A STUDY OF IMPROVING HOSPITAL OUT PATIENT DEPARTMENT (OPD) USING QUEUEING NETWORK ANALYSIS METHODOLOGY

Kirti Makwana and Dr. Govind B Dave

Faculty of Management Studies (FMS),
Indukaka Ipcowala Institute of Management (I²IM),
Charotar University of Science and Technology (CHARUSAT)
Changa, Gujarat, India

ABSTRACT

Service time and waiting time in hospitals are of growing importance in quality healthcare delivery. Long waiting times for health care is a critical issue in many countries. Many of the countries have now introduced benchmarks for that. The objective of this research paper is to study the Out Patient Department (OPD) of a hospital using queueing network analysis. The study aims to analyze the patient flow system by measuring the length of stay, service and waiting time distribution of patients and waiting time between two consecutive services availed / treatment undergone / department visited were calculated in an Out Patient Department (OPD) of a multispecialty hospital. There are major differences in how waiting times are measured: waiting period for kind of care/ services the patient is waiting for; the parameters used; and where in the patient journey the measurement begins. We investigated the waiting time for patients before and during availing any of the services of multispecialty, rural based hospital in Gujarat, India. Various descriptive statistics analyses of routine data for 438 patients determined the association between selected patient characteristics, service time and waiting time. The median time spent by a patient (between patients enters in the hospital, being seen by a physician / availing various services and leaves the hospital is 44 minutes (within a range of 7.59 – 382 minutes). Day of arrival, time of arrival and service/ treatment category were significantly associated with waiting time. Variability in waiting times could be addressed by more standardized hospital operations, but may also be influenced by other clinical or non-clinical factors that require further investigation.

Keywords: Waiting Line Theory, Queueing Theory, Out Patient Department (OPD), Health Care.

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1. INTRODUCTION

In today's competitive market, patient service time and waiting time have received more consideration in the quality delivery of healthcare than ever before. They play an important role in developing and maintaining quality healthcare delivery services. Patients undergo various treatments in outpatient units within the hospital system, but almost, patients' arrival and departure time from the hospital varies. Fernandes et al. (1994), Santos et al. (1994) identified that, the amount of time a patient waits to be seen, is of the one factors affecting the utilization and efficiency of health care services. According to Kurata et al. (1992), long waiting times are perceived as barriers to availing services by the patients. Patient waiting time and service time play important roles in attracting new business by the hospital. Mackey and Cole (1997) claimed that it is difficult for any health service organization, to sell services if patients are dissatisfied with waiting time. Moreover, waiting time becomes a factor in retaining existing patients. Fernandes et al. (1994) found that, a considerably large number of patients left outpatient departments because of extensive waiting times.

Commonly cited factors affecting patient satisfaction in the literature include timely access to appointments, provider-patient relationships, academic versus private practice setting, overall wait times, and time spent with providers. Billing et. al (2007) and Zopf et. al (2008) have identified that, reduction in patient waiting times increases patient satisfaction in the outpatient department. However, some researchers have reported that the amount of time the medical staff spends with the patient may be a better predictor of patient satisfaction. Analysis of the data generated from the study, assessing the patients' waiting time in the outpatients' departments can be of use to hospital administrators, decision makers who address the issues of allocation human resources, logistics, infrastructures, scheduling and other internal standard operating procedures to ensure an effective health care delivery system.

2. RESEARCH METHOD

This research study was a cross sectional primary based observational study using a structured observational checklist in a rural based multispecialty hospital based in Gujarat, India. A non-probability convenient sampling was used to select the patient entering in the hospital. The trained assistants to the research team were following/ accompanying in the patient care activities (starting from patients entering in the hospital till the disposal of the patients) during collection of data. A formal permission was obtained from the Chief Operating Officer (COO) for conducting the study. The study duration was of one week during busy days in the day shift. The descriptive statistical method was used to analyze the collected data. Frequency, percentages, mean, median, range, Standard deviation, histograms and graphs were calculated / prepared to generate the inferences.

3. RESULTS & DISCUSSION

A total number of 438 patients were carefully chosen out of thousands of patients reporting to a multispecialty hospital during the observation period (in a week). Patients visits to the hospital during various working hours.

Table 1 Time of Visits to the Hospital

Time	No. of Patients	% of Patients
09:00 - 10:00	108	24.60
10:00 - 11:00	122	27.85
11:00 - 12:00	83	18.95
12:00 - 13:00	22	5.02
13:00 - 14:00	17	3.88
14:00 - 15:00	66	15.06
15:00 - 16:00	20	4.56
Total	438	100

The peak arrival hours of the hospital to be 09:00 – 11: 00. 52.45 % of patients arrive in the hospital during peak hours. This two hours slot is the busiest time period for the hospital.

Figure 1 No. of Patients Visiting During Various Time

It was observed that, only 3.88 % of patients are reporting to the hospital during 13:00 – 14:00.

Figure 2 No. of Patients Visiting During Various Times

The total duration of spent in the hospital (including service time and waiting time to get served) ranged from 00:07:59 to 06:22:59 with mean length of stay period of 58.45 minutes,

median length of stay in a hospital of 44 minutes and a standard deviation of +/- 51.41 minutes from entry till disposal.

Table 2 Length of Stay (LoS) in the Hospital (hh : mm : ss)

LoS (Minutes)	N	Minimum Time	Maximum Time	Mean Time	Median Time	Std. Deviation
	438	00:07:59	06:22:59	00:58:45	00:44:00	00:51:41

Figure 3 % of Patients' Length of Stay in the Hospital

36.76 % of patients have to spend 30 -60 minutes in the hospital to get served. While, only 9.13% of patients have to wait for more than 120 minutes. The performance of the hospital is far better than many of the multispecialty hospitals in the world. In India the service time in health care is not explicitly published. However, many of the OECD member countries[1] have defined service time in the hospitals. According to latest reports by the Health Foundation, UK (2018), National Health Service (NHS), England has targeted four-hours waiting time. The operational standard is that at least 95% of patients attending the hospital should be admitted, transferred or discharged within four hours.

Table 3 Registration Time in the Hospital (hh : mm : ss)

Registration Time	Minimum Time	Maximum	Mean Time	Median	Std.
	00:00:25	00:19:59	00:04:12	00:03:00	00:02:56

The time taken from arrival to complete the patients' registration (which includes waiting in a queue, complete the formalities of new patient case - providing basic details, such as age, place, gender, marital status, basic understanding of department willing to visit, services to avail, in case of old patient- basic details are fetched from Health Management Information System (HMIS) ranged from 25 seconds to 19.59 minutes with mean duration of 3 minutes, median duration of 3 minutes and standard deviation of +/- 2.56 minutes.

Table 4 No. of Services Availd / Treatments Undergone / Department Visited

Mean	3.04
Median	3.00
Std. Deviation	1.74
Minimum	1
Maximum	10

Range of services are made available for the patients, as the hospital is a multispecialty. Patients avail services / undergo treatments in the relevant departments depending on the nature of the disease. On an average a patient avails three services / treatments during his / her visit to the multispecialty hospital which range from one to ten. Out of 438 patients visiting the hospital, 54.3% of patients are availing at least three or more than three services.

Figure 4 No. of Services Availd / Treatments Undergone / Department Visited

As mentioned in the Appendix -1, a total of 32 services were availed by a total of 1329 patients in a various capacity, which range from minimum one patient (0.08%) visiting (Foot Sensitivity Test, Nerve Conduction Velocity (NCV) and Women's Health) to maximum 234 patients (17.61%) (Pharmacy store). Average service time for billing process is the minimum (2.50 minutes with significantly high number of patients visiting the department - 9.78 % of the total patients), while, CT Scan has the highest mean service time (52.15 minutes and only 0.23 % of patients availing the services).

A+ Scan B+ Scan, CT Scan, Dermatology, Pathology, Women's Health and X-Ray are the services / treatments where patients have to wait an average of approximately 3 minutes to avail the service. 13.63 % of total patients are availing these services. These shows efficiency in providing health services. However, patients have to wait for an average of 44.37 minutes to visit a Physician (1.20 % of total patients are visiting Physician). The delay can be mainly caused due to valuable time spent in consultation of other patients, rush in the department, unavailability of required medical staff. A study was conducted by Hanaffi Abdullah in a Malaysia based hospital to identify the OPD waiting time and to explore possible operational factors which are responsible for patients waiting period. The study identified that registration procedure, number of staff at counter, and decision making time, verifying the identity, completing case sheets, procuring necessary documents and insufficient doctors are the main reasons for the waiting to avail services in the hospital.

4. CONCLUSION AND MANAGERIAL IMPLICATIONS

This research paper has identified the substantial areas for improvement in the hospital with in-depth descriptive analysis of data, and results were supported with root cause analysis findings.

Identifying patterns in patient arrivals can be used by the hospital to match the manpower requirements of various departments and services. The decision makers of the hospital can share the results with the staff members (including staff at registration and billing desk, Doctors, Nurses and various para medical staff members) to enable clarity and equitable workload. Numbers and data gathered were extracted into easy-to-understand charts and tables will contribute in the progress of the quality improvement effort. Addressing the gaps in the human resources, logistics, infrastructure, hospital layout and other internal procedures contributes in reducing waiting times, service times and hence ensure an effective health care delivery system.

KEYNOTES

1. OECD Member Countries

The Organisation for Economic Co-operation and Development (OECD) was established in 1961. OECD is a forum of 34 industrialised countries that develops and promotes economic and social policies. OECD acts on behalf of and in collaboration with its member governments to promote free market policies and trade. Today the OECD consists of 34 countries, including members characterised as emerging economies. The 34 OECD member countries are: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States

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APPENDIX -1 TREATMENTS / DEPARTMENT / SERVICE (OVERALL)

Sr. No.:	Treatment / Department / Activity	No. of Patients	% of Patients	Average Service Time for the Service / Treatment	Average Waiting Time (to Avail Services / Undergo Treatment)
1	A+ Scan B+ Scan	5	0.38	00:01:45	00:00:53
2	Antenatal Clinic	3	0.23	00:02:10	00:04:45
3	Billing	130	9.78	00:02:50	00:02:50
4	Canteen	1	0.08	00:07:00	--
5	Counseling	89	6.70	00:02:57	00:04:21
6	CT Scan	3	0.23	00:52:15	00:01:00
7	Dental Operatory	77	5.79	00:06:28	00:07:16
8	Dermatology	16	1.20	00:04:12	00:02:15
9	Diabetes Clinic	27	2.03	00:02:41	00:08:20
10	Dressing Room	8	0.60	00:11:48	00:04:12
11	ECG	10	0.75	00:10:50	00:06:53
12	ENT Department	21	1.58	00:04:19	00:10:51
13	Foot Sensitivity Test and Nerve Conduction Velocity (NCV)	1	0.08	00:00:30	00:04:00
14	Gynecology	68	5.12	00:04:56	00:06:15
15	Infertility Clinic	23	1.73	00:11:49	00:21:49
16	Medical Officer	83	6.25	00:08:47	00:07:22
17	Ophthalmology	67	5.04	00:04:36	00:15:27
18	Optometry	51	3.84	00:04:53	00:04:55
19	Orthopedic	68	5.12	00:05:25	00:06:27
20	Pediatrics	25	1.88	00:06:49	00:11:35
21	Pathology	134	10.08	00:05:06	00:03:40
22	Pharmacy	234	17.61	00:04:27	00:04:52
23	Physician	16	1.20	00:04:38	00:44:37
24	Physiotherapy	12	0.90	00:14:53	00:24:52
25	Radiology	14	1.05	00:20:34	00:06:58
26	Sonography	31	2.33	00:12:56	00:05:49
27	Surgery	55	4.14	00:04:06	00:11:00
28	USG	21	1.58	00:18:18	00:19:22
29	Vaccination Room	2	0.15	00:12:40	00:17:00
30	Waiting Area	75	5.64	00:14:49	--
31	Women's Health	1	0.08	00:01:00	00:00:00
32	X-Ray	22	1.66	00:07:42	00:03:15
Grand Total		1329	100	00:08:42	00:11:42

APPENDIX -2 TREATMENTS / DEPARTMENT / SERVICE (SERVICE 1 AND 2)

Treatment / Department / Activity	Treatment / Department / Service 1				Treatment / Department / Service 2			
	No. of Patients	% of Patients	Average Service Time Treatment 1	Average Waiting Time (Registration to Treatment 1)	No. of Patients	% of Patients	Average Service Time Treatment 2	Average Waiting Time (Treatment 1 – 2)
A+ Scan B+ Scan	4	0.9	00:02:15	00:00:45	1	0.3	0:03:00	0:01:00
Antenatal Clinic	2	0.5	00:04:30	00:02:30	1	0.3	0:02:00	0:07:00
Billing	--	--	--	--	74	20.7	0:02:06	0:03:54
Counseling	8	1.8	00:03:07	00:15:22	74	20.7	0:02:06	0:03:54
Dental Operatory	52	11.9	00:13:29	00:11:30	6	1.7	0:03:20	0:06:00
Dermatology	2	0.5	00:01:30	00:02:00	11	3.1	0:08:00	0:07:00
Diabetes Clinic	19	4.3	00:05:19	00:07:22	1	0.3	0:01:00	0:05:00
Dressing Room	2	0.5	00:11:00	00:06:00	5	1.4	0:03:12	0:05:36
ECG	--	--	--	--	3	0.8	0:19:00	0:15:20
ENT Department	21	4.8	00:08:37	00:10:51	--	--	--	--
Foot Sensitivity Test and NCV	--	--	--	--	1	0.3	0:01:00	0:04:00
Gynecology	44	10.0	00:09:40	00:07:31	12	3.4	0:01:45	0:05:50
Infertility Clinic	15	3.4	00:11:16	00:03:36	3	0.8	0:02:20	0:06:20
Medical Officer	45	10.3	00:05:13	00:34:49	23	6.4	0:09:37	0:04:39
Ophthalmology	12	2.7	00:06:30	00:13:35	33	9.2	0:07:29	0:23:09
Optometry	26	5.9	00:07:58	00:05:25	7	2.0	0:10:00	0:05:43
Orthopedic	37	8.4	00:06:45	00:04:54	11	3.1	0:02:00	0:07:38
Pediatrics	14	3.2	00:12:47	00:05:51	4	1.1	0:04:45	0:05:30
Pathology	45	10.3	00:05:57	00:09:31	16	4.5	0:02:07	0:08:11
Pharmacy	--	--	--	--	82	22.9	0:03:53	0:04:31
Physician	11	2.5	00:05:33	00:24:05	1	0.3	0:10:45	1:09:00
Physiotherapy	9	2.1	00:51:33	00:05:07	2	0.6	0:06:00	1:04:30
Radiology	3	0.7	00:03:40	00:00:40	2	0.6	0:02:00	0:32:00
Sonography	4	0.9	00:20:15	00:05:30	12	3.4	0:10:10	0:11:25
Surgery	27	6.2	00:05:58	00:05:13	11	3.1	0:02:22	0:07:22
USG	4	0.9	00:19:30	00:18:30	3	0.8	0:23:20	0:37:20
Vaccination Room	--	--	--	--	1	0.3	0:35:00	0:25:00
Waiting Area	28	6.4	00:27:51	00:07:49	14	3.9	0:00:34	0:19:26
X-Ray	4	0.9	00:13:00	00:00:30	8	2.2	0:03:24	0:09:00
Grand Total	438	100	00:10:25	00:11:02	358	100	0:04:38	0:08:46

APPENDIX -3 TREATMENTS / DEPARTMENT / SERVICE (SERVICE 3 AND 4)

Treatment / Department / Activity	Treatment / Department / Service 3				Treatment / Department / Service 4			
	No. of Patients	% of Patients	Average Service Time Treatment 3	Average Waiting Time (Treatment 2 – 3)	No. of Patients	% of Patients	Average Service Time Treatment 4	Average Waiting Time (Treatment 3 – 4)
Billing	29	12.2	0:03:14	0:01:21	7	4.9	0:03:00	0:01:00
Canteen	1	0.4	0:14:00	0:01:00	--	--	--	--
Counseling	4	1.7	0:04:00	0:01:00	2	1.4	0:03:30	0:01:30
CT Scan	1	0.4	0:14:00	0:01:00	1	0.7	0:21:00	0:02:00
Dental Operatory	5	2.1	0:07:36	0:10:12	7	4.9	0:05:34	0:11:09
Dermatology	2	0.8	0:06:30	0:00:00	--	--	--	--
Diabetes Clinic	3	1.3	0:02:00	0:02:40	2	1.4	0:03:30	0:24:00
Dressing Room	--	--	--	--	1	0.7	0:33:00	0:01:00
ECG	3	1.3	0:07:40	0:04:40	2	1.4	0:14:30	0:02:30
Gynecology	3	1.3	0:06:00	0:04:00	3	2.1	0:05:00	0:00:40
Infertility Clinic	2	0.8	0:18:30	0:15:00	--	--	--	--
Medical Officer	8	3.4	0:03:53	0:03:08	3	2.1	0:34:00	0:04:00
Ophthalmology	9	3.8	0:07:47	0:28:27	10	7.0	0:05:54	0:06:00
Optometry	15	6.3	0:06:12	0:06:24	--	--	--	--
Orthopedic	8	3.4	0:07:00	0:08:53	8	5.6	0:06:07	0:01:45
Pathology	31	13.0	0:06:56	0:04:35	30	21.0	0:10:28	0:04:56
Pediatrics	5	2.1	0:05:24	0:02:36	1	0.7	0:12:00	0:44:00
Pharmacy	68	28.7	0:04:23	0:04:03	39	27.3	0:05:09	0:07:09
Physician	2	0.8	0:03:30	0:10:00	--	--	--	--
Radiology	4	1.7	1:44:00	0:01:45	3	2.1	0:12:20	0:06:20
Sonography	8	3.4	0:15:45	0:04:30	3	2.1	0:08:20	0:01:30
Surgery	6	2.5	0:03:00	0:03:20	4	2.8	0:03:45	0:20:30
USG	2	0.8	0:10:30	0:02:00	5	3.5	0:12:36	0:51:24
Vaccination Room	1	0.4	0:03:00	0:09:00	--	--	--	--
Waiting Area	11	4.6	0:15:53	0:00:40	8	5.6	0:20:00	0:01:52
X-Ray	6	2.5	0:06:50	0:02:30	4	2.8	0:15:15	0:01:00
Grand Total	237	100	0:07:47	0:04:59	143	100	0:08:53	0:07:39

APPENDIX - 4 TREATMENTS / DEPARTMENT / SERVICE (SERVICE 5 AND 6)

Treatment / Department / Activity	Treatment / Department / Service 5				Treatment / Department / Service 6			
	No. of Patients	% of Patients	Average Service Time Treatment 5	Average Waiting Time (Treatment 4 – 5)	No. of Patients	% of Patients	Average Service Time Treatment 6	Average Waiting Time (Treatment 5 – 6)
Billing	11	16.4	0:03:55	0:01:16	4	9.1	0:03:45	0:00:30
Counseling	--	--	--	--	1	2.3	0:05:00	0:00:00
Dental Operatory	3	4.5	0:02:20	0:03:00	4	9.1	0:13:00	0:01:45
Dermatology	--	--	--	--	1	2.3	0:05:00	0:00:00
Diabetes Clinic	1	1.5	0:02:00	0:08:00	--	--	--	--
ECG	2	3.0	0:13:00	0:05:00	--	--	--	--
Gynecology	2	3.0	0:03:30	0:07:30	1	2.3	0:10:00	0:18:00
Infertility Clinic	3	4.5	0:27:00	1:02:20	--	--	--	--
Medical Officer	2	3.0	0:09:30	0:02:00	--	--	--	--
Ophthalmology	2	3.0	0:03:30	0:21:30	1	2.3	0:01:00	0:00:00
Optometry	1	1.5	0:01:00	0:00:00	1	2.3	0:01:00	0:12:00
Orthopedic	1	1.5	0:02:00	0:20:00	2	4.5	0:13:30	0:01:00

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Pathology	3	4.5	0:09:40	0:01:20	5	11.4	0:05:24	0:02:00
Pediatrics	--	--	--	--	1	2.3	0:06:00	0:00:00
Pharmacy	15	22.4	0:03:44	0:02:00	12	27.3	0:05:30	0:02:25
Physician	1	1.5	0:02:00	1:58:00	1	2.3	0:06:00	0:02:00
Radiology	1	1.5	0:17:00	0:00:00	1	2.3	0:05:00	0:01:00
Sonography	3	4.5	0:24:00	0:12:00	--	--	--	--
Surgery	4	6.0	0:09:15	0:03:15	3	6.8	0:04:20	0:26:20
USG	3	4.5	0:31:40	0:05:00	4	9.1	0:30:30	0:02:00
Waiting Area	9	13.4	0:34:20	0:01:07	1	2.3	0:02:00	0:01:00
Women's Health	--	--	--	--	1	2.3	0:02:00	0:00:00
Grand Total	67	100	0:12:07	0:08:00	44	100	0:08:18	0:03:53

APPENDIX - 5 TREATMENTS / DEPARTMENT / SERVICE (SERVICE 7 AND 8)

Treatment / Department / Activity	Treatment / Department / Service 7				Treatment / Department / Service 8			
	No. of Patients	% of Patients	Average Service Time Treatment 7	Average Waiting Time (Treatment 6 – 7)	No. of Patients	% of Patients	Average Service Time Treatment 8	Average Waiting Time (Treatment 7 – 8)
Billing	3	10.7	00:02:40	00:01:20	2	22.2	0:04:00	0:10:30
CT Scan	1	3.6	02:54:00	00:00:00	--	--	--	--
Diabetes Clinic	1	3.6	00:05:00	00:03:00	--	--	--	--
Gynecology	2	7.1	00:05:30	00:00:30	--	--	--	--
Medical Officer	1	3.6	00:02:00	00:02:00	1	11.1	0:06:00	0:01:00
Optometry	1	3.6	00:08:00	00:00:00	--	--	--	--
Orthopedic	1	3.6	00:06:00	00:01:00	--	--	--	--
Pathology	2	7.1	00:05:30	00:00:30	1	11.1	0:03:00	0:00:00
Pharmacy	12	42.9	00:05:20	00:11:35	4	44.4	0:07:00	0:03:45
Physiotherapy	1	3.6	00:02:00	00:05:00	--	--	--	--
Sonography	1	3.6	00:12:00	00:00:00	--	--	--	--
Waiting Area	2	7.1	00:03:30	00:00:30	1	11.1	0:43:00	0:01:00
Grand Total	28	100	00:11:04	00:05:36	9	100	0:09:47	0:04:13

APPENDIX -6 TREATMENTS / DEPARTMENT / SERVICE (SERVICE 9 AND 10)

Treatment / Department / Activity	Treatment / Department / Service 9				Treatment / Department / Service 10			
	No. of Patients	% of Patients	Average Service Time Treatment 9	Average Waiting Time (Treatment 8 – 9)	No. of Patients	% of Patients	Average Service Time Treatment10	Average Waiting Time (Treatment 9 – 10)
Gynecology	1	33.33	00:03:00	00:06:00	--	--	--	--
Pathology	1	33.33	00:02:00	00:02:00	--	--	--	--
Pharmacy	--	--	--	--	2	100	00:05:00	00:03:30
Waiting Area	1	33.33	00:01:00	00:01:00	--	--	--	--
Grand Total	3	100	00:02:00	00:03:00	2	100	00:05:00	00:03:30