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IMPROVEMENT AND OPTIMIZING QUEUING MANAGEMENT SYSTEM FOR PUBLIC HOSPITAL IN MALAYSIA

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ABSTRACT

In public hospital, patients always have to wait a longer time to be served by physicians. This is very common to happen in the outpatient department which may lead some negative effects and consequently contributes to a range of public health issues. Hence, it is necessary to overcome this problems by using some effective methods. In this paper, there are some techniques used from the previous research in order to solve the problem of queuing system in public hospital. It can applied in public hospital which facing the same problem.

1.0 INTRODUCTION

The problem of overcrowding in public hospital is often happen which cause negative effect which is longer waiting time. The problem of overcrowding are still unresolved although some efforts have been made to reduce waiting time and increase access to the services for patients (Bahadori et al., 2017). If the problem of waiting line do not handle and solve effectively, it will cause huge loss to human life (Chandra, 2015). However, the high volume of work in the hospitals and the admissions of patients exceeding the exist capacity is the reasons that cause the serious problems of quality in hospital services (Bahadori et al., 2017).

According to Shanmugasundaram & Umarani (2015), queue formation is due to the current demand for a service exceeds the current ability to provide it and queuing theory is very useful which not only use in our daily life but also can be applied in computer programming, networks, medical field, banking sectors and so on. This is due to a queuing system can maximize the utilization of servers such as doctors, nurses and hospital bed, which ultimately will minimize the patient's waiting time. Hence, queuing models can successfully address problem in the health care system which based on mathematical models (C & Appa Iyer, 2013).

To implement the solving techniques, it is necessary to investigate the service time, patients' waiting time on each stage, patients' waiting time in system and effect to healthcare organization if patients refuse to get the service due to the lengthy waiting time (Wangrakdiskul, 2014).

2.0 Literature Review

In literature review, it consist of various types of techniques and methods that used in the previous researches which regarding to the queuing system in hospital.

2.1 Queuing theory technique

Queuing theory is a mathematical method to study the waiting line while queuing system is a system which involve customers who need service but there is a limit in the service that can be provided (Olorunsola *et al*., 2014). According to Aslan (2015), queuing theory is importance to measure the servers and queues with the purpose of decrease waiting and queues. Aslan (2015) stated that adding more capacity to servers or decreasing service time can reduce the waiting and delays, however decreasing the service time will affect the quality negatively, so some useless processes can be eliminated by increase trained staff to raise the performance of measures.

In this previous research, by using online appointment system, a doctor used ten minutes checking time to schedule patients and two hours for recheck the previous patients, but unorganized rechecking and new

patients without appointment caused problems in the queues. However, appointment system is useful since it can increase work efficiency and reduce patients' waiting time (Obulor & Eke, 2016). According to Fatma & Mursyid (2013), the patients' waiting time was predicted which ranges between 27 and 51 minutes, but based on the standards of hospital care, waiting time for outpatients should no more than 30 minutes, so to increase the efficiency, the hospital should provide an appointment system, pay attention on the patients' flow and set scheduling of the capacity. The average time spent in queue is approximately 52 minutes while the average time spent in the system is approximately 63 minutes, hence patients have to spend long waiting time for service which will cause emergency patients suffer (Mala & Varma, 2016). According to Dushime *et al*. (2015), 75% of staff in Muhima Hospital said that long waiting time caused by large number of patients while the rest of staff give the reason of staff shortage. So, the hospital should have a staffing plan and focus in the early of the week in order to make sure available resources can be used effectively. Vass & Szabo (2015) found that the patient flow in the emergency department can characterised by M/M/3 queue model. In this research, they found that the most frequent complaints are about the lengthy waiting time, the size of waiting room and the insufficient of staff.

Table 1. Symbols for queuing model and calculation.

Symbol	Definition	Calculation in M/M/1 model	Calculation in M/M/m model (m = number of channels open)
P_0	The probability that there are zero customers in the system.	$P_0 = 1 - \frac{\lambda}{\mu}$	$P_0 = \frac{1}{[\sum_{n=0}^{m-1}\frac{1}{n!}(\frac{\lambda}{\mu})^n]+\frac{1}{m!}(\frac{\lambda}{\mu})^m\frac{m\mu}{m\mu-\lambda}}$ for $m\mu > \lambda$
L	The average number of customer in the system.	$L = \frac{\lambda}{\mu - \lambda}$	$L = \frac{\lambda\mu(\frac{\lambda}{\mu})^m}{(m-1)!(m\mu-\lambda)^2}P_0 + \frac{\lambda}{\mu}$
W	The average time a unit spends in the waiting line or being served, in the system.	$W = \frac{1}{\mu - \lambda}$	$W = \frac{\mu(\frac{\lambda}{\mu})^m}{(m-1)!(m\mu-\lambda)^2}P_0 + \frac{1}{\mu} = \frac{L}{\lambda}$
L_q	The average number of customers or units in line waiting for service.	$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$	$L_q = L - \frac{\lambda}{\mu}$
W_q	The average time a customer spends waiting in the queue.	$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$	$W_q = W - \frac{1}{\mu} = \frac{L_q}{\lambda}$
P	The probability the service facility is being used.	$P = \frac{\lambda}{\mu}$	$P = \frac{\lambda}{m\mu}$

2.2 Simulation technique

Simulations can used to understand the reality of queues and get results (Aslan, 2015). According to Kocaleva *et al*. (2016), simulation is a process to imitate the operations of a system from the real world, which takes place over time. Kocaleva *et al*. (2016) stated that simulation software can develops a simulation model which can used to study new procedures for the operations of a system without experiment with the real system, however the models are certainly not be the same when the models are constructed by different individuals. One simulation is not enough and it is required to repeat various times to get a clearer image of the simulate system (Kocaleva *et al*., 2016). Next, according to Ehsanifar *et al*. (2017), by using Arena simulation software, it is quick and easy to understand through a simple flowchart modelling approach, so it can prevent long queues, and hence increase satisfaction of customers and quality of services.

The average waiting time of patients in queue was 54.295 minutes while the average service time was 13.481 minutes (Aziati & Hamdan, 2018). By using simulation technique in the study, the pre-consultationn room had longest waiting time and lowest utilization of server which was about 28 minutes and 59%. Lade *et al*. (2013) used simulation technique in their research and stated that if adding one extra doctor for providing the services, the average waiting time in outpatient department can be

reduced by 40.97%. However, the extra doctor must present in the peak hour which is morning session to reduce patients' waiting time.

Due to the arrival rate is greater than the service rate, the average waiting time in pharmacy for both morning and evening session were 39 and 35 minutes (Bahadori *et al*., 2014). Hence, to reduce the waiting time, it is important to use queuing theory and simulation techniques for multitasking persons and reallocating them into the time-consuming stage.

2.3 Observation technique

According to Kawulich (2014), observation is a method that used in social science for collection of data about people, processes and cultures. By using observation method to collect data on seven days during 8 a.m. to 12 p.m., Dilrukshi *et al.* (2016) found that patients' arrival rate on Saturday is higher than other days while minimum arrival rate is during religious holidays. So, the number of channels that required on Saturday is high compared with other days.

When it is impossible to manipulate the behavior of human participants, ex post facto research can be applied to conduct social research which used the collected data (Simon & Goes, 2013). By using observational and ex-post facto case study approach, Afrane & Appah (2014) stated that the average arrival rate and service rate per hour was approximately 53 patients and 12 patients, so the hospital should provide an effective system in outpatient departments to optimize the performance. To reduce the queuing problem, hospital recommended to use a friendly computerized database system in order to reduce number of nodes in the system.

2.4 Survey and sampling technique

According to (Priscilla, 2005), survey method are capable to obtain information from a sample of the population. In a survey research, researcher must predicate a model that can explain the relationship among the independent and dependent variables, then conduct the survey to test this model against the observation of phenomena (Priscilla, 2005). Chandra (2015) stated that the issues in medical care unit which cause the patients' waiting time increase and ultimately dissatisfied patients and delay medical care are appointment systems, progressive patient flow, patient records and examination procedure.

Ahmad *et al*. (2017) applied universal sampling method technique to understand the situation in primary healthcare clinic. From the research, the average total waiting time and consultation time was 41 minutes and 18.21 minutes. It is necessary to improve the waiting time in primary healthcarre clinic and further research is needed for assessment of patients' satisfaction on the clinic services.

To reach the effective satisfaction level, the expected service time and expected waiting time should close or equal to the actual service time and actual waiting time (Komashie *et al.*, 2015). Yaduvanshi *et al*. (2019) used survey method technique and calculated the waiting time in the system of outpatient department according to the flow of patients. From the research, there are 95% accuracy that the waiting time was 19.45 minutes while the waiting time according to patient flow came out was 20.6 minutes. Since it was difficult to keep track of patients especially on Mondays, Thursdays and Saturday, hence it is needed to prioritize hospital operations which based on the need, benefit and feasibility.

2.5 Qualitative study technique

Qualitative data are non-numerical data in which the data collected are in the form of words and sentences (Megel & Heermann, 1994). By using qualitative study technique, Bahadori *et al*. (2017) found that overcrowding in ward caused by the low number of hours of patients' visit, physicians' delays and shortage of the physician which lead to the lengthy waiting time and ultimately dissatisfy the patients. To reduce the factors that affect the overcrowding, the physicians' schedules need to avoid interference in physicians' schedules, reduce the problems of physician shortage and delays, then using a triage system when patient are admitted. "Triage" is the term which means the classification of patients in emergency departments and multi casualty incidents, disasters, and battlefield settings for treatment priority (Iserson & Moskop, 2007). Hence, triage system can determine the needs of patients and avoid inappropriate referrals to the clinic (Bahadori *et al*., 2017).

2.6 Business Process Reengineering (BPR) method technique

According to (Hlupic *et al*., 2000), although the failure rate of Business Process Reengineering (BPR) is as high as 70%, however this method will brings significant improvements and benefits. By using Business Process Reengineering (BPR) method technique, Dachyar *et al*. (2018) suggested to improve the outpatient services in the three clinics of a public hospital in Jakarta, so that the service time in internal disease polyclinic, cardiac polyclinic and pulmonary polyclinic can be reduced.

2.7 Summary of previous study

The research problems and disadvantages of previous studies were stated in Table 2.

Table 2. Summary of previous study.

Author	Year	Technique	Research Problems
Dilrukshi *et al*.	2016	Observations	• To investigates the application of queuing theory and reduce the patients' waiting time at the outpatient department of the National Hospital which located in Sri Lanka. • This study focus more on the patients in the consultation phase than pharmacy.
Aslan	2015	Queuing Theory	• To define queues and models that can be used to decrease waiting an important indicator of measuring system quality and queues. • The extreme situations were not included in this study which is patients had to wait few hours for system returning.
Lade *et al*.	2013	Simulation	• To reduce the average waiting time of patients for each section in the radiation therapy and oncology department. • The study only recorded the arrival time of patients for 3 days in outpatient department.
S. A *et al*.	2014	Queuing Theory	• To show that queue theory can accurately model the flow of in-patient in hospital and determine the optimal bed count and its performance measure. • This study mainly focus on Emergency and Accident Departments (EAD) only.
Aziati & Hamdan	2018	Simulation	• To determine the waiting arrival time and service time of patients at the outpatient counter and model suitable queuing system by using simulation technique. • Software ARENA student version is used in this research which is unable to develop model more than 150 entities waiting so it is difficult to simulate a complex model.
Bahadori *et al*.	2014	Simulation	• To optimize the management of studied outpatient pharmacy by developing suitable queuing theory and simulation technique. The over-the-counter drugs and patients requesting such drugs were not considered in this study.
Afrane & Appah	2014	Observation	• To investigate the application of queuing theory and modelling to the queuing problem at the outpatient department. • This study didn't include the aspect of emergency outpatient clinic.
Ahmad *et al*.	2017	Survey and Sampling	• To assess patient waiting time and doctor consultation time in a primary healthcare clinic and to formulate strategies for improvement. • The use of manual recording might have introduced bias to data collection.
Bahadori *et al*.	2017	Qualitative Study	• To determine the factors influencing the overcrowding in the specialty and subspecialty clinic of a teaching hospital. • To conduct interviews was one of the study limitations.

Chandra	2015	Survey and Sampling	• To provide information to the Health care analysts who are engaged in improvement of hospital efficiency using an appropriate operational research model. • The study did not focus on lack of coordination between hospital interfaces and waiting time of patients for special treatments.
Komashie *et al.*	2015	Survey and Sampling	• To investigate the connection between patient satisfaction, waiting time, staff satisfaction and service time. • The mathematical formulation was not a perfect representation of a real Accident and Emergency (A&E) system.
Dachyar *et al*.	2018	Business Process Reengineering (BPR) method	• To improve the efficiency of public hospital services by using Business Process Reengineering (BPR) method. • The study used Business Process Reengineering (BPR) method which might require a substantial investment in IT with proper planning, teamwork and exceptional implementation.
Vass & Szabo	2015	Queuing Theory	• To understand the magnitude of the broader problem, the relationship between resources and waiting times. • The data used in the case study only within the period from 1st January to 31st December 2012.
Prabakaran & Kumar	2019	Queuing Theory	• To explain the problem in their urgency of medical cases with respect to allocation problem of the patients and can be categorized. • The study did not develop the efficient dynamic priority rules for expensive shared healthcare facilities.
Yaduvanshi *et al*.	2019	Survey and Sampling	• To understand how patients perceive waiting time through survey method. • This study did not include the emergency counter.
Fatma & Mursyid	2013	Queuing Theory	• To provide a study of the major causes of patients length of time for medical treatment in an outpatient clinic at one of Indonesian public hospital and also provide recommendation on the best strategy to improve the appointment system so that can maximize the effectiveness and efficiency of resource and capacity. • This study did not make a simulation of all variable that affects bottleneck.
Dushime *et al*.	2015	Queuing Theory	• To analyse time that patients can spend waiting for service in Muhima District hospital. • Only 36 days has been considered in this study.
Obulor & Eke	2016	Queuing Theory	• To provide an efficient outpatient appointment queuing model for proper appointment scheduling thus, reduces patients waiting times, doctors' idle time and overtime as well as improving the outpatient's satisfaction. • It only focused on first come first service (FCFS) queue discipline.
Varma	2016	Queuing Theory	• To analyse the use of queuing theory in a local health care clinic. • The case study was based on the actual observed data which only collected in 22 days.
Kocaleva *et al*.	2016	Simulation	• To analyse the queuing system with finite capacity M / M / n / m and demonstrate the simulation of the market. • This paper only reviewed the case of simulation of single server.
Ehsanifar *et al.*	2017	Simulation	• To predict the waiting time of each customer in an M/M/C queuing model. • There are uncertainly and complexity in the systems.

3.0 CONCLUSION

As mentioned before, problems of longer waiting time in public hospital should be overcome as it will cause some negative effects. From the previous research, there are various techniques that can be used in order to improve the efficiency of queuing system in public hospital, so the satisfaction level of patients will be increased. It is useful to be applied in public hospital which facing the problem of overcrowding of patients and lengthy waiting time. However, there are some limitation in the previous research, hence it is recommended for the further research to overcome the problems and weakness that are exist.

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