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EFFICIENT WORKPLACE PLANNING AND DESIGNING STRATEGIES TO REDUCE WAITING TIME IN THE OUTPATIENT DEPARTMENTS (OPD) OF GOVERNMENT HOSPITALS IN SRI LANKA

D.P.I.M. Pathirana[1] and Nayanthara De Silva[2]

ABSTRACT

The waiting time is a major challenge for government hospitals around the world, particularly in developing countries, due to inefficient design and limited facilities. This waiting time causes long queues, especially in service providing facilities. Hence, queuing is considered a key performance indicator when evaluating the performance of healthcare facilities. The outpatient department (OPD) is the main division of a hospital that handles a large number of patients daily. This research aimed to provide solutions for minimising waiting time in OPD premises through efficient planning and designing strategies. This study applied the queuing theory for two case studies to analyse the waiting time of the patients at the OPD. Hospital records and field observations were used to gather data. Further solutions for minimising the waiting time were identified using semi-structured interviews with hospital management and a questionnaire survey with patients at OPD. Field observations revealed that there were long waiting queues and long waiting times at the registration counter and the consultant rooms. Due to increased demand for OPD services, unnecessary arrivals, a lack of resources, and patients' ignorance of OPD procedures were identified as causes of overcrowding. Further, to minimise waiting time at the OPD, it should leverage the efficient designs with properly placed inquiry counters, walkways, and directions; provide adequate facilities such as a spacious waiting area, and restructuring should be implemented. The findings of the research mark valuable insights into government hospitals, and the proposed solutions will be useful for hospital management.

Keywords: *Government Hospitals; Out-Patient Department (OPD); Planning and Designing; Queues; Queuing Theory; Waiting Time.*

1. INTRODUCTION

Hospitals typically provide emergency services, secondary care facilities, and tertiary medical services, while primary care and some basic treatment or first aid are provided by health centers under the government and private hospital categories. In a hospital facility, there are several departments such as inpatients wards, outpatient department (OPD), emergency or accident wards, clinical area, laboratory, and pharmaceutical area. Among those facilities, OPD servicers are significant tasks that provide diagnostic,

[1] Department of Building Economics, University of Moratuwa, Sri Lanka, ishmadu97@gmail.com
[2] Department of Building Economics, University of Moratuwa, Sri Lanka, endds@uom.lk

curative, preventive, and rehabilitative services to a large number of the patient charter (Mital, 2010). Further, patients visit to take numerous facilities for OPD within the hospital system, such as primary treatments and consultations, tests, emergency treatments, health education, and family planning (Al-Zain, et al., 2019). OPD is a facility where patients receive healthcare services on an outpatient basis for conditions of minor illness that can be treated without admitting them to the hospital.

According to a health bulletin (Ministry of Health, 2020), the total number of government hospitals in Sri Lanka is 776 excluding temporary covid treatments units, offering free service for over 5 million patients. However, to ensure easy access to the nearest hospital in all areas by limiting patients coming from another region or district, a greater number of hospitals are required. Further, most Sri Lankan government hospitals face many problems because of lacking facilities, insufficient staff, and improper infrastructure (Dasanayaka and Sardana, 2011).

The healthcare sector in Sri Lanka operates in 03 levels for medical services, namely primary, secondary, and tertiary care institutions. The central dispensaries, maternity homes, rural hospitals, peripheral units, and district hospitals come under primary health care institutions. The base and provincial hospitals are secondary care institutions. The teaching and special hospitals come under tertiary care institutions. They operate in inadequate spaces with limited facilities in built environments, but at a satisfactory level as a free service. Those built environments create overcrowded places resulting in long queues and waiting times (Benevento, et al., 2019).

The waiting time of an OPD patient includes the time spent from arrival time at the OPD until the patient leaves the OPD with the treatments obtained and prescribed medicines from the OPD drug counters (Munavalli, et al., 2017). Furthermore, the same authors mentioned that waiting time in queues is the key reason for complaints and patient dissatisfaction and thus plays a crucial role in quality assurance in hospitals. The waiting time in queues can be taken as a major waste of time cost, social cost, customer cost as well as employee costs (Barlow, 2002). This waiting time can impact patients in different ways such as loss of their time, increased suffering from illness, limited consultation time (risk of inaccuracies in diagnosis), and deterioration of the condition (maybe due to delay in treatment or due to stress and anxiety developed by prolonged waiting) (Benevento, et al., 2019). The impact is not only for patients but also for hospital staff mainly doctors and nurses who may over-stress and in turn, it may cause inefficient service delivery (Willoughb, et al., 2010).

The queuing theory has increasingly been used as a decision-making tool in the service-providing sectors in developed countries to enhance the service delivery process efficiency (Fomundam and Herrmann, 2007). Government hospital can consider essential workplace in Sri Lanka which provides vital service to the public. Thus, this research is focused to use queuing theory to identify waiting time in OPD and address proper workplace planning and designing strategies to reduce the long waiting time in OPD. Efficiency planning of queues, computerised administration work, and work procedure chart was proposed through this queue analysis. The objectives of the study are to derive a "queuing model" to calculate the waiting time and propose efficient strategies to reduce waiting time in government hospitals OPD.

2. LITERATURE REVIEW

OPD is the gateway to every health care facility and OPD care represents the total quality of treatment in the hospital (Haldar, et al., 2008). The OPD serves the following functions (Dilrukshi, et al., 2016);

1. General OPD section - This section treats mainly medical and surgical patients. General OPD also provides Anti-Rabies Vaccine (ARV), Dressings, Tetanus toxoid, and other injections.
2. Admission Section - This section is functioning round the clock and patients' admissions are done through this section.
3. Emergency Treatment Unit (ETU) - Seriously ill patients are resuscitated and kept under observation here before being sent to the wards.
4. Operation Theatre - Minor operations are performed in OPD Operation Theatre.
5. Clinics - Specialist clinics are held in the clinic sections of OPD. They include Medical, Neurology, Surgical, Thoracic, Skin, and Psychiatric.

As per the OPD procedure, registration of patients is done at the registration counters and directed to consultation rooms with a registration number to approach an available doctor.

2.1 WAITING TIMES AT THE OPD

Government hospitals in Sri Lanka provide vital free services for the whole society without assessing a patient's status, income, or assets, as the country believes that health is a prerequisite for a nation's overall economic and social growth (Jayasekara and Schultc, 2017). However, patient waiting time is one of the major reasons for complaints and patient dissatisfaction over this vital service. For instance, even in a normal situation with a smaller number of patients, they have to wait for at least 2 to 3 hours for taking treatments and collecting laboratory reports at the OPD of the National hospital in Colombo (Dilrukshi, et al., 2016). Further, the annual health bulletin in 2021 reported that there is an increment of 3.3% in the waiting time from 2018 to 2019. It is outpatient attendance per 1000 population. Similarly, many other developing countries face the same problem (Bittencourt, et al., 2016). According to (Puri, et al., 2011), in India, patients have to wait in OPD for more than 45 minutes to have at least a five-minute consultation. Further in developed countries link Japanese, a study by (Zhang and Oyama, 2016) revealed that overall, among all Japanese hospitals 40% have to wait less than half an hour before they met the doctor. Overall, 35 % of patients wait 30 to 59 minutes for taking medicines from the hospital and the other 25% of patients have to wait one hour or more. In Hong Kong, the average waiting time for OPD patients from 2014 to 2016 was around two hours (Tsui and Fong, 2018).

2.2 ADVERSE EFFECTS OF LONG WAITING TIME

Waiting time affects patients as well as the employees of the hospital (Tsui and Fong, 2018). The heavy workload and low incentives are often attributed to shortages of employees due to the high turnover rate of frontline health care workers in government hospitals and that turnover, will result in overcrowded circumstances (Puri, et al., 2012). That situation is compounded by other external factors from private hospitals, including attractive remuneration packages and greater opportunities for clinical development (Ishtiaq, 2014). As well as the large number of patients at OPD, the staff allocates very less time per patient. Most OPD doctors see between 60 to 80 patients in their six-hour

shift, and they could spend on average 5 minutes for the treatment as well as for a referral (Mathugama, 2015). Therefore, always patients feel dissatisfied with government healthcare facilities.

2.3 QUEUING THEORY MODEL

Queuing theory involves analysing queues or waiting lines in mathematical terms to measure performance (Hiller and Liebeman, 2019). The queue is the flow of service customers and is defined by the highest number of acceptable customers that may be included. (Benevento, et al., 2019). The basic queuing process assumed by most queuing models is as follows:

1. An input source or calling population generates customers requiring service.
2. A member of the queue is chosen for service by a rule at certain times.
3. The service required is then performed by the service mechanism for the client.
4. Customers exist or return to the queue (Mathugama, 2015).

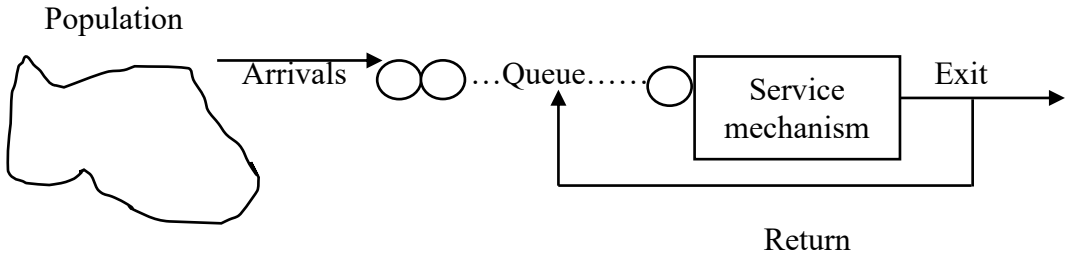

Figure 1: Basic queuing process

Customers who arrive for service, wait for service, and leave after getting service can be defined as a queuing system (Mital, 2010).

A queuing system can be described by:

- Input sources - The group from which arrivals arise is referred to as the calling population. Its population size is one parameter of the input data. The size is the total number of patients from time to time who may need service. It may be finite or infinite in size.
- Arrival process - The arrival process contains four parts.
  1. Pattern - Whether it is controlled or not.
  2. Grouping - The way customers occur
  3. For example, customers arrive singly as well as in groups.
  4. Time between arrival statistics - Mean, variability, and distribution of successive arrivals.
  5. Degree of impatience - Whether customers leave before being served.
- Physical Characteristics of Queue - This means a number of queues (one or more) It can be defined as a number of service channels and the length of the queue (limited or unlimited capacity).
- Queue discipline - This means the way a customer is selected from all those awaiting service for service. Those disciplines can introduce as FIFO - First-In-First-Out, LIFO - Last-In-First-Out, JSQ - Join the Shortest Queue, SIRO - Service e-In-Random-Order, Favourite server specified (in barbershops), Priority queue

- Service mechanism - Service systems are generally categorized according to their number of service channels (servers).

3. RESEARCH METHODOLOGY

The research design reveals the path to answering the research problems through specific research strategies (Millet, 2009). Three main research approaches including quantitative, qualitative, and mixed are used by researchers. The research process based on clear evidence and records is known as the quantitative approach (Naum, 2007). The qualitative approach, on the other hand, is a subjective process consisting of exploring the participants' attitudes and opinions (Dawson, 2002). The mixed approach is adopted when quantitative or qualitative approaches alone do not produce satisfactory results (Johnson and Turner, 2003). Due to the availability of data mixed philosophical approach that combines elements of both pragmatism and interpretivism was adopted in this research. A case study and quantitative research strategy were adopted to design an efficient workplace and proving solutions to enhance the operation of OPD by minimizing waiting time. The mixed approach was taken as the best way of proving quantitatively the number of patients in the queue reference concerning the time while interview outputs prove the quality of the hospital service.

In queuing theory (Mital, 2010) the following equations were used to calculate the waiting time of a patient at OPD.

- Waiting time in the queue $Wq = Lq/\lambda$
- λ - average arrival rate
- Lq - Average number of patients waiting for service.
- $Lq = \frac{P_0(\frac{\lambda}{\mu})^s p}{s!(1-p)^2}$
- p - Server utilization $p = {}^{\lambda}/_{\mu}$
- P_0 –the probability that the number of patients in the OPD
- $p_{0=}\left[s^{-1}\sum n = 0\frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^s}{s!} + (\frac{1}{1-p})^{-1}\right]$
- s - number of channels (servers)
- μ - average service rate at each channel (service)
- n - number of patients

Data were collected from two case studies (i.e., two base hospitals located in Colombo). Within the case studies questionnaire survey, observations, semi-structured interviews, and reviewing of internal records such as patient's attendance logbooks, staff attendance sheets, doctor's and nurser's working rosters were carried out to gather appropriate data. The questionnaire survey was conducted using a sample of 50 patients at the OPD at the time of data collection. Data obtained from the questionnaire survey were used to analyse the real waiting time of patients. In addition, hospital records were reviewed to identify staff attendance, and daily patient's attendance. Further, a work procedure chart was introduced to manage OPD premises efficiently.

Semi-structured interviews were conducted with OPD doctors and administrative staff who are having a greater exposure and knowledge of OPD operation to obtain data such as current practices of the OPD, service time of the OPD, staff capacities, and their

opinions regarding waiting time and related design drawbacks for inefficient OPD operations. Detailed profiles of the interviews were tabulated in Table 1.

Table 1: Profile of the interviewees

Case Name	Respondent	Designation	Experience
Case A	Respondent - 1	OPD Consultant Doctor	08 years
	Respondent - 2	OPD Medical Doctor	05 years
	Respondent - 3	OPD Nurse	03 years
Case B	Respondent - 1	OPD Consultant Doctor	10 years
	Respondent - 2	OPD Medical Doctor	4 years
	Respondent - 3	OPD Nurse	05 years

4. RESEARCH FINDINGS AND DATA ANALYSIS

4.1 CASE A

According to collated primary data, Monday is the most crowded day of the week, and the patient number is counted as 1520 (average based on working hours; from 6 a.m. to 4.30p.m). In case A, OPD has a single queue for both consultation rooms while having multiple service channels. Thus, average arrival rates (λ) and the number of service channel(s) are considered for fed input data for the queuing model. In front of the consultation rooms, there was not enough seating facility. Most of the patients standing near the queue. That is a very pathetic situation for a healthcare-providing organization. Those situations decrease the quality of their service. In addition to the consultation queue, there was a separate queue at the registration counter to get a registration number. But this study considered only the consultation queue for the queue model.

The average service rate is calculated as 12 (patients/minutes) of consultation. This implies that 12 patients can be seen per hour by a doctor. In both cases, the service rate for all channels was assumed to be the same. In case A, the highest and lowest number of arrivals can be seen around 10-11 a.m. and 1-2 p.m. respectively, according to collected data. In cases A and B there was a barrier to collecting data for patients' attendance on hourly basis due to a lack of records. Therefore, queuing model analysis including server utilization (P), the probability that the number of patients in the OPD (P0), the average number of patients waiting for service (Lq) and waiting time in the queue (Wq) parameters were calculated by changing the number of channels after the average one-month patient arrival data. As the number of channels increases, the length of the queue and the waiting time decreases. These channels indicate the service points in the consultation rooms.

Table 2 shows the calculations for the consultation on average monthly data from 6 a.m. to 10 a.m. Currently, six consultation channels are operated in case of A, with 81 patients in the queue with 32 minutes of waiting time. The service's required number of channels has been increased to 8 channels after calculations. The inefficient situations are indicated by the empty columns in front of the occupied columns in each row. Those channels were indicated as inefficient because 1 to 5 channels were unable to cater to all the current patients. It is proved in the 06th channel still there are 81 patients in the queue (Lq= 81). When the server utilization (P) exceeds one with the available number of channels,

inefficient situations occur. On the other hand, cost factors should be considered. Non-cost-effective situations are indicated by the empty columns after the occupied columns in each row. Because of the cost factors, the calculation was stopped when the length of the queue (Lq) was less than or equal to one. And also, there is no point in increasing the number of channels further because in the 08th channel there is only one patient in the queue (Lq=0.041). The number of channels can be expanded even more. But it is more additional cost for hospital staff requirements.

Table 2: Calculation of queuing parameters for case A

Parameters	No of channels									
	1	2	3	4	5	6	7	8	9	10
p	INEFFICIENT					0.8625	0.546	0.29	NOT COST EFFECTIVE	
P_0 (%)						0.0111	0.024	0.028		
Lq(patients)						81.12368	53.21	0.0.41		
Wq(minutes)						32.44947	25.631	0.075		

4.2 CASE B

OPD opens from 6.30 a.m. to 4.30.p.m. providing their service for 10 hours per day. According to collated primary data, Wednesday is the most crowded day of the week, and the patient number is counted as 2235 (average based on working hours; from 6 a.m. to 4.30p.m). In case B, OPD has a single queue for both consultation rooms while having multiple service channels. In case B, the highest and lowest number of arrivals can be seen around 8-9 a.m. and 2-3 p.m., respectively, according to collected data.

Table 3 shows waiting time with reference to increasing service channels in order to minimise the number of patients in the waiting queue and waiting time in OPD.

Table 3: Calculation of queuing parameters for case B

Parameters	No of channels														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
p	INEFFICIENT						1.428571	1.111111	0.909091	0.769231	0.666667	0.588235	0.2395	NOT COST EFFECTIVE	
P_0 (%)							0.0009	0.0005	0.0001	0.00111	0.00015	0.000002	0.000001		
Lq(patients)							10.852	7.528	5.348	4	2.381	1.532	0.002		
Wq(minutes)							5.5	4	2.5	2	1	0.5	0.004		

As same as case A the empty columns which are in front of the occupied columns in each row showing an inefficient situation. Beyond the occupied columns after 13 channels were not cost-effective implementation.

After analysing queuing theory models with the current practice of OPD it consists of 7 channels in the OPD, and it will result in the average number in the queue (Lq) of 11 patients and the average time in queue (Wq) of 5.5 minutes. With the 08 channels, it gives the average number in the queue (Lq) 7 patients and the average time in queue (Wq) 4 minutes. Changing into 09 channels provides the most effective performance of the system by giving values as an average number in the queue (Lq) 5 patients and the average time in queue (Wq) 2.5 minutes. The change from 7 channels to 09 channels reduces the average number in the queue (Lq) from 11 patients to 5 patients Similarly, the average time in the queue (Wq) drops from 4 minutes to 2.5 minutes, respectively. 09 channels considering as an effective approach because of its server utilization amount (p). It is 0.909091 and that proves that it is an efficacy system operating according to queuing

theory models P < 1. This means that patients spend less time in the queue with the above factor. Again, it is essential thing to consider cost aspects such as this kind of marginal change. Increasing channels into 13 were identified as the zero queues with zero waiting time.

4.3 Planning and Designing Strategies for Reducing Waiting Time in OPD Premises

4.3.1 Introduce Work Procedure Chart

The work procedure chart is presented in Figure 1.

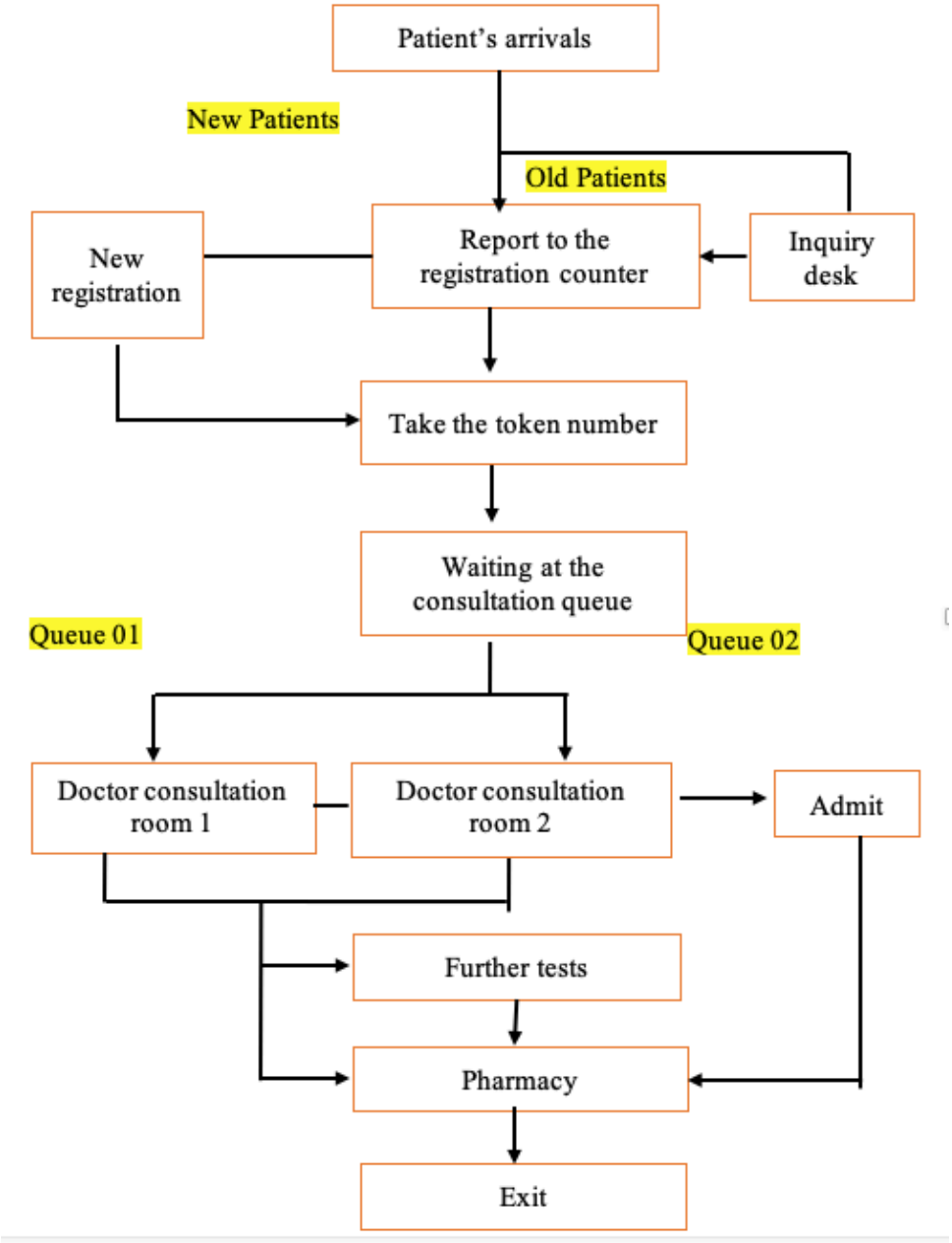

Figure 1: Work procedure chart

Both cases included two consultation rooms having a single queue model with First Comes First Serve. Instead of one queue for both consultation rooms, separate 2 queues can be introduced. It helps to increase doctors' efficiency and decrease doctors' stress levels, as well as, implementing 2 queues helps to reduce the anxiety and impatience of patients. Because patients have not to wait in long queues after implementing two queues. With the proposed work procedure chart number of patients is divided into two queues which help to reduce the long queue in front of the consultation room. In addition to that, it is suggested to create an inquiry counter for further convenience of patients.

In this system person who arrived first at the OPD can go for the patient's queue number 1 and the second person can go for the patient's queue number 2 likewise a third person can go to queue number 1 and the fourth person can go to queue number 2. According to this order, long waiting queues in front of consultation rooms can be reduced. Providing an inquiry desk, helps to provide accurate information for the patients as well as it can direct patients to the correct locations. As a result, that decreases patients' nervousness and reduces their spending time on OPD. This inquiry desk may help in finding relevant counters and other operational information from it.

Apart from the above suggestions summary of the interviewee's responses was that no major renovation was done for the OPD premises during their service period. Both respondents 1 and 3 of case A stated that they have been facing insufficient staff and facilities in the OPD unit compared to the high number of patients. As suggested respondent 1 comments on providing more staff such as more nurses and sisters. And also, further commented on providing more facilities to doctors to save time such as more investigating beds, sanitary equipment, and changing shifts considering patients' demands. According to responded 2, space utilization is not at a satisfactory level. He commented that though there are 2 consultation rooms those 2 rooms are not utilized efficiently. That is why this new work procedure chart is proposed by the researcher. And also, he proposed that overloaded documentary activities consume more time in OPD for that he is proposing a computerized system for admirative and managing processes.

4.3.2 Computerisation of the Administrative Work

These hospitals' general outpatient departments use two consultation types: old patients and new patients. The new patients are those who are coming to the hospital for the first time for treatment, while the old patients are those who have been there before. This computerized system enables old patients for getting queue tokens quicker than new patients. It's because patients' folders are sorted and a tally with a serial number is issued based on arrival time for old patients, and new patients must first register with the hospital, then a file will be created before a token is issued. That registration process takes 5 to 10 minutes. By issuing a serial-based hospital card that time can be saved.

Increasing service efficiency is one of the main suggestions for reducing the waiting time of the patients. For providing more efficient service may occur high cost. Without considering the cost this study is proposing computerized system in order to manage daily work in the OPD. Respondent 3 of Case B commented on the computerized system can increase the server efficiency and helps to speed the patient's admission process. Further patient information such as demographical information, medical history, test reports, prescribed medicines, etc., can be computerised for quick access. Further, it can be used as a database that would reduce administrative work.

4.3.3 Increased Resources

Delay at every point of service will affect the total final waiting time. Therefore, increasing overall system efficiency is one way of reducing waiting time in the OPD. It was a suggestion of case B respondent 2. Respondent 2 proposed that providing more hospital resources with modern technology, evaluating staff, giving awareness to patients, and targeting settings for staff are major activities that can be introduced. According to respondent 3 of Case B, the service capacity or service channels can be altered according to the arrival pattern of the patients. The OPD doctor of Case B reviewed that severe efficiency can be improved by enhancing the built environment. For instance, providing more equipment, doctor's tables, chairs, examine beds could be considered.

4.3.4 Signage and Direction

Respondent 3 of case A stated that proper direction boards should be created and pasted on the walls which will help to properly guide the patients. If not when a new patient comes into the OPD that patient feels nervous and has to ask for every information from the inquiry counter. It takes more time for the patient and sometimes the patient may fall into other troubles when getting information from the wrong person. Therefore, implementing information boards using standard colours, and symbols will help to patient's convenience.

5. CONCLUSION

Empirical findings prove that waiting time is one of the major issues that can see in Sri Lankan government hospitals. As a patient, time is a more significant factor when considering their perspectives. Therefore, this study's purpose is to minimize patient waiting with new strategies concerning two different government hospitals' OPDs in Sri Lanka. In this effort is further established that the theory and modelling of queuing is an efficient instrument that can be used to create decisions on staff requirements regarding queuing challenges for optimum performance of hospital OPD. Properly designed internal space, computerized systems, and other managerial changes proposed based on the model outputs in each hospital, enable to minimize of the number of patients in the queue and the average waiting time in the queue. Planning and design teams could have a role to play in minimizing the waiting time of patients in hospitals.

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