Table 2. ANOVA for Bed size

		Sum of Squares	df	Mean Square	F	Sig.	Result
Q_4_Avg#_arrival_rate_of_patients_per_day	Between Groups	7383.971	3	2461.324	9.844	.000	Rejected
	Within Groups	13001.743	52	250.034			
	Total	20385.714	55				
Q_5_Average_waiting_time_of_patient_in_min	Between Groups	573.763	3	191.254	2.440	.075	Accepted
	Within Groups	4076.362	52	78.392			
	Total	4650.125	55				
Q_7_Average_length_of_queue	Between Groups	206.635	3	68.878	1.755	.167	Accepted
	Within Groups	2040.347	52	39.237			
	Total	2246.982	55				

Table 6. Responses of the hospitals to the different methods they are adopting to tackle waiting lines

Sr. No.	Methods adopted to tackle waiting lines	Yes	No
A	Keeping an assistant doctor to the senior doctor for attending the patients to minimize waiting time	55	1
B	Increase speed of operations by raising the resources	17	39
C	Collaboration with another hospitals to cope up with the rise in demand	7	49
D	Discharging non-critical patients before expected date of discharge to serve the patients in waiting queue in case of IPD	45	11
E	Restricted appointments or admissions in hospitals	29	27
F	Any other technique/ method adopted by hospital which is not listed above	3	53

Respondents were also asked to share the challenges they are facing while adopting methods. (See Table. 7):

- Non-uniform flow of patients, change in the arrival rate of patients
- Emergency and individual cases may take additional time which leads to long waiting lines
- Cost associated with additional resources is too high
- Some patients’ treatment and consultation takes too long time than the expected

5. Conclusion

The Average arrival rate of patients per day has association (relevance) with the number of beds, but Average waiting of the patient (from Table.2) as significance is less than 0.05 from Anova and Average length of the queue data don’t show any association or relevance with number of beds since value of significance is more than 0.05.

As every patient is treated with unique treatment and consequently the time taken for the consultation differs, having understood this, every hospital should have an appropriate system which will accommodate these

Table 7. Responses of the hospitals to the challenges they are facing in implementing waiting lines

Sr. No.	Challenges faced by the hospitals	Yes	No
A	Non-uniform flow of patients, change in the arrival rate of patients	47	9
B	Emergency and individual cases may take additional time which leads to long waiting lines	51	5
C	Cost associated with additional resources is too high	45	11
D	Some patients treatment and consultation takes too long time than the expected	55	1
E	Patients want treatment from particular doctor so they are not ready to meet assistant doctors	24	32
F	Unpredicted delays from Doctors due to association with other hospitals or personal reasons	19	37
G	Analysis is based on unrealistic assumptions	20	36
H	Any other reason	0	56

uncertainty and balance can be achieved. Depending on the type of specialty, process has to be designed, by considering the arrival rate, servicing rate, resources and its availability. This will help them to reduce unnecessary delays in delivery of services. Simulation models can be used for designing systematic process flow.

Raising the capacity or resources is beyond the scope of many hospitals. Hence resource scheduling plays very important role in resource optimization thereby reducing waiting lines.

Findings of the research will help small hospitals to manage their long queues and thereby efficiency of the healthcare system. (By Mor Armony, January 19, 2015)

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