

## STATISTICAL ANALYSIS OF WAITING TIME OF PATIENTS BY QUEUING TECHNIQUES: CASE STUDY OF LARGE HOSPITAL IN PAKISTAN

Muhammad Ahmed Kalwar<sup>a\*</sup>, Muhammad Saad Memon<sup>b</sup>, Muhammad Ali Khan<sup>b</sup>,  
Anwaruddin Tanwari<sup>c</sup>

<sup>a</sup> Assistant Manager, Shafi Private Limited, Lahore, Pakistan.

<sup>b</sup> Assistant Professor, Industrial Engineering & Management, Mehran UET, Jamshoro, Sindh, Pakistan.

<sup>c</sup> Professor(Ex), Industrial Engineering & Management, Mehran UET, Jamshoro, Sindh, Pakistan.

[a kalwarama@gmail.com](mailto:kalwarama@gmail.com)

### Abstract:

The purpose of this empirical research was to analyze the comfortable waiting time (CWT) of patients at the outpatient department (OPD) of Gastrology of ABC hospital of Karachi. It is based on the analysis of CWT of patients who were being served at the OPD of Gastrology of ABC hospital of Karachi. The data was collected by the help of questionnaire. Altogether 250 questionnaires were distributed among the patients, 210 of them were collected back and 10 of them were incompletely filled. Data was analysed in the statistical package for social sciences (SPSS) version 22. Data analysis included frequency distribution of various demographics; stratification tables were made for the comparison of CWT across various demographics. Results indicated that more females (old aged) had greater CWT in the comparison of males. It is found that the mean CWT of patients decreased with decreasing age, increasing OPD visiting time and increasing income. It is also found that the mean CWT for the patients from Afghanistan was greater than the patients from other regions i.e. Baluchistan, interior Sindh and Karachi. The authors highlighted that when patients arrive at the hospital and wait for their service, in this scenario, waiting cost is associated with their waiting time; since it is the matter of cost, thus it should be known to the hospital that if patients are made to wait longer, it can lead to the customer dissatisfaction. In this regard, analysis of comfortable waiting time of patients was extremely needed. Since, Karachi is the biggest city of Pakistan and targeted hospital is one the biggest private hospitals of Karachi and in the analysis of this paper. Only 200 patients were approached for data collection which is the main limitation of the paper. In future, the researchers should also focus on the same OPD for more responses and at the same time, other departments can also be targeted for conclude better and precise results. The authors have tried to focus on the CWT of patients so that the waiting capacity of patients could be highlighted. At the same time, detailed analysis was conducted across demographics so that their influence on CWT could be analysed.

**Keywords:** comfortable waiting time; queuing system; healthcare; out-patient department.

**Cite as:** Kalwar, M.A, Memon, M.S., Khan, M.A., Tanwari, A. (2021). Statistical analysis of waiting time of patients by queuing techniques: case study of large hospital in Pakistan. *J Appl Res Eng Technol & Engineering*, 2(2), 101-112. <https://doi.org/10.4995/jarte.2021.14741>

### 1. Introduction

Healthcare has been defined by World health Organization (WHO), 2000 that "all organizations, institutions and resources that are devoted for producing health actions" (Musgrove et al., 2000). Health care is always expected to serve the population's medical needs in efficient way. To improve the health of countrymen is one of the main objectives of healthcare (Mashhadi et al., 2016; Musgrove et al., 2000). Researchers and practitioners have always taken interest in the patient flow at hospitals with the assumption that patient satisfaction can be improved by improving the hospital's patient flow (Armony et al., 2015). In recent years, patients' satisfaction perspective has been taken seriously in healthcare (Khamis & Njau, 2014). Patient satisfaction and quality of service are closely associated with each other; good service quality

yields patients' engagement which result in his/her strong relationship with the hospital (Surydana, 2017). Defines service quality as difference between real and expected service quality to be provided (Surydana, 2017). Nowadays, patients have many options to decide to have the healthcare service (Yeddule, 2012). Patient satisfaction and the image of company are the most important factors to influence and retain customers (Juhana et al., 2015). In Pakistani hospitals, ignorance in healthcare service quality and lacking in the process are not considered as the major problem of healthcare facilities (Sajid et al., 2008). With the growing population, patients' visits to the hospital are observed to be increasing because of relationship between health and development; since Pakistan is counted to be 6<sup>th</sup> largely populated country with the population of 191.70 million and growth rate of 1.71% (Mashhadi et al., 2016). In the way to the overall

\*Corresponding author: Muhammad Ahmed Kalwar, [kalwarama@gmail.com](mailto:kalwarama@gmail.com)

development of Pakistan, poor healthcare services are acting as hindrances (Mustafa, 2015). Therefore, it is extremely needed for to enhance and improve their service so that the countrymen can be provided better healthcare. Hospitals are known as the basic and major link in healthcare and lives of the people are directly affected by healthcare service quality (Gunal, 2012; Dong et al., 2015). They play their major role in prevention of disease, its earlier detection, treatment and recovery of patients (Haghighinejad et al., 2016). Occupancy and discharge rate of patients is main global focus of the hospitals for the calculation of their executive capacity. Applications of management sciences and industrial engineering can be used by managers for planning and managing resources (Gunal, 2012). An explicit framework is required to be made for the performance management by the help of which, performance of resources can be quantified (Tandon et al., 2002). Because of inconsistencies in the monitoring of customer services, demand of service can complicate the capacity planning of the departments (Goienetxea et al., 2015).

Over crowdedness of patients at reception, emergency departments (EDs), intensive care units (ICUs), outpatient departments and waiting areas is one of the major problems of hospitals (Kalwar et al., 2018; Kalwar et al., 2020b; Khaskheli et al., 2020). In the last decade, EDs are stressed for problem of congestion and ability of hospital to come across emergency needs and their impact on the service time (Haghighinejad et al., 2016). This is the result of inadequate queuing system of hospital in its various areas. Formation of queue is the common occurrence (Agyei et al., 2015; Kembe et al., 2012; Mwangi & Ombuni, 2015; Obamiro, 2010; Winston, 2004; Yusuff, 2015). When the number of doctors are less than number of patients then queue is to be formed. ED and outpatient department (OPD) are the most visited departments of any hospital and they are initial confrontation of hospital's staff and its service (Wang et al., 2009). In the way to consult the doctor, a long queue is the most highlighted problem patients face at the hospital (Kalwar et al., 2018; Kalwar et al., 2020b; Khaskheli et al., 2020). Delay is the subtraction of service demand and the capacity available to come across that demand (Green, 2011). Patients' long waiting times in the queue result in the dissatisfaction of patients (Obamiro, 2010). Due to long queues and over crowdedness, doctors don't even examine the patients deeply because of stress of serving large crowd of patients; which again leads to patients dissatisfaction (Obamiro, 2010; Kembe, 2012; Khamis & Njau, 2014). Patient waiting time in hospitals is often the major reason for patients' complaints regarding their experiences in assessing care. Therefore, patient satisfaction with waiting time plays a crucial role in the overall satisfaction with services (Ekpe & Peter, 2016). It should be highlighted for sure that customer dissatisfaction incurs cost to the organization i.e. cost of dissatisfaction (Imahsunu, 2007; Haghighinejad et al., 2016). In healthcare systems, patient's satisfaction has been the benchmark for provision of desired healthcare delivery. Patient satisfaction is associated with the patients' waiting time they spend in healthcare facility to see the doctor (Umar et al., 2011). Patients' satisfaction is affected by the shorter waiting time of patients (Akbari et al., 2009). There is need for the hospital to find a way of reducing the long waiting time in the hospital (Ekpe & Peter, 2016).

## 2. Literature Review

In doctor's waiting room, to wait is the common phenomenon (Ariffin et al., 2017). Healthcare delivery centers would be in serious problems if the problem of WT is not adequately solved (Aburayya et al., 2020). Ekpe and Peter (2016) conducted a cross-sectional study with the objective of investigating the patients' assessment and satisfaction of provided services at the department of Surgery. Generally, patients were found to be satisfied with the ease of assessing care in the hospital. Whereas, waiting time of >60 minutes for services at the surgical outpatient department (SOPD), accident and emergency (A&E), Laboratories, Blood bank, medical records, and pharmacy were 41.7%, 22.72%, 31.03%, 21.05%, 16.67%, and 14.29% respectively (Ekpe & Peter, 2016). Kalwar et al., 2018 conducted research to measure the comfortable waiting time of patients across various demographics. Questionnaire was used for data collection and it was collected from 200 patients. It was indicated that the comfortable waiting time of either gender was found to be the same: whereas, it was found to be different across the various age groups: moreover, patients with varying OPD visiting experience (1st, 2nd, 3rd) were also found to be with the same comfortable waiting time (Kalwar et al., 2018). Umar et al. (2011) conducted a cross-sectional descriptive study at the out patients' departments of the Usmanu Danfodiyo University, Sokoto. The study was based on 384 randomly selected patients. Pretested questionnaire was used for data collection. Results indicated that 118 (31%) patients waited <60 minutes in waiting room, 371 (96.6%) waited <30 minutes with the doctor. Two hundred eleven (55%) were found to be satisfied with the service delivery in the hospital, whereas, only 63 (16%) patients admitted to being given health talks while waiting to be seen by the doctor (Umar et al., 2011). Burström et al. (2013) conducted a research on waiting management at the emergency department (ED). The objective of the research was to minimize the non-acceptable waiting time. Signs for non-acceptable waiting were defined i.e. contact seeking, physical densification and critical situations. Staff of the ED felt like being frustrated, shameful and eventually they resigned from the job when they could not minimize non-acceptable waiting. This problem was resolved either by increasing patients' throughput by structure pushing and shuffling them around or by changing the waiting experience by calming them down and fainting maneuvers to cover up (Burström et al., 2013). Shaikh et al. (2012) conducted a research on the evaluation of patients' threshold for waiting at the emergency department. Three hundred seventy five patients were approached for data collection and 340 (91%) from them participated. One hundred and seventy one (51%) responded that they were willing to wait up to 2 hours before leaving, 58 (17%) responded to wait from 2 to 8 hours, and 110 (32%) responded to wait indefinitely. No association between insurance status, race, gender, or perceived symptom severity. Patients who could wait >2 hours were found to be older than 25 (Shaikh et al., 2012). Aburayya et al. (2020) analyzed the waiting time (WT) at healthcare delivery centers in Dubai it was tried to be minimized. Universal sampling approach was used for data collection and WT of patients was recorded for a month by the use of an electronic medical record audit. Total obtained records and collected questionnaires were counted to be 76,780 and 938 respectively. Results

indicated that 45.2% patients got registered themselves in <7 minutes and their average visiting and WT was 11.7 minutes after entrance. Moreover, 75.3% patients' WT was half an hour and average time of their consultation was calculated to be 34.2 minutes. The average WT of patients for their appointment was 35 days. The reasons behind that must WT were higher workload, inadequate procedure of work, availability of facilities and interaction between employees and supervisors (Aburayya et al., 2020). Companies needs to innovate their process and machines for improving the productivity and efficiency (Arain et al., 2020; Kalwar & Khan, 2020a; Kalwar & Khan, 2020b). Aggressive driving is also known as road rage (Kalwar et al., 2020a; Khaskheli et al., 2018). Constanzo et al. (2020) reported that 56,614 patients were waiting for their first adult appointment with neurologist and this was because of shortage of doctors in Chile. This study was conducted at Hospital Las Higueras de Talcahuano (HHT) in Chile where Teleneurology Program was implemented in 2015 in order to minimize the WT of patients for having their first consultation with the neurologist. Data was collected from the primary, secondary and tertiary care centers and it was revealed that between 2013 and 2018, total number of 8269 patients were referred to HHT neurology clinic. Data analysis included the cox regression technique by which the factors having the impact on the outcome were analyzed. Results indicated that 1743 patients used the channel of teleneurology program for consultation, whereas, 6526 consulted at HHT. Decrease in the number of patients (from 3084 to 298) was reported till 2018 (Constanzo et al., 2020). Ahmad et al. (2017) aimed to analyze the doctor's consultation time and WT at primary healthcare clinic so that the adequate strategies could be formulated for the improvement. Universal sampling technique was used in this research and it was conducted in the time period of four weeks. The patients who had visits in that period were put into the inclusion criteria. Arrival time of patients was recorded by using queue management system (QMS); in that patients were given the paper and the staff was supposed to write the time manually on that paper at every stage (registration, before consultation, consultation, and appointment, payment and pharmacy and consultation time) at the clinic. Data was analyzed in statistical package for social sciences (SPSS). The 53% of patients were indicated to be registered in the duration of 15 minutes and overall WT of patients from registration to seeing a doctor was calculated to be 41 minutes. The 99% patients' WT for getting their medicines was <30 minutes; mean time of consultation was calculated to be 18.21 minutes. For the improvement of system, number of staff was increased at the registration counter, staggered appointment system was introduced for follow-up patients and queuing system was improved for walk in patients Ahmad et al. (2017). Present research was conducted to analyze the comfortable waiting time (CWT) of patients of different groups coming the OPD of Gastrology at ABC hospital of Karachi, Sindh Pakistan; so that the hospital can be informed to improve their service for their greater good and so the patients/customers.

### 3. Research Gap

In this world every man is busy in his business, job etc. This is because they may have reasonable or no time to

spend at hospital while waiting for the service. In already conducted research presented under the heading of literature review, just waiting time of patients was collected, analyzed and reduced/minimized. As mentioned earlier, that it is matter of waiting cost and because this, there is the question of affordability and reasonableness. In this regard, former question give birth to the question of waiting capacity; in other words, the time for which the patients can wait comfortably: so that the patients could be saved from loss (higher opportunity cost). In this regard, in the present research paper, it was tried to focus on the CWT of patients so that the waiting capacity of patients could be highlighted. At the same time, detailed analysis of Cottas conducted across demographics so that their influence on CWT could be analyzed.

## 4. Research Methodology

### 4.1. Data Collection

This empirical research was conducted in the setting of OPD of Gastrology of ABC hospital of Karachi. Data was collected by the help of closed ended questionnaire, which was designed by reviewing the literature. It was consisted on two sections i.e. demographics and other variables. Section 1 was consisted of five characteristics i.e. gender, age, income, OPD visiting time and region. Section 2 was consisted of 6 questions. Two hundred twenty questionnaires were distributed among the patients; 210 questionnaires were collected back and 10 responses were found to be incompletely filled therefore, they were excluded.

### 4.2. Data Analysis

Two hundred questionnaires were put into the statistical package for social sciences (SPSS) version 22 and MS excel for data analysis. Frequency distribution of various demographics was conducted. Stratification tables were made for the comparison of CWT across various demographics. Frequency distribution of waiting time patients was plotted on line chart in MS excel; moreover, mean and standard deviation of CWT of patients was calculated in detail across each of the demographic characteristic.

## 5. Results

Frequency distribution of demographics and questions was conducted. On the same time, frequencies of CWT were compared across various demographics and the options of various questions (see Table 2).

### 5.1. Frequency Distribution of Demographics and CWT along with its Mean+SD

Frequency distribution shows that there were 80 (40%) male respondents and 120 (60%) were females. Age was categorized into four different groups i.e. teenager (12-19) years = 9 (4.5%), young (20-30) years = 29 (14.5%), middle aged (31-40) years = 61 (30.5%), old Aged (>40) years = 101 (50.5%). Mean age was calculated to be 42.24±14 years.

Income of the respondents was categorized into three classes i.e. lower class (Rs.20000-Rs.40000) = 79 (39.5%), lower middle class (Rs.25000-Rs.65000) = 34 (17%), upper middle class (Rs.65000-Rs.250000) = 87 (43.5%). Mean income was computed to be Rs.64350 + Rs.36879.92. Respondents were from four different regions i.e. Afghanistan = 60 (30%), Baluchistan = 87 (43.5%), interior Sindh = 30 (15%), Karachi = 23 (11.5%). Respondents who visited OPD had different visiting experiences i.e. 1st Time = 133 (66.5%), 2nd Time = 32 (16%), 3rd Time = 24 (12%), 4th Time = 11 (5.5%). Respondents could wait comfortably for varying magnitude of time i.e. 15 minutes = 1 (0.5%), 20 minutes = 1 (0.5%), 30 minutes = 14 (7%), 45 minutes = 27 (13.5%), 60 minutes = 127 (63.5%), 90 minutes = 30 (15%). Mean comfortable waiting time of patients was computed to be 59.95 + 15.74 minutes.

### 5.2. Comfortable Waiting Time of Patients

Graphical representation of comfortable waiting time of patients indicates that comfortable waiting time of patients ranged from 15 - 90 minutes as shown in Figure 1 and Table 1 as well.

**Table 1:** Distribution of Demographic characteristics.

Demographic Characteristics	N(%)	Mean±SD
<b>Gender</b>		
Female	120(60.00%)	
Male	80(40.00%)	
<b>Age</b>		
Middle Aged (31-40) years	61(30.50%)	42.24 ± 14
Old Aged (>40) years	101(50.50%)	
Teenager (12-19) years	9(4.50%)	
Young (20-30) years	29(14.50%)	
<b>Class</b>		
lower Class (Rs.20000-Rs.40000)	79(39.50%)	64350 ± 36879.92
Lower Middle Class (Rs.25000-Rs.65000)	34(17.00%)	
Upper Middle Class (Rs.65000-Rs.250000)	87(43.50%)	
<b>Region</b>		
Afghanistan	60(30.00%)	
Baluchistan	87(43.50%)	
Interior Sindh	30(15.00%)	
Karachi	23(11.50%)	
<b>OPD Visiting Time</b>		
1st Time	133(66.50%)	
2nd Time	32(16.00%)	
3rd Time	24(12.00%)	
4th Time	11(5.50%)	
<b>Comfortable Waiting Time of Patients</b>		
		Mean±SD
15 minutes	1(0.50%)	59.95 ± 15.74
20 minutes	1(0.50%)	
30 minutes	14(7.00%)	
45 minutes	27(13.50%)	
60 minutes	127(63.50%)	
90 minutes	30(15.00%)	

**Table 2:** Frequency distribution of various questions.

Variables	n(%)
<b>When you visit the hospital, mostly how many people you are?</b>	
Accompanied	192(96.00%)
Unaccompanied	8(4.00%)
<b>Are you happy with the serving time?</b>	
No	15(7.50%)
Yes	185(92.50%)
<b>If no to Q3, how have you solved the issue?</b>	
Tried to jump at the queue	8(4.00%)
Waited until served	192(96.00%)
<b>Have you ever turned away due to longer time being taken to be served?</b>	
No	195(97.50%)
Yes	5(2.50%)
<b>How do you rate the serving time?</b>	
Competitive	106(53.00%)
Moderate	91(45.50%)
Slow	3(1.50%)

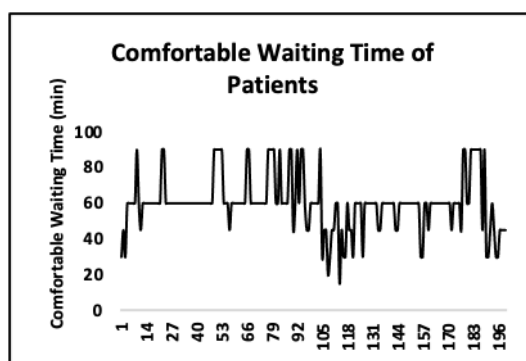
### 5.3. Frequency Distribution of Other Variables

Frequency distribution of the various question indicates that 192 (96%) respondents came accompanied to the OPD whereas, 8 (4%) respondents came unaccompanied. Fifteen (7.5%) respondents were not happy with the serving time of OPD and 185 (92.5%) were happy with the serving time. Eight (4%) respondents tried to jump at the queue and 192 (96%) of them waited until they were served. When the question of turning away because of longer waiting time was asked from the respondents; 195 (97.5%) of them responded 'no' and remaining 5 (2.5%) responded 'yes'.

A hundred and six (53%) of the respondents ranked the serving time as 'competitive'; 91 (45.5%) of them ranked it moderate and 3 (1.5%) ranked the serving time OPD as 'slow' as shown in the Table 2.

#### 5.3.1. CWT across Various Demographics and Variables

Presentation of CWT (frequency distribution, mean and standard deviation) across various demographics and variables is shown in the Table 3. It can be seen in the



**Figure 1:** Graphic representation of data of CWT.

table 3 that the frequency of patients was found to be greater, who's CWT was one an hour. Comparison of CWT across gender indicates that, there were 88 (44%) and 14 (7%) females, whose CWT was 60 and 90 minutes respectively whereas 39 (19.5%) and 16 (8%) males had that much waiting time of 60 and 90 minutes respectively. Mean CWT of males and females was computed to be  $60 \pm 17.70$  and  $59.91 \pm 14.36$  respectively. There were 43 (21.5%) middle aged patients who could wait comfortably for an hour; 69 (34.5%) old aged patients who could wait for comfortably for an hour; and there were only 6 (3%) and 9 (4.5%) teenagers and young patients who could wait comfortably for an hour. Mean comfortable time for middle aged patients was computed

to be  $56.55 \pm 12.06$  minutes, for old aged patients, it was  $59.30 \pm 14.61$  minutes, for teenagers and young patients, it was calculated to  $70 \pm 15$  and  $66.20 \pm 22.86$  minutes respectively. Frequency distribution of CWT across income indicated that maximum number of patients [58 (29%)] had the CWT of 60 minutes ( $62.08 \pm 15.87$ ) and they were from upper middle class; there were 20 (10%) patients who could wait for an hour ( $52.20 \pm 14.04$ ) from lower middle class and from lower class there were 49 (24.5%) patients, who could wait comfortably for an hour ( $60.94 \pm 15.44$ ) at the OPD (see Table 3). There were 39 (19.5%) patients, whose CWT was one hour ( $65.5 \pm 17.01$ ); 69 (34.5%) patients from Baluchistan had the CWT of an hour ( $64.13 \pm 11.81$ ); 17 (8.5%) patients

**Table 3:** Comparison of comfortable waiting time (CWT) of patients across various demographics and responses of various questions.

Variables	How long can you wait comfortably in the outpatient department (OPD)?						Total	Mean±SD of CWT
	15 min	20 min	30 min	45 min	60 min	90 min		
<b>Gender</b>								
Female	1(0.50%)	1(0.50%)	7(3.50%)	9(4.50%)	88(44.00%)	14(7.00%)	120(60.00%)	60 ± 17.70
Male	-	-	7(3.50%)	18(9.00%)	39(19.50%)	16(8.00%)	80(40.00%)	59.91 ± 14.36
<b>Age</b>								
Middle Aged	-	-	5(2.50%)	10(5.00%)	43(21.50%)	3(1.50%)	61(30.50%)	56.55 ± 12.06
Old Aged	-	1(0.50%)	7(3.50%)	12(6.00%)	69(34.50%)	12(6.00%)	101(50.50%)	59.30 ± 14.61
Teenager	-	-	-	-	6(3.00%)	3(1.50%)	9(4.50%)	70 ± 15
Young	1(0.50%)	-	2(1.00%)	5(2.50%)	9(4.50%)	12(6.00%)	29(14.50%)	66.20 ± 22.86
<b>Income Class</b>								
lower Class	1(0.50%)	-	2(1.00%)	14(7.00%)	49(24.50%)	13(6.50%)	79(39.50%)	60.94 ± 15.44
Lower Middle Class	-	1(0.50%)	5(2.50%)	7(3.50%)	20(10.00%)	1(0.50%)	34(17.00%)	52.20 ± 14.04
Upper Middle Class	-	-	7(3.50%)	6(3.00%)	58(29.00%)	16(8.00%)	87(43.50%)	62.08 ± 15.87
<b>Region</b>								
Afghanistan	-	-	5(2.50%)	-	39(19.50%)	16(8.00%)	60(30.00%)	65.5 ± 17.01
Baluchistan	-	-	-	4(2.00%)	69(34.50%)	14(7.00%)	87(43.50%)	64.13 ± 11.81
Interior Sindh	-	-	1(0.50%)	12(6.00%)	17(8.50%)	-	30(15.00%)	53 ± 8.57
Karachi	1(0.50%)	1(0.50%)	8(4.00%)	11(5.50%)	2(1.00%)	-	23(11.50%)	38.69 ± 11.40
<b>OPD Visiting Time</b>								
1st Time	1(0.50%)	-	12(6.00%)	19(9.00%)	81(40.50%)	21(10.50%)	134(67.00%)	59.88 ± 16.04
2nd Time	-	1(0.50%)	1(0.50%)	2(1.00%)	25(12.50%)	3(1.50%)	32(16.00%)	59.68 ± 13.49
3rd Time	-	-	-	4(2.00%)	16(8.00%)	4(2.00%)	24(12.00%)	62.5 ± 13.75
4rth Time	-	-	1(0.50%)	2(1.00%)	5(2.50%)	2(1.00%)	10(5.00%)	59.50 ± 22.34
<b>When you visit the hospital, how many are you mostly?</b>								
Accompanied	-	1(0.50%)	11(5.50%)	6(3%)	125(62.50%)	30(15.00%)	192(96.00%)	60.80 ± 15.17
Unaccompanied	1(0.5%)	-	3(1.5%)	2(1%)	2(1.00%)	-	8(4.00%)	39.375 ± 15.90
<b>Are you happy with the serving time?</b>								
No	-	1(0.50%)	6(3.00%)	6(3%)	2(1.00%)	-	15(7.50%)	39.33 ± 11.78
Yes	1(0.50%)	-	8(4.00%)	21(10.5%)	125(62.50%)	30(15.00%)	185(92.50%)	61.62 ± 14.82
<b>If no to Q3, how have you solved the issue?</b>								
Tried to jump at the queue	1(0.50%)	1(0.5%)	1(0.50%)	3(1.5%)	2(1.00%)	-	8(4.00%)	40 ± 16.90
Waited until served	-	-	13(6.50%)	24(12%)	125(62.50%)	30(15.00%)	192(96.00%)	60.78 ± 15.17
<b>Have you ever turned away due to longer time being taken to be served?</b>								
No	No	1(0.50%)	1(0.50%)	11(5.5%)	25(12.50%)	127(63.50%)	30(15.00%)	195(97.5%)
Yes	Yes	-	-	3(1.5%)	2(1.00%)	-	-	5(2.5%)
<b>How do you rate the serving time?</b>								
Competitive	-	-	3(1.50%)	7(3.5%)	75(37.50%)	21(10.50%)	106(53.00%)	64.10 ± 14.27
Moderate	1(0.50%)	1(0.50%)	11(5.50%)	17(8.5%)	52(26.00%)	9(4.50%)	91(45.50%)	55.60 ± 16.22
Slow	-	-	-	3(1.5%)	-	-	3(1.50%)	45 ± 0

from interior Sindh had the CWT of an hour (53 ± 8.57); only 2 (1%) Karachi patients (i.e. from Karachi) had the CWT of one an hour (38.69 ± 11.40). It can be seen in the table 3 that frequency of patients' CWT after each visit decreases. The frequency of patients with first visit whose CWT was 60 minutes was 81 (40.5%) and mean CWT was 59.88 ± 16.04; 2<sup>nd</sup> visit frequency was 25 (12.5%) with mean CWT 59.68 ± 13.49; 3<sup>rd</sup> visit frequency was 16 (8%) with mean CWT 62.5 ± 13.75 and 4<sup>th</sup> visit frequency was 5 (2.5%) with mean CWT 59.50 ± 22.34.

Frequency of patients who came accompanied to the OPD and whose CWT was one an hour was taken out to be 125 (62.5%) with mean CWT 60.80 ± 15.17; whereas, frequency of those patients who came unaccompanied and whose CWT was one an hour was taken out to be 2 (1%) with the mean CWT 39.375 ± 15.90. In the below given tables i.e. 4, 5, 6, 7, 8, 9, the detailed frequency of against CWT across various demographics has been presented.

### 5.4. Comparison of CWT across Demographics

Detailed analysis of CWT across each of the demographics along with its mean and standard deviations is presented in the below given headings.

#### 5.4.1. Comparison of CWT across Gender and Age

Frequency distribution, mean and standard deviation of CWT across gender and age groups is presented in the Table 4 shown below. It can be seen that the quantity of female patients having the CWT of 60 minutes is greater. Fifty-one (25.5%) female patients had the CWT of 60 minutes whereas, 11 (5.5%) young females had the

CWT of 90 minutes (see Table 4). Moreover, there were only 17 middle aged males and 18 old aged males having the CWT of 60 minutes; interestingly, there were 12 old aged males having the CWT of 90 minutes at the OPD (see Table 4).

#### 5.4.2. Comparison of CWT across Gender and OPD Visiting Time

Frequency distribution, mean and standard deviation of CWT across gender and visiting time groups is presented in the Table 5 shown below. Fifty-one (25.5%) female patients who came for the first time at the OPD had the CWT of 60 minutes and 30 (15%) males had the same CWT who came for first time at the OPD (see Table 5). A look at the Table 5 shows that CWT decreases with increasing visiting time of patients surprisingly slow in females and faster in male patients. It can also be noted that less male patients greater CWT in the comparison female patients.

#### 5.4.3. Comparison of CWT across Income Class and Age

Frequency distribution, mean and standard deviation of CWT across income class and age groups is presented in the Table 6 shown below. It can be seen in the Table 6 that there were 23 (11.5%) old aged lower class patients, 15 (7.5%) old aged patients from lower middle class and 31 (15.5%) old aged patients who's CWT was 60 minutes. Old aged patients were indicated to have the greater waiting capacity in the comparison of other age groups. It was also seen in the analysis that greater number of patients from upper middle class was noted for their longer CWT (see Table 6).

**Table 4:** Frequency distribution and mean ± standard deviation of comfortable waiting time (CWT) of respondents across gender and age.

Gender	Age	How long can you wait comfortably in the outpatient department (OPD)?						Total	Mean±SD of CWT
		15 min	20 min	30 min	45 min	60 min	90 min		
Female	Middle Aged	-	-	1(0.50%)	3(1.50%)	26(13.00%)	1(0.50%)	31(15.50%)	57.6 ± 15.73
	Old Aged	-	1(0.50%)	4(2.00%)	3(1.50%)	51(25.50%)	-	59(29.50%)	61.76 ± 15.48
	Teenager	-	-	-	-	5(2.50%)	2(1.00%)	7(3.50%)	72.85 ± 16.03
	Young	1(0.50%)	-	2(1.00%)	3(1.50%)	6(3.00%)	11(5.50%)	23(11.50%)	73.75 ± 17.46
Male	Middle Aged	-	-	4(2.00%)	7(3.50%)	17(8.50%)	2(1.00%)	30(15.00%)	51.81 ± 10.31
	Old Aged	-	-	3(1.50%)	9(4.50%)	18(9.00%)	12(6.00%)	42(21.00%)	56.81 ± 13.35
	Teenager	-	-	-	-	1(0.50%)	1(0.50%)	2(1.00%)	60 ± 0
	Young	-	-	-	2(1.00%)	3(1.50%)	1(0.50%)	6(3.00%)	60.88 ± 25.13

**Table 5:** Frequency distribution and mean ± standard deviation of comfortable waiting time (CWT) of respondents across gender and outpatient department (OPD) visiting experience.

Gender	OPD Visiting Experience	How long can you wait comfortably in the OPD?						Total	Mean ± STD of CWT
		15 min	20 min	30 min	45 min	60 min	90 min		
Female	1st Time	-	-	7(3.50%)	9(4.50%)	51(25.50%)	14(7.00%)	81(40.50%)	61.95 ± 15.28
	2nd Time	-	1(0.50%)	-	-	23(11.50%)	-	24(12.00%)	58.33 ± 15.81
	3rd Time	-	-	-	-	12(6.00%)	-	12(6.00%)	65 ± 16.69
	4th Time	1(0.50%)	-	-	-	2(1.00%)	-	3(1.50%)	56.25 ± 7.51
Male	1st Time	-	-	5(2.50%)	10(5.00%)	30(15.00%)	7(3.50%)	52(26.00%)	55.24 ± 16.91
	2nd Time	-	-	1(0.50%)	2(1.00%)	2(1.00%)	3(1.50%)	8(4.00%)	60.21 ± 12.83
	3rd Time	-	-	-	4(2.00%)	4(2.00%)	4(2.00%)	12(6.00%)	58.33 ± 5
	4th Time	-	-	1(0.50%)	2(1.00%)	3(1.50%)	2(1.00%)	8(4.00%)	55.71 ± 28.34

**Table 6:** Frequency distribution and mean ± standard deviation of comfortable waiting time (CWT) of respondents across income and age.

Income	Age	How long can you wait comfortably in the OPD?						Total	Mean ± STD of CWT
		15 min	20 min	30 min	45 min	60 min	90 min		
lower Class	Middle Aged	-	-	1(0.50%)	6(3.00%)	16(8.00%)	1(0.50%)	24(12.00%)	56.25 ± 11.05
	Old Aged	-	-	1(0.50%)	3(1.50%)	23(11.50%)	-	27(13.50%)	57.22 ± 7.25
	Teenager	-	-	-	-	3(1.50%)	2(1.00%)	5(2.50%)	72 ± 16.43
	Young	1(0.50%)	-	-	5(2.50%)	7(3.50%)	10(5.00%)	23(11.50%)	67.82 ± 22.09
Lower Middle Class	Middle Aged	-	-	3(1.50%)	2(1.00%)	3(1.50%)	-	8(4.00%)	45 ± 13.88
	Old Aged	-	1(0.50%)	2(1.00%)	5(2.50%)	15(7.50%)	-	23(11.50%)	52.39 ± 12.04
	Teenager	-	-	-	-	1(0.50%)	-	1(0.50%)	60 ± 0
	Young	-	-	-	-	1(0.50%)	1(0.50%)	2(1.00%)	75 ± 21.21
Upper Middle Class	Middle Aged	-	-	1(0.50%)	2(1.00%)	24(12.00%)	2(1.00%)	29(14.50%)	60 ± 10.6
	Old Aged	-	-	4(2.00%)	4(2.00%)	31(15.50%)	12(6.00%)	51(25.50%)	63.52 ± 17.12
	Teenager	-	-	-	-	2(1.00%)	1(0.50%)	3(1.50%)	70 ± 17.32
	Young	-	-	2(1.00%)	-	1(0.50%)	1(0.50%)	4(2.00%)	52.5 ± 28.72

**5.4.4. Comparison of CWT across Income Class and OPD Visiting Time**

Frequency distribution, mean and standard deviation of CWT across income class and OPD visiting time is presented in the Table 7 shown below. Thirty-three (16.5%) and 38 (19%) patients from lower class and upper middle class were indicated to have CWT of 60 minutes and they came to the OPD for first time respectively. There were 13 (6.5%) and 7 (3.5%) patients from lower class and upper middle class had CWT of 90 minutes respectively and they also came for the first time at the OPD (see Table 7).

**5.4.5. Comparison of CWT across Region and OPD Visiting Time**

Frequency distribution, mean and standard deviation of CWT across region and OPD visiting time is presented in the Table 8 shown below. Twenty eight (14%) patients from Afghanistan and 44 (22%) patients from Baluchistan had the same CWT (60 minutes) who came for the first time at the OPD. Moreover there were no patients from Karachi and interior Sindh noted to have the CWT of 90 minutes. Patients from Afghanistan and Baluchistan were indicated to have greater CWT (see Table 8). Overall

it was indicated that CWT of patients coming for the first time at the OPD was greater in the comparison of patients who have been there already.

**5.4.6. Comparison of CWT across Region and Age**

Frequency distribution, mean and standard deviation of CWT across region and age is presented in the Table 9 shown below. Twenty one (10.5%) and 37 (18.5%) old aged patients from Afghanistan and Baluchistan had the CWT of 60 minutes respectively; whereas, there were only 12 (6%) old aged patients and 11 (5.5%) young patients from Afghanistan and Baluchistan having the CWT of 90 minutes respectively (see Table 9).

**6. Discussion**

Healthcare facilities` distribution either public or private is unjust in Pakistan and that`s why it is inaccessible to the people with low income especially in rural areas (Naz et al., 2012; Bergman, 2011). Healthcare delivery systems (HCDS) are consisted of organizations, agencies, people and various resources which are used to provide the healthcare services to people, community and population (Kumar & Bano, 2017; Musgrove et al., 2000). Pa-

**Table 7:** Frequency distribution and mean±standard deviation of comfortable waiting time (CWT) of respondents across income and outpatient department (OPD) visiting experience.

Income	OPD Visiting Experience	How long can you wait comfortably in the OPD?						Total	Mean ± STD of CWT
		15 min	20 min	30 min	45 min	60 min	90 min		
lower Class	1st Time	-	-	2(1.00%)	10(5.50%)	33(16.50%)	13(6.50%)	58(29.00%)	63.1 ± 16.32
	2nd Time	-	-	-	2(1.00%)	8(4.00%)	-	10(5.00%)	57 ± 6.32
	3rd Time	-	-	-	2(1.00%)	5(2.50%)	-	7(3.50%)	55.71 ± 7.31
	4th Time	1(0.50%)	-	-	-	3(1.50%)	-	4(2.00%)	48.75 ± 22.5
Lower Middle Class	1st Time	-	-	4(2.00%)	5(2.50%)	10(5.00%)	1(0.50%)	20(10.00%)	51.75 ± 14.98
	2nd Time	-	1(0.50%)	1(0.50%)	-	6(3.00%)	-	8(4.00%)	51.25 ± 16.42
	3rd Time	-	-	-	1(0.50%)	4(2.00%)	-	5(2.50%)	57 ± 6.7
	4th Time	-	-	-	1(0.50%)	-	-	1(0.50%)	45 ± 0
Upper Middle Class	1st Time	-	-	6(3.00%)	4(2.00%)	38(19.00%)	7(3.50%)	55(27.50%)	59.45 ± 15.26
	2nd Time	-	-	-	-	11(5.50%)	3(1.50%)	14(7.00%)	66.42 ± 12.77
	3rd Time	-	-	-	1(0.5%)	7(3.5%)	4(2%)	12(6%)	68.75 ± 16.25
	4th Time	-	-	1(0.5%)	1(0.5%)	2(1%)	2(1%)	6(3%)	62.5 ± 24.03

**Table 8:** Frequency distribution and mean±standard deviation of comfortable waiting time (CWT) of respondents across region and outpatient department (OPD) visiting experience.

Region	OPD Visiting Experience	How long can you wait comfortably in the OPD?						Total	Mean ± STD of CWT
		15 min	20 min	30 min	45 min	60 min	90 min		
Afghanistan	1st Time	-	-	5(2.50%)	-	28(14.00%)	7(3.50%)	40(20.00%)	61.5 ± 16.57
	2nd Time	-	-	-	-	6(3.00%)	3(1.50%)	9(4.50%)	70 ± 15
	3rd Time	-	-	-	-	5(2.50%)	4(2.00%)	9(4.50%)	73.33 ± 15.81
	4th Time	-	-	-	-	-	2(1.00%)	2(1.00%)	90 ± 0
Baluchistan	1st Time	-	-	-	4(2.00%)	44(22.00%)	14(7.00%)	62(31.00%)	65.8 ± 13.67
	2nd Time	-	-	-	-	14(7.00%)	-	14(7.00%)	60 ± 0
	3rd Time	-	-	-	-	7(3.50%)	-	7(3.50%)	60 ± 0
	4th Time	-	-	-	-	4(2.00%)	-	4(2.00%)	60 ± 0
Interior Sindh	1st Time	-	-	1(0.50%)	6(3.00%)	9(4.50%)	-	16(8.00%)	52.5 ± 9.48
	2nd Time	-	-	-	2(1.00%)	4(2.00%)	-	6(3.00%)	55 ± 7.74
	3rd Time	-	-	-	2(1.00%)	4(2.00%)	-	6(3.00%)	55 ± 7.74
	4th Time	-	-	-	2(1.00%)	-	-	2(1.00%)	45 ± 0
Karachi	1st Time	-	-	6(3.00%)	9(4.5%)	-	-	15(7.50%)	39 ± 7.6
	2nd Time	-	1(0.50%)	1(0.50%)	-	1(0.50%)	-	3(1.50%)	36.66 ± 20.81
	3rd Time	-	-	-	2(1.00%)	-	-	2(1.00%)	45 ± 0
	4th Time	1(0.50%)	-	1(0.50%)	-	1(0.50%)	-	3(1.50%)	35 ± 22.91

**Table 9:** Frequency distribution and mean±standard deviation of comfortable waiting time (CWT) of respondents across region and age.

Region	Age	How long can you wait comfortably in the outpatient department?						Total	Mean ± STD of CWT
		15 min	20 min	30 min	45 min	60 min	90 min		
Afghanistan	Middle Aged	-	-	1(0.50%)	-	16(8.00%)	2(1.00%)	19(9.5%)	61.57 ± 12.13
	Old Aged	-	-	2(1.00%)	-	21(10.50%)	12(6.00%)	35(17.50%)	68.57 ± 17.17
	Teenager	-	-	-	-	1(0.50%)	1(0.50%)	2(1.00%)	75 ± 21.21
	Young	-	-	2(1.00%)	-	1(0.50%)	1(0.50%)	4(2.00%)	52.5 ± 28.72
Baluchistan	Middle Aged	-	-	-	1(0.5%)	20(10.00%)	1(0.50%)	22(11.00%)	60.68 ± 7.28
	Old Aged	-	-	-	-	37(18.50%)	-	37(18.50%)	60 ± 0.00
	Teenager	-	-	-	-	4(2.00%)	2(1.00%)	6(3.00%)	70 ± 15.49
	Young	-	-	-	3(1.5%)	8(4.00%)	11(5.50%)	22(11.00%)	72.95 ± 18.1
Interior Sindh	Middle Aged	-	-	1(0.50%)	4(2.00%)	5(2.50%)	-	10(5.00%)	51.00 ± 10.48
	Old Aged	-	-	-	6(3.00%)	11(5.50%)	-	17(8.50%)	54.700 ± 7.38
	Teenager	-	-	-	-	1(0.50%)	-	1(0.50%)	60.00 ± 0.00
	Young	-	-	-	2(1.00%)	-	-	2(1.00%)	45.00 ± 0.00
Karachi	Middle Aged	-	-	3(1.50%)	5(2.5%)	2(1.00%)	-	10(5.00%)	43.50 ± 11.06
	Old Aged	-	1(0.50%)	5(2.50%)	6(3.00%)	-	-	12(6.00%)	36.66 ± 9.12
	Young	1(0.50%)	-	-	-	-	-	1(0.50%)	15.00 ± 0.00

kistan is considered as the country of low income (The World Bank, 2006) and as per human poverty index, it is 65<sup>th</sup> low income country among 102 countries (Watkins, 2006). Structure, roles and responsibilities of healthcare services are at the stage of evolution (WBG, 2015). A systemic review of literature by Basu et al., 2012 indicates that public sector is not more efficient in terms of medical services but public healthcare lacks for its hospitality and timeliness (Basu et al., 2012). Present study has been conducted to analyze the waiting time of patients coming at the OPD so that hospital management can be of their patients that how much they can wait to see the doctor comfortably. Demographic characteristics (gender) have been reported to have influence on the expectations of patients (Naseer et al., 2012). Patients' waiting time is associated with patients' gender difference. In the present research, 51 (25.5%) old aged females' CWT was one an hour (mean CWT = 61.76 ± 15.48) and 18 (9%) old age males' CWT was 60 minutes (mean CWT = 56.81 ± 13.35); CWT of 26 (13%) middle aged females was 60 minutes (mean CWT = 57.6 ± 15.73) and 17 (8.5%) middle aged

males had the same CWT (mean CWT = 51.81 ± 10.31); 6 (3%) young females had the CWT of one an hour (mean CWT = 73.75 ± 17.46) whereas, 3 (1.5%) had the same CWT (mean CWT = 60.88 ± 25.13); 5 (2.5%) teenager females had the CWT of one an hour (mean CWT = 72.85 ± 16.03) and 1 (0.5%) teenager male had the same CWT (mean CWT = 60 ± 0). Oche and Adamu (2013) conducted a research which indicated that waiting time of 30/60 females was recorded to be 3 hours; whereas, waiting time of 6/36 males was 3 hours at the clinic (Oche & Adamu, 2013). It has been reported for males to be in hurry (Robertson, 2014). Another research was conducted in the setting of eye clinic and results indicated that waiting time female patients for eye cataract extraction was more than that of males (Smirthwaite et al., 2017). Age has been indicated to have influence on the expectations of patients (Naseer et al., 2012; Asadi-Lari et al., 2004). The association of age and waiting time has been discussed in literature. Patients with the age of >25 years were reported to wait willingly for >2 hours and an incomplete visiting rate was reported for younger patients in the



comparison of old aged patients (Shaikh et al., 2012). People of the older age were reported to have longer waiting times without any complaints in the comparison of young people (Robertson, 2014). Old aged patients were indicated to have the greater waiting capacity in the comparison of other age groups. It was also seen in the analysis that greater number of patients from upper middle class were noted for their longer CWT. CWT decreases with increasing visiting time of patients surprisingly slow in females and faster in male patients. It can also be noted that less male patients greater CWT in the comparison female patients. There were 13 (6.5%) and 7 (3.5%) patients from lower class and upper middle class had CWT of 90 minutes respectively and they also came for the first time at the OPD. Patients from Afghanistan and Baluchistan were indicated to have greater CWT. Twenty eight (14%) patients from Afghanistan and 44 (22%) patients from Baluchistan had the same CWT (60 minutes) who came for the first time at the OPD. Twenty one (10.5%) and 37 (18.5%) old aged patients from Afghanistan and Baluchistan had the CWT of 60 minutes respectively; whereas, there were only 12 (6%) old aged patients and 11 (5.5%) young patients from Afghanistan and Baluchistan having the CWT of 90 minutes respectively.

## 7. Conclusion

This research highlights the comfortable waiting time (CWT) of patients across various demographics (i.e. gender, age, OPD visiting time, income and region). Gender and age has the influence on the CWT of patients. Old aged females had the highest CWT from all the patients. Income class and OPD visiting time (i.e. experience) were highlighted to have noteworthy influence on the CWT because, the frequencies of patients decreased for a particular CWT (i.e. 60 minutes) across income class and OPD visiting time. Karachi patients and who were from interior Sindh had less CWT as compared to those patients who were from Baluchistan and Afghanistan. This research can be extended by considering the larger sample size and more OPDs of the case hospital in order to reach the fine conclusion. Since, OPD visiting time, income and

## References

- Aburayya, A., Alshurideh, M., Albqeen, A., Alawadhi, D., & Al A'yadeh, I. (2020). An investigation of factors affecting patients waiting time in primary health care centers: An assessment study in Dubai. *Management Science Letters*, 10(6), 1265–1276. <https://doi.org/10.5267/j.msl.2019.11.031>
- Agyei, W., Asare-darko, C., & Odilon, F. (2015). Modeling and Analysis of Queuing Systems in Banks: A case study of Ghana Commercial Bank Ltd. Kumasi Main Branch. *International Journal of Scientific & Technology Research*, 4(07), 160–163.
- Akbari, A.H., RankuUuwa, W., & Kiani, A.K. (2009). Demand for public health care in Pakistan. *Pakistan Development Review*, 48(2), 141–153. <https://doi.org/10.30541/v48i2pp.141-153>
- Arain, M.S., Khan, M.A., & Kalwar, M.A. (2020). Optimization of Target Calculation Method for Leather Skiving and Stamping: Case of Leather Footwear Industry. *International Journal of Education and Management Studies*, 7(1), 15–30. <https://www.questia.com/library/journal/1P3-4312702391/influence-of-organizational-climate-on-job-performance>
- Ahmad, B A., Khairatul, K., & Farnaza, A. (2017). An assessment of patient waiting and consultation time in a primary healthcare clinic. *Malaysian family physician: the official journal of the Academy of Family Physicians of Malaysia*, 12(1), 14-21.

region are the variables worthy of being investigated at the broader level so that outcomes of this research can be made useful for the healthcare providers. In future research, waiting cost of the respondents can also be focused and investigated so that hospital management can be made to understand the cost implication of patients while they wait at the OPD.

## 8. Suggestions

The concerned hospital should take remedial measures to minimize the waiting time of patients. Since, it is the problem of queues and waiting lines, this can better be solved by the help of queuing theory and simulation of queuing systems.

## 9. Limitations and Future Work

Since, Karachi is the biggest city of Pakistan and targeted hospital is one the biggest private hospitals of Karachi and in the analysis of this paper, only 200 patients were approached for data collection. Authors should also focus on the same OPD for more responses and at the same time, other departments can also be targeted for conclude better and precise results.

## Acknowledgement

Authors of this research paper thank the management committee of ABC private hospital of Karachi for allowing us to collect the data and we are also thankful to the patients who cooperated in filling the questionnaires.

## Conflict of Interests

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

- Armony, M., Israelit, S., Mandelbaum, A., Marmor, Y.N., Tseytlin, Y., & Yom-Tov, G.B. (2015). On patient flow in hospitals: a data-based queueing-science perspective. *Stochastic Systems*, 5(1), 146–194. <https://doi.org/10.1214/14-SSY153>
- Asadi-Lari, M., Tamburini, M., & Gray, D. (2004). Patients' needs, satisfaction, and health related quality of life: towards a comprehensive model. *Health and Quality of Life Outcomes*, 2(1), 32. <https://doi.org/10.1186/1477-7525-2-32>
- Basu, S., Andrews, J., Kishore, S., Panjabi, R., & Stuckler, D. (2012). Comparative performance of private and public healthcare systems in low- and middle-income countries: A systematic review. *PLoS Medicine*, 9(6). <https://doi.org/10.1371/journal.pmed.1001244>
- Bergman, A. (2011). *Health and Social Work-Private Secotr hospitals*.
- Burström, L., Starrin, B., Engström, M.L., & Thulesius, H. (2013). Waiting management at the emergency department - a grounded theory study. *BMC Health Services Research*, 13(1), 1–10. <https://doi.org/10.1186/1472-6963-13-95>
- Constanzo, F., Aracena-Sherck, P., Hidalgo, J.P., Peña, L., Marrugo, M., Gonzalez, J., Vergara, G., & Alvarado, C. (2020). Contribution of a synchronic teleneurology program to decrease the patient number waiting for a first consultation and their waiting time in Chile. *BMC Medical Informatics and Decision Making*, 20(1), 1–9. <https://doi.org/10.1186/s12911-020-1034-2>
- Dong, J., Yom-tov, E., & Yom-tov, G.B. (2015). *The Impact of Delay Announcements on Hospital Network Coordination and Waiting Times*.
- Ekpe, E.E., & Peter, A.I. (2016). Surgical patient's satisfaction with services at a tertiary hospital in south -south state of Nigeria. *The Journal of Medical Research Research Article JMR*, 2(25), 157–162. Accessible at [http://www.medicinearticle.com/JMR\\_201625\\_08.pdf](http://www.medicinearticle.com/JMR_201625_08.pdf)
- Goienetxea Uriarte, A., Ruiz Zúñiga, E., Urenda Moris, M., & Ng, A.H.C. (2015). System design and improvement of an emergency department using Simulation-Based Multi-Objective Optimization. *Journal of Physics: Conference Series*, 616(1), 12–15. <https://doi.org/10.1088/1742-6596/616/1/012015>
- Green, L. (2011). Queueing theory and modeling. In *Handbook of healthcare delivery systems*. Ed. Yuehwern Yih. London: Taylor & Francis. (pp. 1–22).
- Gunal, M.M. (2012). A guide for building hospital simulation models. *Health Systems*, 1(1), 17–25. <https://doi.org/10.1057/hs.2012.8>
- Haghighinejad, H.A., Kharazmi, E., Hatam, N., Yousefi, S., Ali Hesami, S., Danaei, M., & Askarian, M. (2016). Using Queueing Theory and Simulation Modelling to Reduce Waiting Times in An Iranian Emergency Department. *IJCBNM January*, 44(11), 11–26.
- Imahsunu, A.F. (2007). *Queueing Theory For Healthcare Operations Management: A Case Study of University of Benin Health Center and Faith Mediplex*.
- Juhana, D., Manik, E., Febrinella, C., & Sidharta, I. (2015). Empirical Study on Patient Satisfaction and Patient Loyalty on Public Hospital in Bandung, Indonesia. *International Journal of Applied Business and Economic Research*, 13(6), 4305–4326.
- Kalwar, M.A., & Khan, M.A. (2020a). Increasing Performance of Footwear Stitching Line by Installation of Auto-Trim Stitching Machines. *Journal of Applied Research in Technology & Engineering*, 1(1), 31–36. <https://doi.org/10.4995/jarte.2020.13788>
- Kalwar, M.A., & Khan, M.A. (2020b). Optimization of Procurement & Purchase Order Process in Foot Wear Industry by Using VBA in Ms Excel. *International Journal of Business Education and Management Studies*, 5(2), 80–100.
- Kalwar, M.A., Khan, M.A., Shaikh, S.A., Salam, A., Memon, M.S., & Khaskheli, S.A. (2020a). Aggressive Driving Behavior: A Case Study of Mehran UET,. *Proceedings of the International Conference on Industrial Engineering and Operations Management Dubai*, 2350–2359.
- Kalwar, M.A., Khaskheli, S.A., Khan, M.A., Siddiqui, A.A., & Gopang, M.A. (2018). Comfortable Waiting Time of Patients at the OPD with Varying Demographics. *Industrial Engineering Letters*, 8(2), 20–27.
- Kalwar, M.A., Mari, S.I., Memon, M.S., Tanwari, A., & Siddiqui, A.A. (2020b). Simulation Based Approach for Improving Outpatient Clinic Operations. *Mehran University Research Journal of Engineering and Technology*, 39(1), 153–170. <https://doi.org/10.22581/muet1982.2001.15>
- Kembe, M.M., Onah, E.S., & Iorkegh, S. (2012). A Study of Waiting And Service Costs of A Multi- Server Queueing Model In A Specialist Hospital. *International Journal of Scientific & Technology Research*, 1(8), 19–23.

- Khamis, K., & Njau, B. (2014). Patients' level of satisfaction on quality of health care at Mwananyamala hospital in Dar es Salaam, Tanzania. *BMC Health Services Research*, 14(400), 1–8. <https://doi.org/10.1186/1472-6963-14-400>
- Khaskheli, S.A., Kalwar, M.A., Siddiqui, A.A., Nagar, M.A.K., & Wadho, T.H. (2018). Impatience Among Drivers With Varying Demographics. *Professional Trends in Industrial and Systems Engineering*, 465–469.
- Khaskheli, S.A., Marri, H. B., Nebhwani, M., Khan, M.A., & Ahmed, M. (2020). Comparative Study of Queuing Systems of Medical Out Patient Departments of Two Public Hospitals. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 1913, 2702–2720.
- Kumar, S., & Bano, S. (2017). Comparison and Analysis of Health Care Delivery Systems: Pakistan versus Bangladesh. *Journal of Hospital & Medical Management*, 03(01), 1–7. <https://doi.org/10.4172/2471-9781.100020>
- Mashhadi, S.F., Hamid, S., Roshan, R., & Fawad, A. (2016). Healthcare in Pakistan-A Systems Perspective. *Pak Armed Forces Medical Journal*, 66(1), 136–142.
- Mustafa, S., un Nisa, S. (2015). A Comparison of Single Server and Multiple Server Queuing Models in Different Departments of Hospitals. *Punjab University Journal of Mathematics*, 47(1), 73–80.
- Musgrove, P., Creese, A., Preker, A., Baeza, C., Anell, A., & Prentice, T. (2000). *The World Health Report 2000. Health Systems: Improving Performance*. World Health Organization. <https://www.who.int/whr/2000/en>
- Mwangi, S.K., & Ombuni, T.M. (2015). An empirical analysis of queuing model and queuing behaviour in relation to customer satisfaction at Jkuat Students Finance Office. *American Journal of Theoretical and Applied Statistics*, 4(4), 233–246. <https://doi.org/10.11648/j.ajtas.20150404.12>
- Naseer, M., Zahidie, A., & Shaikh, B.T. (2012). Determinants of patient's satisfaction with health care system in Pakistan: a critical review. *Pakistan Journal of Public Health*, 2(2), 56–61.
- Naz, A., Daraz, U., Khan, T., Khan, W., & Hussain, M. (2012). An Analytical Study Of Patients' Health Problems In Public Hospitals o Khyber Pakhtunkhwa Pakistan. *International Journal of Business and Social Science*, 3(5), 133–143.
- Obamiro, J.K. (2010). Queuing Theory and Patient Satisfaction: An Overview of Terminology and Application in Ante-Natal Care Unit. *Petroleum-Gas University of Ploiesti Bulletin*, LXII(1), 1–12.
- Oche, M.O., & Adamu, H. (2013). Determinants of patient waiting time in the general outpatient department of a tertiary health institution in North Western Nigeria. *Annals of Medical and Health Sciences Research*, 3(4), 588–592.
- Puoza, J.C., & Hoggar, E.K. (2014). Patients Flowin Health Care Centers: An Overview of Terminology and Application in the Out Patient Department (OPD) Julius. *International Journal of Innovative and Applied Research*, 2(9): 5–11.
- Robertson, J. (2014). *Waiting Time at the Emergency Department from a Gender Equality Perspective*. University of Gothenburg.
- Sajid, A., Ali, H., Rashid, M., & Raza, A. (2008). Impact of Process Improvement on Patient Satisfaction in Public Health Care Facility in Pakistan. *Quality Management and Organizational Development*, 481–494.
- Shaikh, S., Jerrard, D., Witting, M., Winters, M., & Brodeur, M. (2012). How Long Are Patients Willing to Wait in the Emergency Department Before Leaving Without Being Seen. *Western Journal of Emergency Medicine*, 13(6), 463–467. <https://doi.org/10.5811/westjem.2012.3.6895>
- Smirthwaite, G., Lundström, M., & Swahnberg, K. (2017). Doctors Doing Gender at Eye Clinics—Gender Constructions in Relation to Waiting Times for Cataract Extractions in Sweden. *NORA - Nordic Journal of Feminist and Gender Research*, 25(2), 107–125. <https://doi.org/10.1080/08038740.2017.1345006>
- Surydana, L. (2017). Service Quality, Customer Value and Patient Satisfaction on Public Hospital in Bandung District, Indonesia. *International Review of Management and Marketing*, 7(2), 187–192.
- Tandon, A., Murray, C.J., Lauer, J.A., Evans, D.B. (2002). Measuring health system performance for 191 countries. World Health Organization. GPE Discuss. Pap. Ser. No. 30. Available from: <http://www.who.int/healthinfo/paper30.pdf>
- The World Bank. (2006). *The World Bank Annual Report 2006*.
- Umar, I., Oche, M.O., & Umar, A.S. (2011). Patient waiting time in a tertiary health institution in Northern Nigeria. *Journal of Public Health and Epidemiology*, 3(2), 78–82. <http://www.academicjournals.org/jphe>
- Wang, T., Guinet, A., Belaidi, A., & Besombes, B. (2009). Modelling and simulation of emergency services with ARIS and Arena. case study: The emergency department of Saint Joseph and Saint Luc Hospital. *Production Planning and Control*, 20(6), 484–495. <https://doi.org/10.1080/09537280902938605>

- Watkins, K. (2006). Human Development Report 2006 - Beyond scarcity: Power, poverty and the global water crisis. In *United Nations Development Programme UNDP*. <http://hdr.undp.org/en/content/human-development-report-2006>
- WBG. (2015). *Country Snapshot 100119*.
- Winston, W. (2004). Queuing Theory. *Operations Research*, 3, 1051–1144.
- Yeddula, V.R. (2012). *Healthcare Quality: Waiting Room Issues* [University of Nebraska]. <https://digitalcommons.unl.edu/imssediss/29>
- Yusuff, S.A. (2015). Analysis of Expected, Actual Waiting Time and Service Delivery: Evidence from Nigeria Banking Industry. *The International Journal Of Humanities & Social Studies*, 3(1), 398–402.