

USED OF SIMULATION MODEL TO STUDY THE EFFECT OF INCREASING NUMBER OF DOCTOR AND PATIENTS' ARRIVAL CONTROL

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INTRODUCTION

Computer simulation is growing in popularity as a methodological approach for organizational researchers. Other research methods must make various assumptions about the exact cause and effect nature of the system under study; for example, in survey research, one must define the form and content of cause and effect a priori in order to learn from the data observed. Simulation allows for researchers to assume the inherent complexity of organizational systems as a given. If other methods answer the questions “What happened, and how, and why?” simulation helps answer the question “What if?” Simulation enables studies of more complex systems because it creates observations by “moving forward” into the future, whereas other research methods attempt to look backwards across history to determine what happened, and how. Because the nature of living systems is to either increase in entropy (disorder) or complexity (order), looking backwards is inherently more difficult than moving forwards.

There are a lot of simulation researches being conducted in health care area. For example the work of (1) and (2) in emergency department, (3) and (4) in outpatient department and (5) and (6) in pharmacy.

PROBLEM STATEMENT

The health care industry in Malaysia is under increased pressure from not only national political forces, but also from the competitive marketplace, to manage patient services more efficiently. The impact of restructuring the delivery of health care will cause significant changes in the entire health care system, resulting in a shift of overall hospital management philosophy. Greater attention is now being focus on the effectiveness and efficiency of outpatient clinics with particular emphasis on the delivery of care. In the outpatient department, the main indicator of quality assurance for patients is waiting time; patients should be attended to within an acceptable time.

PROBLEM BACKGROUND

Waiting time is defined as the total time from registration until consultation with a doctor. There were two types of waiting times, the first is time taken to see a doctor and the second is time to obtain medicine. In 2008, Ministry of Health Malaysia had

promised to reduce waiting time at government hospital to see the doctor to 30-minute (7). By January 2010, it is claimed that only 70% of local hospitals had achieved the 30-minute waiting limit (8). There are many reasons that contributed to the problem, such as registration time, limited number of available doctors and insufficient counter staff (9). However, another factor that often being neglected is patients' arrival pattern. Since Malaysia did not implement appointment system for outpatient, there are tendencies that patients will arrive at the same time, especially during early morning. Even for the follow up patients who already had appointments, only the date of treatment was stated in the appointment card while time was not specified.

OBJECTIVES

This research was conducted in order to give suggestions to reduce waiting time in outpatient department by using computer simulation method. Two factors were studied for this purpose; number of doctors available and patients' arrival pattern. Thus, the objectives of this research are;

- i. to collect data in outpatient department.
- ii. to model the patient's flow using simulation method.
- iii. to conduct 'what-if' analysis study on the model.

METHODOLOGY

This study was conducted at Outpatient Department in Jitra Hospital. The total staff there during the study is 20 of which 3 doctors, 2 medical assistants, 2 staff nurses, 5 nurse aid, 2 pharmacist assistants and 6 staffs responsible at the registration counter. There are three sections in the OPD; registration, treatment and pharmacy. The flowchart for the research is presented in Figure 1.

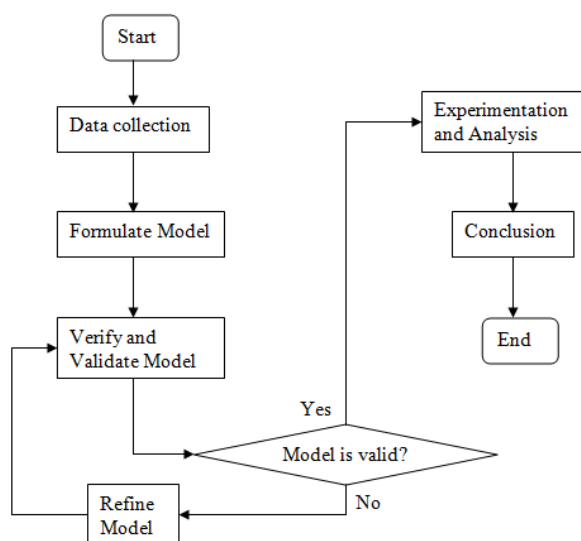


Figure 1 Flowchart of methodology

For data collection, two research assistants were placed at the entrance and exit of the health center. The assistant at the registration counter took the patients' sequence number and their time of arrival while the other one at the pharmacy recorded the patients' time when they take their prescription. Both data were combined by using patients' arrival number. Beside the data on patient's arrival and exit, the schedule of doctor was also collected. The flow of outpatients in the medical center is shown in Figure 2.

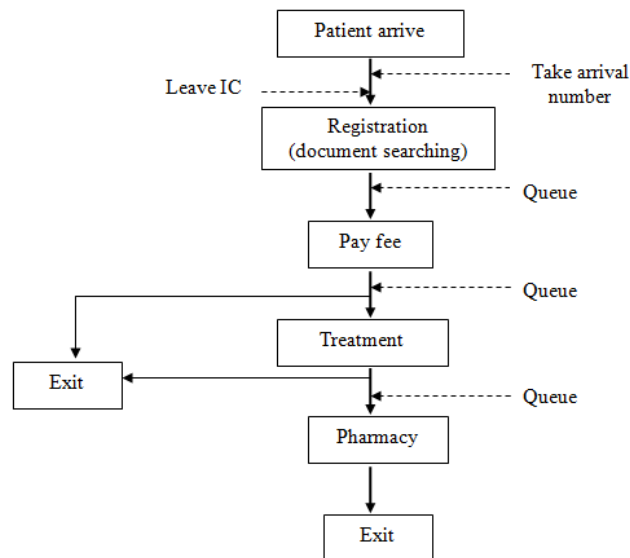


Figure 2 Outpatient flow at Jitra Hospital

RESULTS

A total of 1143 sequencing number was used during this research. However, only 1089 patients have attended to the center. The remained numbers were error caused by patients (specially the elderly) who push the button at sequencing-number-produce-machine many times which made the sequencing number produced rapidly. Among 1089 patients that attend the medical center, only 942 patients who were really get the treatment from doctors. The remaining patients were leaved the center before they get medical treatment.

Table 1 shows the number of outpatients for every hour. The figure exposed that the number of patients who arrive before 0900 are almost 50% of the day's patients. The situation gets even worse as the registration counter opened at 0700 thus make waiting time increases one hour prior doctors arrival. As the result, as shown in Figure 3, waiting time for patients who came before 10 am is usually more than an hour.

MODEL DEVELOPMENT

Base on the basic flow, a simulation model of the health center was built. The basic simulation model was shown in Figure 4. However, it is difficult to use one arrival block to simulate the patients' arrival because the arrivals were different from time to time on the day. Thus, a number of arrival blocks were used. The blocks were based on one-hour time interval.

For processing time, there were three processes in the outpatient department, which are registration, medical treatment and pharmacy. The processing time in each section was considered as constant. The average processing time in registration, treatment and pharmacy were identified as 1.5, 5.0 and 2.0 minutes respectively. These processing times were determined by interviewed staffs that responsible for each section. For model's verification, the results from the simulation were compared with the actual results by using Means Squared Error (MSE).

Table 1 Outpatients' arrival pattern

	Sunday	(%)	Monday	(%)	Tuesday	(%)	Wednesday	(%)	Thursday	(%)	Saturday	(%)
0700	55	27.09	50	32.89	35	23.81	49	26.78	38	38.78	30	18.87
0800	44	21.67	41	26.97	37	25.17	44	24.04	20	20.41	33	20.75
0900	17	8.37	19	12.50	21	14.29	18	9.84	15	15.31	22	13.84
1000	18	8.87	1	0.66	12	8.16	12	6.56	12	12.24	15	9.43
1100	13	6.40	6	3.95	8	5.44	12	6.56	9	9.18	13	8.18
1200	4	1.97	0	0.00	3	2.04	4	2.19	4	4.08	10	6.29
1300	11	5.42	8	5.26	5	3.40	10	5.46	-	-	12	7.55
1400	31	15.27	18	11.84	17	11.56	21	11.48	-	-	20	12.58
1500	9	4.43	8	5.26	9	6.12	13	7.10	-	-	4	2.52
1600	1	0.49	1	0.66	0	0.00	0	0.00	-	-	0	0.00
Total	203	100.00	152	100.00	147	100.00	183	100.00	98	100.00	159	100.00

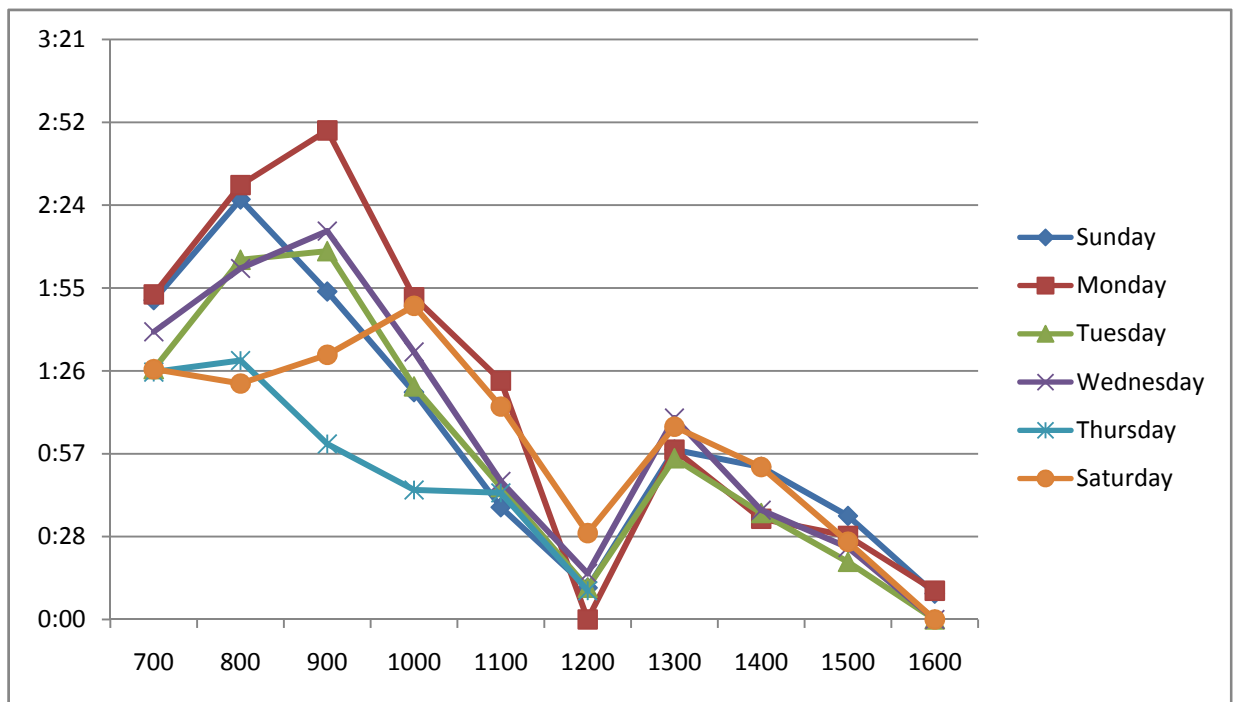


Figure 3 Waiting time for each arrival

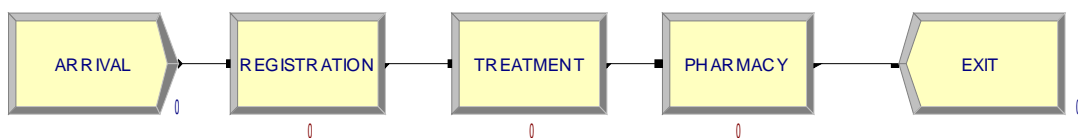


Figure 4 Jitra Hospital simulation model

NUMBER OF DOCTORS

First, the simulation model was used to analyze the effect of number of doctors on the waiting time. There are three doctors at the hospital. However, this number will reduce if one of the doctors needs to go to smaller health clinic or takes holiday.

For the simulation model, three situations were considered; hospital with two doctors, three doctors and four doctors all the time. All of the analyses were run on Monday because it has the lowest MSE.

The result of the simulation model is shown in Figure 5. Analysis of the result shows that the waiting time is decrease significantly especially for morning. However, after 1300, the simulation data show almost the same result. Base on the result, if one doctor is added to the system, it can reduce waiting time at the hospital up to 30%. However, the increase of the number of doctors will decrease their utilization rate as shown in Figure 6.

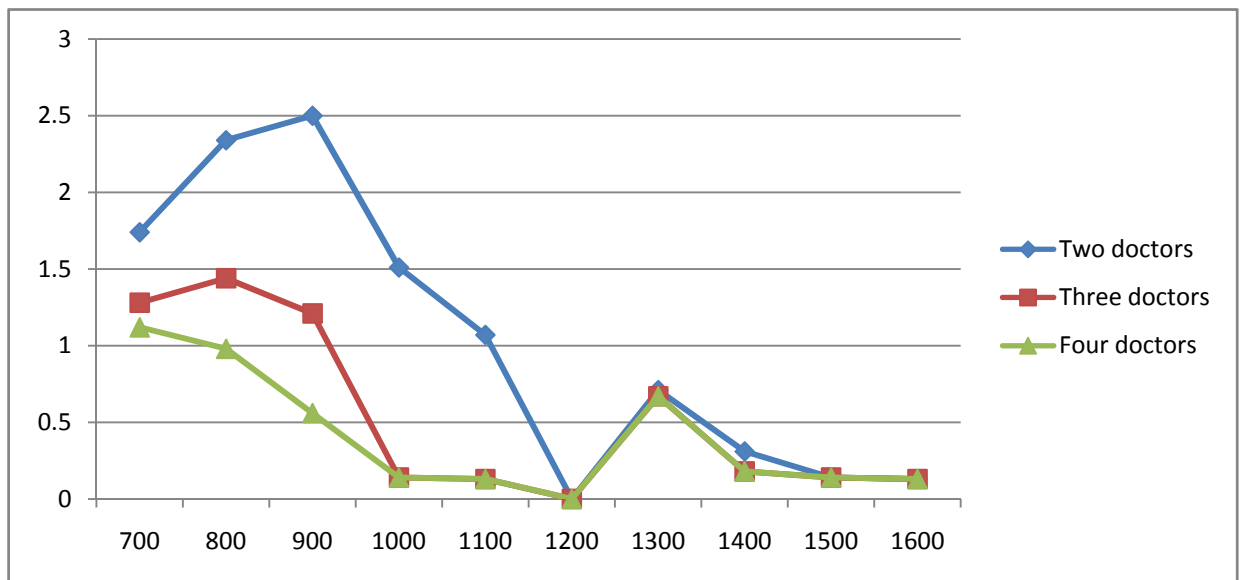


Figure 5 Waiting time for each arrival according to the number of doctors

Number of doctors	Instantaneous Utilization	Number Busy	Number Scheduled	Scheduled Utilization
2	0.6103	0.6103	0.7895	0.7832
3	0.4178	0.4178	0.7895	0.5292
4	0.3107	0.3107	0.7895	0.3936

Figure 6 Utilization rates of doctors

PATIENTS' ARRIVAL SIMULATION

A simulation model was developed to analyze situation if patients' arrival pattern was changed. The new arrival pattern is shown on Table 2. Based on the new arrival pattern, the developed simulation model was run. The new patients' spending time average is shown in Figure 7.

The result of new simulation model shows that the average spending hour in the hospital was reduced drastically from 1.60 hours to 0.62 hours (or 37.2 minutes). It was 61.25 percent decreases.

Table 2 The actual arrival and the new arrival pattern

	Real arrival	Percentage	New arrival	Percentage
0700	50	32.89	23	15.13
0800	41	26.97	23	15.13
0900	19	12.50	20	13.16
1000	1	0.66	20	13.16
1100	6	3.95	20	13.16
1200	0	0.00	11	7.24

1300	8	5.26	8	5.26
1400	18	11.84	18	11.84
1500	8	5.26	8	5.26
1600	1	0.66	1	0.66
Total	152	100.00	152	100.00

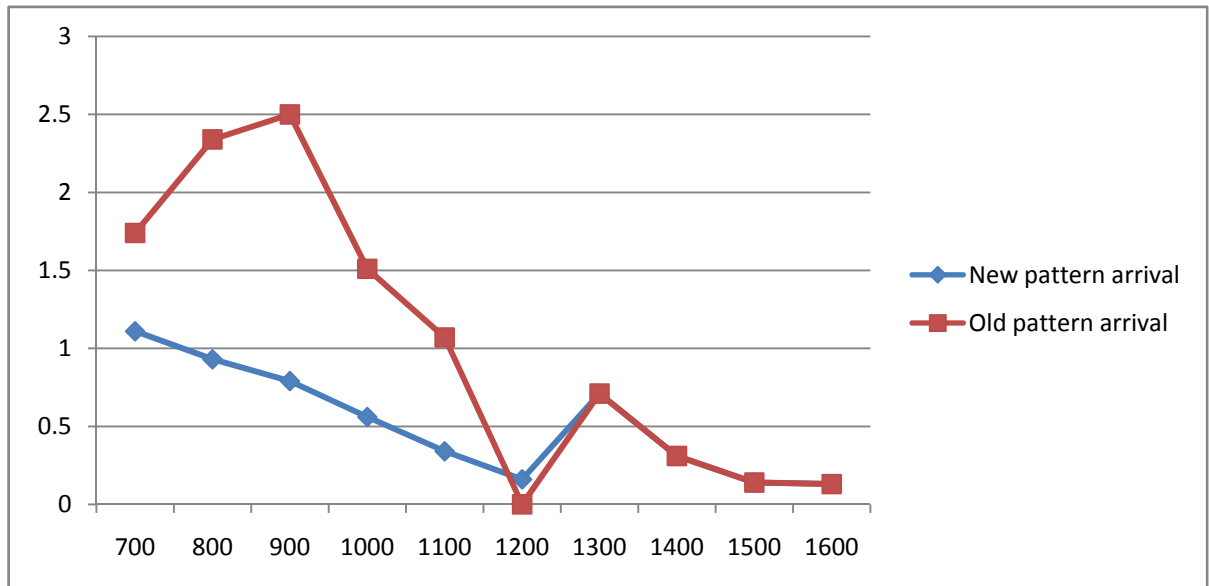


Figure 7 Comparison of waiting time between arrival patterns

DISCUSSION

The main factor that leads to the length in spending time in hospital is lies in number of doctors and patients' arrival pattern. Based from the simulation models that have been analyze above, the increasing number of doctors will help to reduce waiting time especially during morning session. However, the increase will affect the doctors' scheduled utilization rate to just over 50% or lower.

Another suggestion is by implement patients' arrival control. The method probably the most effective to reduce waiting time. Among initiatives to start the patients control is by introducing appointment system for follow up patients. Currently, follow up patients was provided with date of treatment only in the appointment card. It is suggested that the hospital allocate a special time, may be during the first hour of its opening, only for these patients. If possible, it is also suggested that the hospital to introduce appointment system for all its patients. This system is being adopted in many developed countries, such as in the UK. The system had reduced waiting time at the hospital for its patients.

CONCLUSION

This research has conducted an analysis by using computer simulation to model the effect of some parameters on waiting time at the outpatient department. The finding suggests that the increasing number of doctors, even though will help to reduce the waiting time, but it will affect their utilization. The research also explored the effect of introducing patients' arrival control. The result suggests that it will significantly reduce the waiting time.

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