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Optimization of Outpatient Department Performance Using Simulation

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Abstract

In recent years, the efficiency has, been one, of the most significant issues for hospitals, which utilized a limited 'resources' for maximum, value. Hospitals in developing countries are facing overcrowding of patients in outpatient treatment that caused many problems for the patients; as it takes a long waiting time. In addition, the resources and facilities are required to operate effectively in the outpatient department to relieve with these problems. Therefore, to cope with theses problem a simulation model is developed with the objective of minimizing waiting time and utilizing the resources effectively. An experiment study carried out by using data from Al-Alwaiya Children's Hospital in (Baghdad). The study constructs six scenarios to analyze results of waiting time and utilization of doctors and number of patient in the queue, and compared the achieved results with the hospital's current situation. Arena simulation tool was a core of this environment study.

1. Introduction

Effective allocation and utilization of resources is a significant issue facing outpatient department administrator. The public hospitals play as an essential part in healthcare system in any society, and specifically in Iraq. The problem of overcrowding of patients in the hospitals and long waiting time, made the patients choose the private hospitals rather than public hospitals. Private hospitals offers better quality services and shorter waiting time in outpatient departments at the expense of cost, of course. Scheduling of the outpatient department considered as one of the significant factors that effect on hospitals efficiency, which plays an important role in bringing efficiency to hospitals, by using the available (resources) in the department effectively, and provide a good service to attain the patient satisfaction by minimizing waiting time [1].

A simulation model based on two performance measures is a core of this study. Firstly, minimizing the waiting time on the doctor consultation queue per patient, and secondly maximizing the utilization of doctors are these two performance measures.

The waiting time for patients is one of the important factors that should be considered in the management and organization of the healthcare system. Patients waiting time is not the only factor that affects patient satisfaction but also is one of the indexes to evaluate the quality of outpatient services [2]. In other hand, utilization of doctors is also plays as an important factor effecting on hospitals performance. According to (Mcquarrie) [3] the reasonable utilization rate for hospital activities is in (70% ~ 80%). The utilization when exceed 80% be irrational, it will affect the efficiency and decrease the satisfaction of patient and doctors.

2. Literature Survey

Efficiency has become one of the most attractive work areas of healthcare management literature. Studies on hospital efficiency mostly focus on the issue of maximum gain with limited resources. The interest on hospital efficiency has increased because of the desire to control the increasing costs. Accordingly, hospital resources and their processes became critical and, as a result, the number of studies has increased in recent years.

Aeenparast et al. [4] Provided a simulation model for reducing outpatient waiting time by presenting 10 scenarios based on (Changing the time of resident physician's and senior staff physician's, Increasing the number of novice residents and experienced residents). For reducing outpatient waiting time, using the data of arrival time, service time and flow of 357 patients referred to orthopedic clinic of a general teaching hospital in Tehran. The results show the 9th scenario was the best way for reducing outpatient's waiting time.

Tako et al. [5] Developed computer models of patient flows in an obesity service in an academic health science center that provides lifestyle, pharmacotherapy and surgery treatment options for the UK's National health service. Then experiment with different scenarios to investigate the likely impact of alternative resource configurations on patient waiting times. The results show that the timing and combination of adding extra resources to the service are important.

Bahadori et al. [6] Explored four scenarios to optimize the management of outpatient pharmacy in a military hospital in Iran, by using SPSS 18 software, to calculate the pharmacy queuing network performance indicators. Then, Arena v.12 software was used to model and simulate the queuing system of current situation. The results showed that the queue characteristics of the studied pharmacy during the situation analysis were very undesirable in both morning and evening shifts.

Lurkittikul and Kittithreerapronchai [7] developed a discrete event simulation model to evaluate an appointment system. The simulation model examined various appointment systems. The simulation had shown that average waiting time could be reduced thirty-seven to forth-four percent as compared to the current status.

VanMerode et al. [8] used the simulation to determine the optimal production and inventory, policies for the combination of each; (patient type) and (drug type) to minimize patients waiting times & costs.

Taheri et al. [9], described discrete event simulation model in 'Duke University Medical Center' to create a hospital 'endoscopy unit' and review strategies, to improve (unit efficiency) and minimize (nurse overtime), using (Arena) simulation software. The results suggest that the 'endoscopy unit' could (decrease) the risk of nurse overtime by staggering the scheduling of Monitored Anesthesia Care (MAC) patients.

Best et al. [10] developed a simulation model of acute care at a district level hospital in Ghana to test the effects of resource-neutral (e.g. modified staff start times and roles) and resource additional (e.g. increased staff) operational interventions on patient throughput. The results show the base-case (no change) scenario had a mean length of stay (LOS) of 292 minutes. In isolation, neither adding staffing, changing staff roles, nor varying shift times affected overall patient LOS. Specifically, adding two registration workers, history takers, and physicians resulted in a 23.8 minute LOS decrease. However, when shift start-times were coordinated with patient arrival patterns, potential mean LOS was decreased by 96 minutes, and with the simultaneous combination of staff roles there was an overall mean LOS reduction of 152 minutes.

Haghighinejad et al. [11] determined the number of patients who are waiting and waiting time in emergency department (ED) services in an Iranian hospital and proposed scenarios to reduce its queue and waiting time, using simulation Arena software. The results show first scenario in the number of beds had to be increased from 81 to 179 in order that the number waiting of the "bed area" server become almost zero. The second scenario attempted to limit hospitalization time in the ED bed area to the third quartile of the serving time distribution could decrease the number waiting to 586 patients.

Mohammed Ali [12] analyzed the efficiency in the outpatient department of hospitals in Baghdad by analyzing the relative efficiency using DEA and change in the productivity using LPI. Then used the Arena simulation to analyze waiting time and utilization of doctors in outpatient department, by constructing (8) alternatives depending on (3) components. The results show the utilization of doctors is up normal which effects on the hospitals performance and on satisfaction of patients.

3. Methodology

The study methodology consists of seven steps to develop the simulation model in outpatient department, as illustrated in Figure 1. The steps are described as below:

3.1. Formulate Problem

To formulate the problem, we first set the objectives of the study:

1. Analyzing the efficiency (waiting time and utilization of doctors) in outpatient department, using the application of Arena simulation software.
2. Monitor the activities to calculate the queue within doctor room and the utilization of doctors.
3. Minimizing waiting time and Investigate the best utilization of doctors in the outpatient department.
4. Determine the number of patients wait in doctor room.

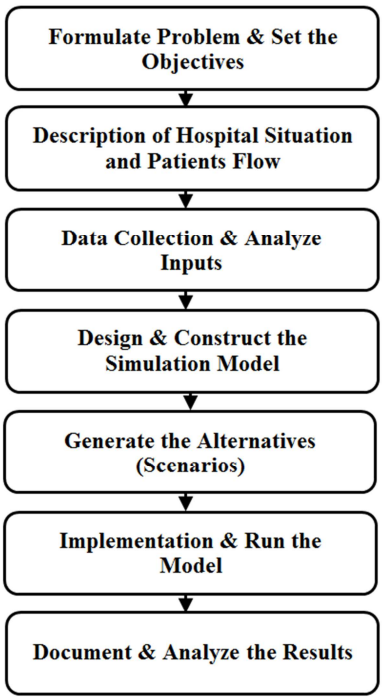

Figure 1. *The study framework.*

In order to meet these objectives, the study proposed the model to study the average waiting time and utilization of resources (doctors) and number of patients waiting in the doctor consultation queue of outpatient department.

3.2. Description of Hospital Situation and Patients Flow

The outpatient department in the hospitals operates six days (Saturday to Thursday) in a week for six hours, from (8.00 am to 2.00 pm). The new patient has to go to the reception. Therefore, the patient who tack a number from the reception, has to go to the (consultation room), and wait in the consultation room queue to be called. After getting the patients consultation from the doctor, the patient who don't need either of (laboratory test, sonar test or X- ray test), will drop out the system. While patient who sent to the (laboratory, sonar or X- ray) to make a test, will go to complete his tests, then return back, to the consultation room with (new patients) and wait until he called. The rule 'first in first out' (FIFO), is used as the patients order in entering to the doctor consultation room. After the patient finished consultation with the doctor will drop out the system. Figure 2 shows the hospitals outpatient department daily routine.

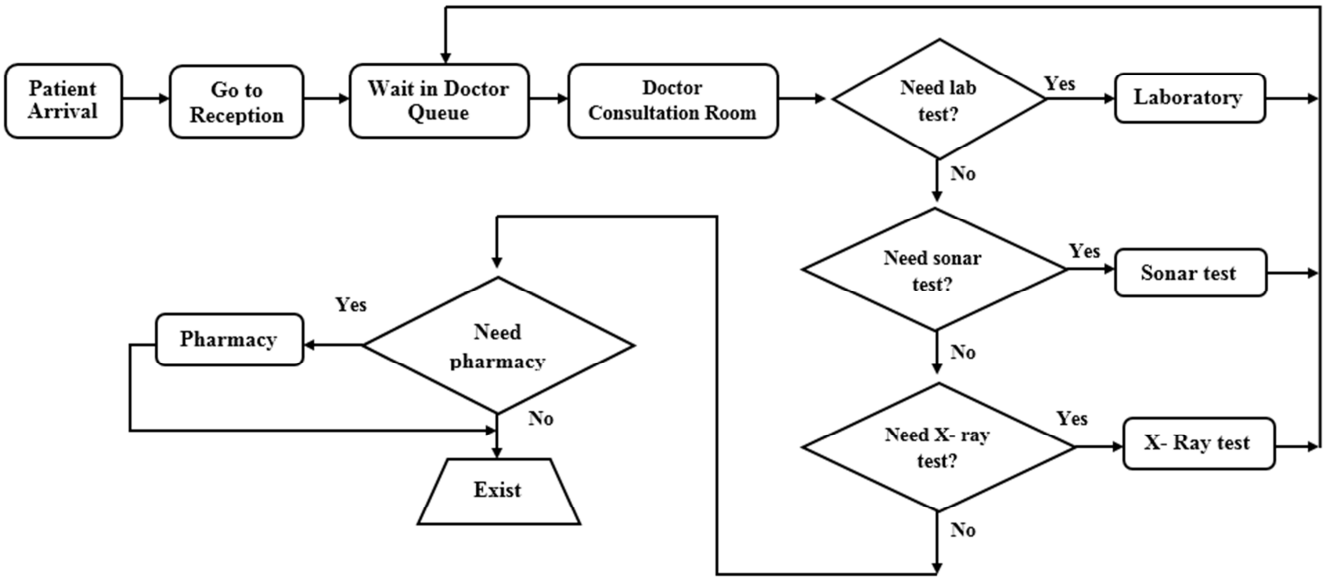

Figure 2. *The outpatient department daily routine.*

3.3. Data Collection

A hospital in study district (Baghdad) has been selected in order to implement the simulation model, the selected hospital is Al- Alwaiya Children's Hospital. The collected data of current situation in outpatient department are illustrated in Table 1.

Table 1. *The collected data from outpatient department.*

Collected Data From Outpatient Department	
Average Patients Served per day	325
Doctor's Working Hours	six hours
Number of Resources (Doctors)	2

Table 2. *The Statistics achieved from the Input analyzer.*

Statistics	Parameter
Service time in doctor consultation room	3.15 + 3.85 * BETA(1.44, 1.2)
Time spend in laboratory test	8 + 2 * BETA(0.964, 0.956)
Time spend in sonar test	UNIF(5.5, 8)
Time spend in X- ray test	TRIA(5, 7.5, 10)
Time spend in pharmacy	TRIA(3, 4.5, 7)
Percentage of patients that needs lab test	30%
Percentage of patients that needs sonar test	25%
Percentage of patients that needs X-ray test	45%
Percentage of patients that needs pharmacy	60%

The statistical distribution data in Table 2 are collected from above studied area and then analyzed using Arena input analyzer [13].

3.4. Simulation Model

In this section, the simulation model is constructed to represent the situation of outpatient department using Arena v.14 Modules. Thus, one (create module) is used to generate initial arrivals, then (process module) is used, to determine process time at doctor consultation.

Then (assign module) is used to assign patients as passed from doctor consultation. Thereafter, four (decide modules) are used, first, to decide whether, the patient is new or returned in the loop described as: (If the patient is returned then go to exist of the system, else, the patient is new patient, then go to next module), the other three decide modules, to decide whether the patient need (lab, sonar and X- ray) test or not. After the three modules (lab, sonar and X- ray), the patient returns back to doctor consultation. Before the patient leaves the system he pass through one decide module to decide whether the patient need pharmacy or not. Then go to exist system through (disposed module). Figure 3 shows the design of simulation model. The statistical data that can be collected from this model are:

1. Average waiting time from (doctor queue) per patient.
2. Number of patients in the queue.
3. Average utilization of the (doctor).

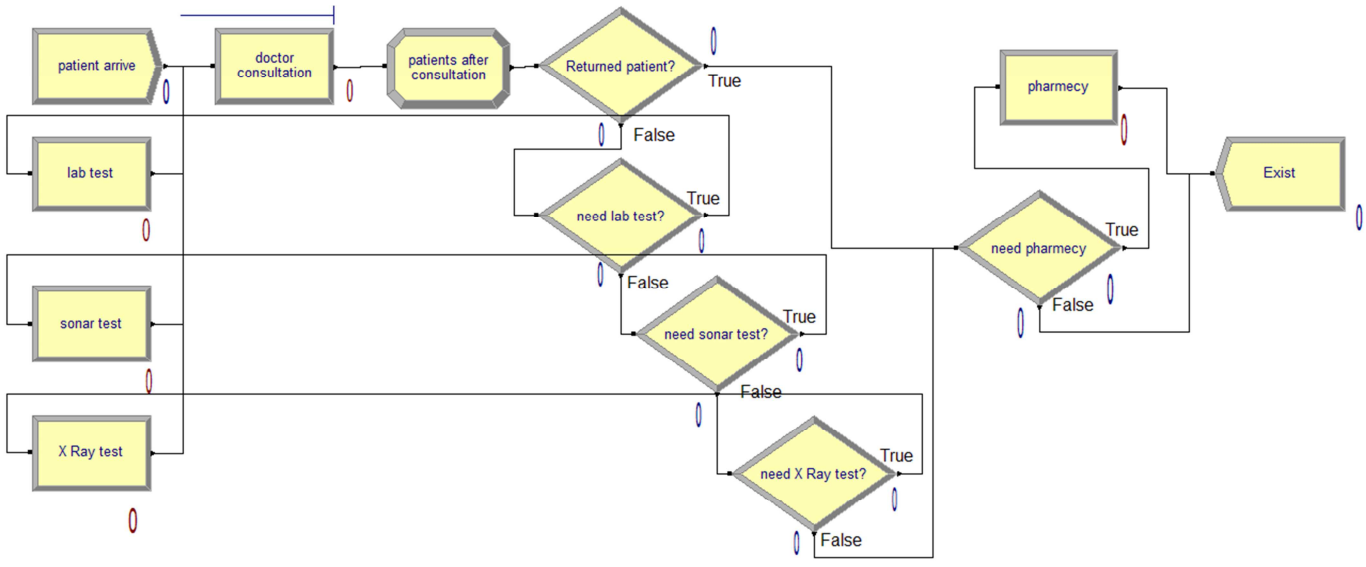

Figure 3. *Design of the simulation model.*

3.5. Generating Alternative (Scenarios)

Six scenarios are constructed to optimize the performance of the outpatient department by analyzing the doctor utilization and patient waiting time using Arena simulation software. The six scenarios are based on four components:

a. Time between arrivals two consecutive patients.
b. Number of resources (doctors).
c. Doctor Service time.

The constructed scenarios are listed below:

a. Scenario (0): the hospital's current situation without change.
b. Scenario (1): increase the time between arrivals by (1) minute.
c. Scenario (2): add one additional resource (doctor).
d. Scenario (3): decrease the doctor consultation service time about one minute.
e. Scenario (4): both Scenarios (1) and (2).
f. Scenario (5): both Scenarios (1) and (3).
g. Scenario (6): both Scenarios (2) and (3).

3.6. Implementation and Results

The implementation of the simulation model is carried out

using data from Tables 1 and 2. Based on six scenarios, with the model time duration of six hours, and running for (10) numbers of replications. After running the model, the waiting time (per each patient), number of patients in the queue, and utilization of doctors of hospitals for each scenario are analyzed. The results are listed in Table 3.

Table 3. *Achieved results of running simulation model on hospitals for each scenario.*

Scenarios	Average Waiting Time (Hours)	Average Number of Patients in the Queue	Average Utilization of Doctors
0	1.91	126.43	100%
1	1.33	50.62	99%
2	1.54	115.03	99.6%
3	1.73	115.57	100%
4	0.51	21.4	98%
5	0.96	39.55	98.5%
6	1.42	105.72	99.6%

As shown above, average waiting time had its lowest value when add one minute to time between arrivals and add one additional doctor to the hospital current situation as in scenario (4). The utilization of doctors is fully utilized (100%) in scenario (0) (the current situation of hospital), which indicate unrealistic situation. And points out that the doctors are under higher stress which decreases the performance during diagnosis and dealing with the patients. The average number of patients in the queue is decreased when add both (one minute to time between arrivals) and (one additional doctor) to the hospital's current situation as in scenario (4).

4. Conclusions

A simulation model is constructed to deal with the parameters of outpatient department in hospitals precisely based on minimizing waiting time and maximizing utilization of doctors as the main factors in view of attaining satisfaction of patients. The model is implemented on a hospital in Baghdad as a sample study. Six scenarios are constructed based on three components: (Time between arrivals consecutive patients, number of doctors allocated in the outpatient department and service time of resources).

From the results achieved in table 2, it is clear that the designed simulation model and proposed scenarios give a results better than the current hospital situation. The utilization of doctors is still up normal in all scenarios, this problem may effects on doctor's performance during diagnosis of patient and giving treatment to patients. So the government should solve this problem by upgrading the hospital or building another hospitals. Finally, the constructed model can be considered as a base line to deal with the problem in reality environment for health care service.

References

[1] A. I. Aliyu, T. A. Sulaiman, and A. Yusuf, "Modeling and Simulation Analysis of Health Care Appointment System using ARENA," Int. J. Sci. Appl. Inf. Technol., vol. 4, no. 1, pp. 1–7, 2015.

[2] R. Sibbel and C. Urban, "Agent-based modeling and simulation for hospital management," Coop. Agents, 2001.

[3] D. G. McQuarrie, "Limits to efficient operating room scheduling. Lessons from computer-use models," Arch. Surg., vol. 116, no. 8, pp. 1065–1071, 1981.

[4] A. Aeenparast, S. J. Tabibi, K. Shahanaghi, and M. B. Aryanejhad, "Reducing outpatient waiting time: A simulation modeling approach," Iran. Red Crescent Med. J., vol. 15, no. 9, pp. 865–869, 2013.

[5] A. A. Tako, K. Kotiadis, C. Vasilakis, A. Miras, and C. W. le Roux, "Improving patient waiting times: a simulation study of an obesity care service," BMJ Qual. Saf., vol. 23, no. 5, pp. 373–381, 2014.

[6] M. Bahadori, S. M. Mohammadnejhad, and R. Ravangard, "Using Queuing Theory and Simulation Model to Optimize Hospital Pharmacy Performance," Iran Red Crescent Med J., vol. 16, no. 3, 2014.

[7] N. Lurkittikul and O. Kittithreerapronchai, "Designing an appointment system for an outpatient," IOP Conf. Ser. Mater. Sci. Eng., vol. 58, 2014.

[8] G. VanMerode, Groothuis S., Schoenmakers M. and Boersma H., "Simulation Studies and the Alignment of Interests," Health Care Management Science, vol. 5, pp. 97-102, 2002.

[9] J. Taheri e. al, "A Simulation Study to Reduce Nurse Overtime and Improve Patient Flow Time at A Hospital Endoscopy Unit," Winter Simulation Conference, 2012.

[10] A. M. Best, W. D. Dixon, K. W. David, C. J. Lindsell, and M. J. Ward, "Using Discrete Event Computer Simulation to Improve Patient Flow in a Ghanaian Acute Care Hospital," Am J Emerg Med., vol. 32, no. 8, pp. 917–922, 2014.

[11] H. A. Haghighinejad, E. Kharazmi, and N. Hatam, "Using Queuing Theory and Simulation Modelling to Reduce Waiting Times in An Iranian Emergency Department Original Article," vol. 4, no. 1, pp. 11–26, 2016.

[12] A. A. Mohammed Ali, "Productivity and Efficiency Analysis of Hospital Wards Enhance by Arena Simulation," M.Sc. Thesis, University of Technology, 2016.

[13] J. E. Hammann and N. A. Markovitch, "Introduction to Arena [simulation software]," Winter Simul. Conf. Proceedings, 1995., pp. 519–523, 1995.