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A Simulation Study of the Negative Effects of the Single Block Appointment System in Specialist Outpatient Clinics of a Tertiary Healthcare Institution

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Abstract: This paper is concerned with the investigation of the negative effects of the Single Block Appointment System via a simulation study of queues in selected specialist outpatient clinics of a tertiary healthcare Institution. The single block appointment system is presently in use in the specialist outpatient clinics of the tertiary healthcare Institutions in Nigeria. This work has being able to model and study the existing single block appointment system via simulation in other to reveal its negative effects on the queue performance measures namely; average waiting time of patients, average number of patients in queue, doctor's utilization and additional time spent by doctors after clinic closed. Two specialist outpatient clinics of the Federal Medical Centre Makurdi Nigeria have being selected for the simulation study. These include the Paediatrics and Surgical, clinics. The result across the clinics shows that the single block appointment system causes long waiting time of patients, shortens idle time for doctors with the tendency of over utilization. It does not allow for the determination of the optimal number of appointments within the six (6) hours clinic duration. The reason been that the additional time spent by doctors after clinic closed, increases as the number of appointment increases.

Keywords: Queue, Simulation, Appointment System

1. INTRODUCTION

The tertiary healthcare system in Nigeria is characterized with high influx of patients needing specialized clinical services, an outrageous Doctor-patient ratio of 1:33000 [2] against the world health organization standard of 1: 600, [14] and the use of the single block appointment system in the management of the queues. If this trend is allowed to continue, problems of long waiting lines, long waiting times of patients and over utilization of doctors and other health personnel will continue to confront the tertiary healthcare facilities in Nigeria. The attention of the Nigerian government has been drawn to this ugly situation as the honorable minister of health Prof. C.O Oyebuchi Chukwu in a briefing on July 30th 2012, stated that His target is to achieve a 25 minutes waiting time for patients (from registration to first contact with a doctor) by December 2012, [6].

This paper argues that one immediate solution is a good management of the queues via the replacement of the existing single block appointment system with better and more efficient appointment systems especially in the specialist outpatient departments. This is because employment of doctors that will meet the WHO Doctor-patient ratio standard is obviously not realistic and patients will continue to need specialized clinical services.

According to [13], researchers have identified the root of the problem of long waiting times for outpatients as being the result of an improper appointment system in place at a hospital. They also added that over the years, numerous researchers, from [3] to [11], have investigated this issue extensively and verified the claim. [15] added that a good appointment system is not without an appointment scheduling rule that helps to determine the optimal number of planned appointments according to specific operational requirements and consult room configurations.

A preliminary survey of the specialized outpatient clinic appointment system in place at the Federal Medical Centre Makurdi shows that the appointment system is the single-block type and that an optimal number of planned

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appointments for a clinic session has not being ascertained scientifically for each specialist outpatient clinic. The single-block system assigns all patients to arrive at the beginning of the clinic session. It allocates a "date" rather than a specific appointment time thus it causes long waiting time for patients and shortens idle time for doctors leading to them being over utilized, [4]. Such a system was in the past used by most hospitals, but its criticism began since the work of [3].

The tertiary healthcare system in Nigeria consists of the teaching hospitals, Federal Medical Centres other specialist hospitals and some private hospitals of similar standards. The basic processes and patient workflow in most of the specialist outpatient departments in the tertiary healthcare institution are similar hence the Paediatrics and the Surgical specialist outpatient clinics of the Federal Medical centre Makurdi have been selected for an in-depth study of the existing single block appointment system in order to reveal its negative effects on both patients and doctors and to advocate its replacement with a better and more efficient appointment system. It is important to mention that analytical queuing models are not considered appropriate for this work since they are based on simplifying assumptions on arrival and service time distributions which may not be true in real life situations. This is is revealed in the fitted consultation time distributions used in the clinics. Another setback is the fact that they provide steady state solutions, but the clinic system is transient (8 a.m – 2 p.m) and we cannot guarantee that the system will achieve steady states in a six- hour period. Finally, the complexities in the patient flow and the constant interactions with the doctors and nurses are greatly eased by the simulation approach. The paper is organized as follows; section 2 is devoted to the methods and models, section 3 to the simulation results, section 4 to discussion and section 5 to conclusion and recommendation.

2. METHODS AND MODELS

2.1 The workflow of the specialist Outpatient clinics

In this section, we describe the workflow of the specialist outpatient clinics studied. A patient, whether new or follow-up, arrives at the clinic and proceeds for registration at the registration desk or card room where either a new file is opened (for new patients) or an old file is retrieved (for follow-up patients). The patient then proceeds for Pre-medical examinations by the nurses, if required and finally queues in the waiting area. The arrival and registration/pre-examination activities go on over a period of time (usually between 8:00 am and 10:00 am) until doctors arrive for consultation after which any new arrivals are not attended to. Patients files are arranged for consultation before the arrival of doctors in the order in which they came and their names or numbers are called for consultation in that order (First-Come-First- Served basis). After consultation with the Doctor, the patient proceeds for payments/booking for the next appointment and finally departs. Figure 1 depicts these flows for the Paediatrics specialist outpatient clinic while figure 2 depicts it for the Surgical specialist outpatient clinic. As shown in the figures, the Paediatrics clinic differs from the Surgical clinic in the sense that it includes the pre-medical examination activity. The pre-medical examination activities include; Measurements of pulse respiration, height, temperature and weight.

Further distinction is that the Surgical clinic separates patients into New and Follow-up patient types, while the junior doctors see the new patients, the senior doctors and consultants see the follow-up patients. The Padiatrics clinic does not show clear distinctions and thus it was difficult to separate it into patient types.

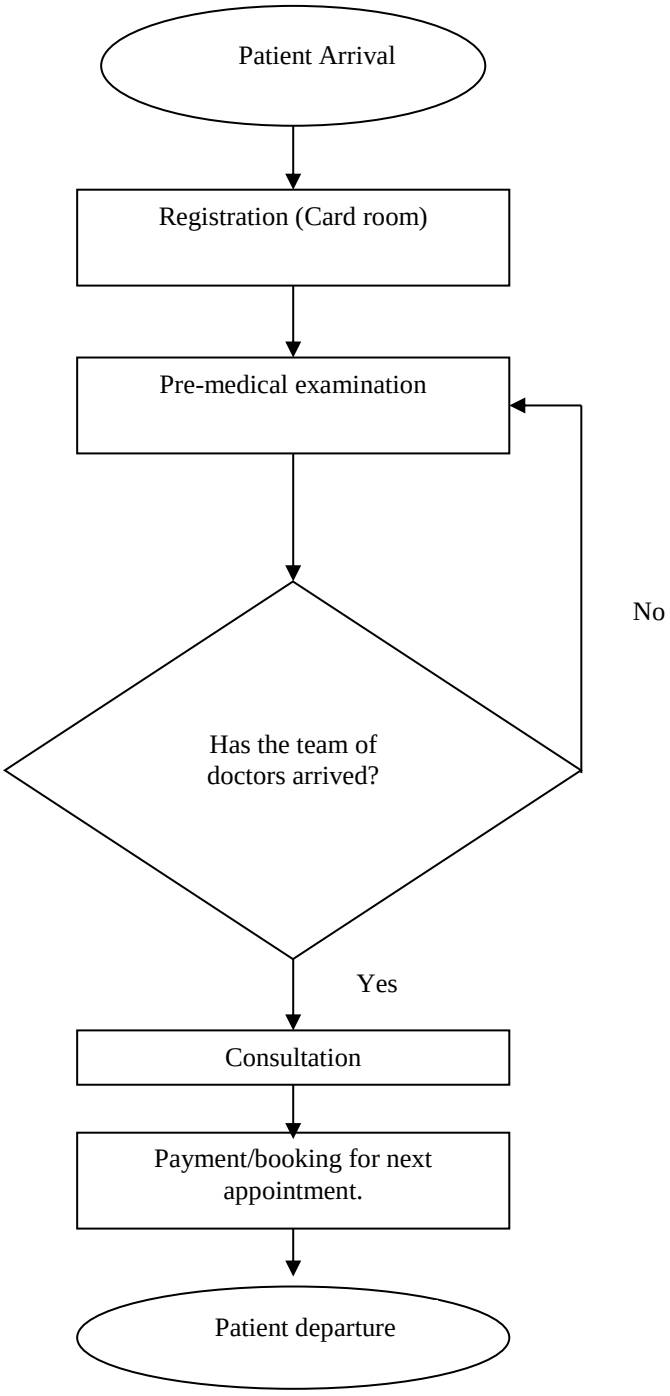

Figure 1: Workflow of Paediatrics Outpatient Clinic.

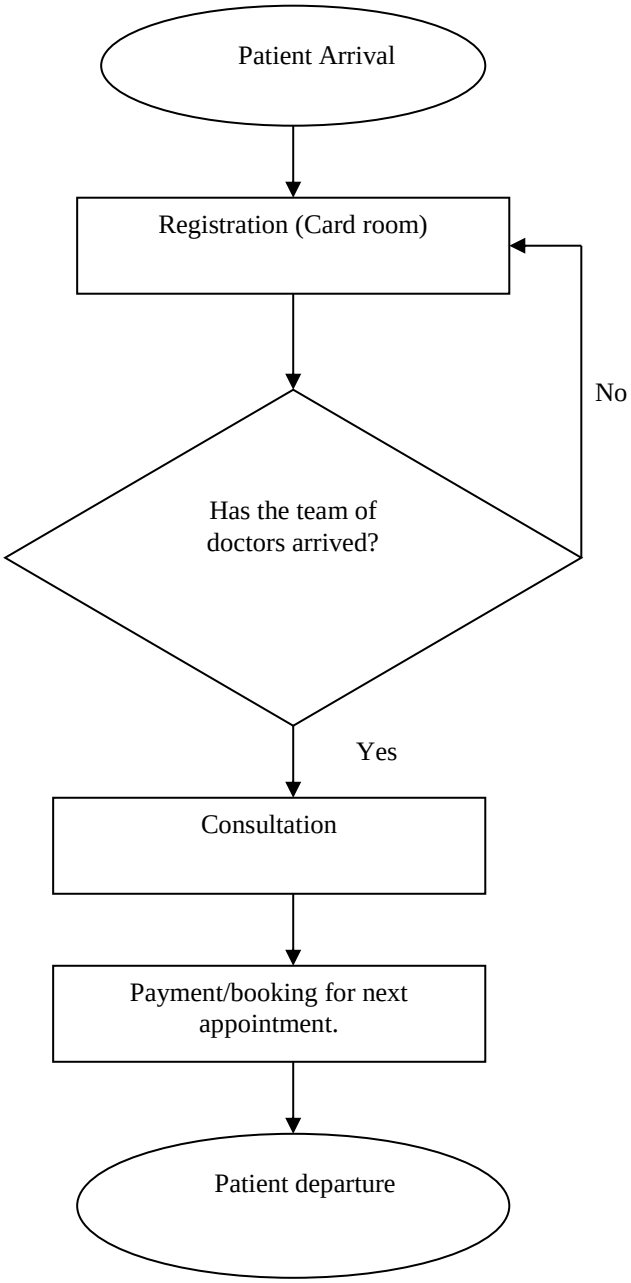

Figure 2: Workflow of the Surgical Outpatient Clinic.

2.2 *Construction of the Simulation model*

Figures 3 and 4 illustrate the schematic models for the queue and existing single block appointment system based on the work flows described in the previous section.

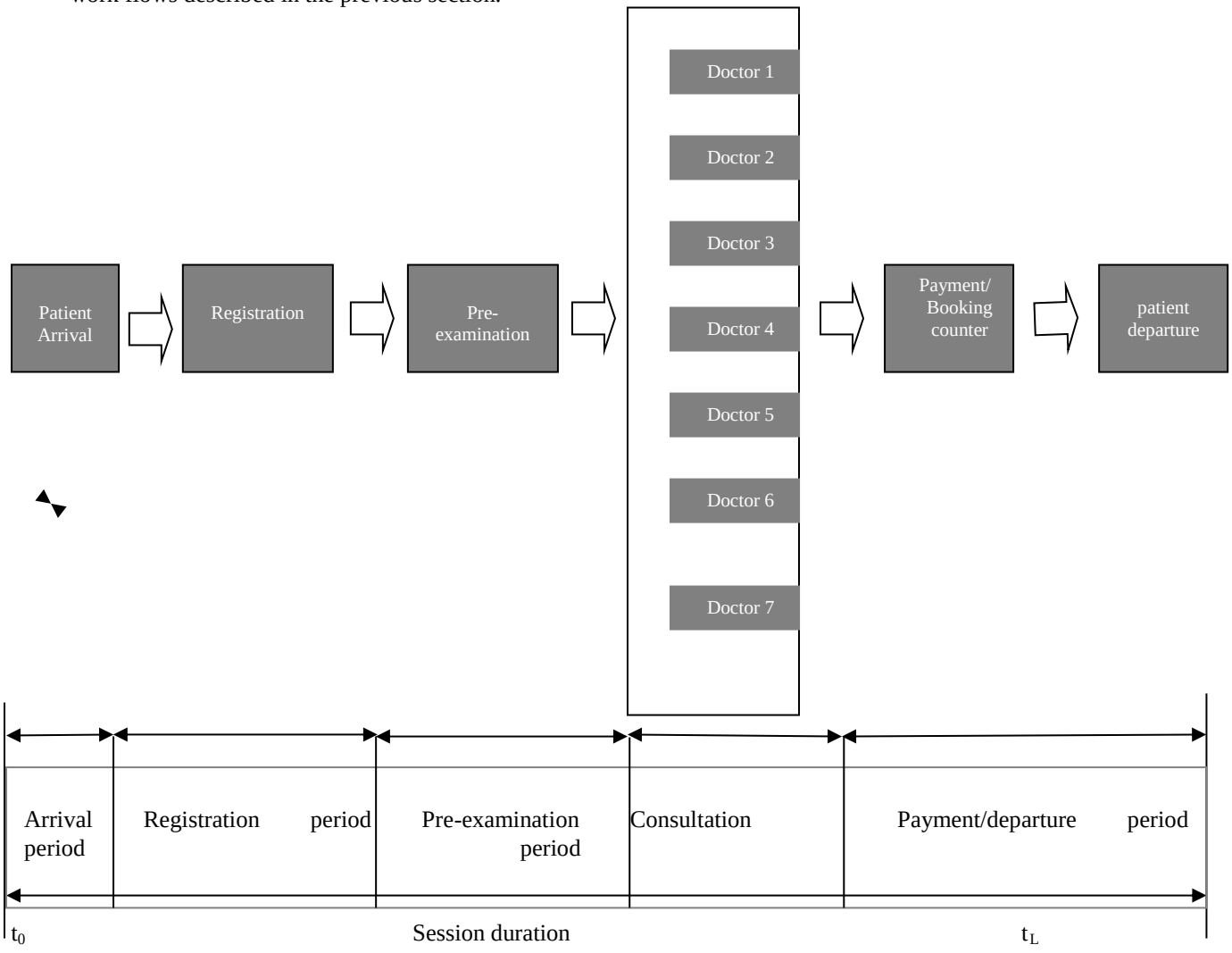

Figure 3: A schematic model of the Paediatrics outpatient clinic

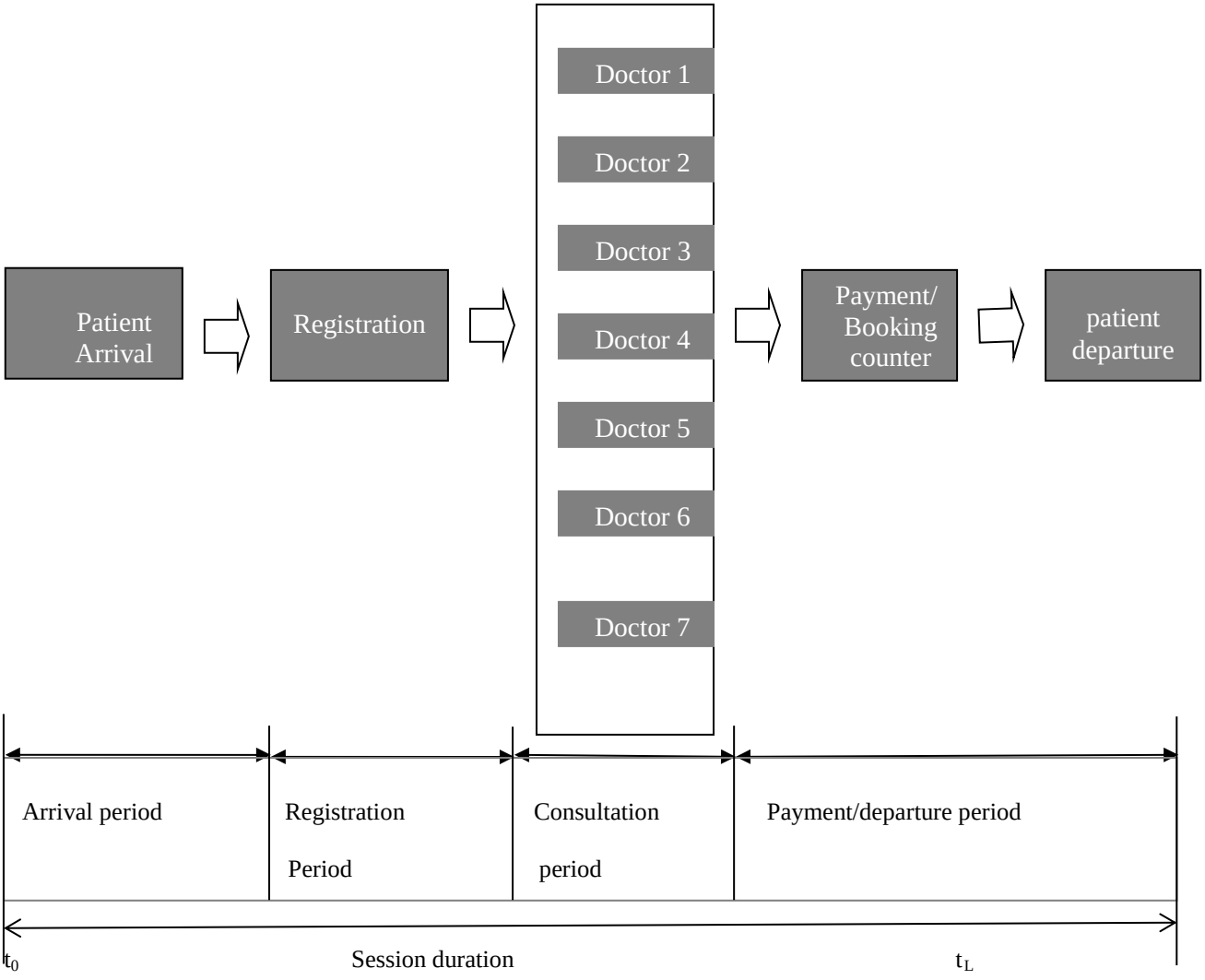

Figure 4: A schematic model of the Surgical outpatient clinic.

where; t_o = time patients start arriving.
t_l = time the last patient leaves the service facility or ends service.

(a) **Model assumptions**: The assumptions made in the existing single block appointment simulation model are given below:

(i) Registration time is negligible compared to the consultation time.
(ii) Each patient visits a doctor once and only once on a clinic day.
(iii) Difference in consultation time among doctors is considered negligible
(iv) Difference in Pre-medical examination times among nurses is considered negligible.

(b) **Parameters and input distribution**: The parameters and input distribution used in the simulation model are listed as follows:

(i) Session duration: The official opening and closing times for each outpatient clinic is 8:00 am and 2:00 pm respectively.

(ii) The Distribution of inter-arrival time: the distribution of inter-arrival time and its parameters are determined from collected across clinics see table 1.

(iii) The Distribution of consultation time: the distribution of consultation time and its parameters are determined from data collected for each outpatient clinic and shown in table 2.

(v) The distribution of pre-examination time: the distribution of pre-examination time and its parameters are determined from data collected for the Paediatrics outpatient clinic and shown in table 3.

(c) Verification: The conceptual simulation model and corresponding programs were checked to ascertain that they perform as intended i.e. the debugging of the computer program. The following techniques were used.

(i) The simulation programs were written and debugged in modules and sub programs.

(ii) The simulation programs were ran under a variety of settings of input parameters and checked to see that the output is reasonable.

(iii) The trace method of verifying a simulation model is employed; this is implemented by printing out the states of the simulated system (i.e., the contents of the event list) and variable values, comparing them with hand calculations to see that the program is performing as intended.

(d) Validation: The simulation model of the existing single block appointment system was validated by comparing the simulation output data of average patient waiting time in queue, with the actual average waiting time of patients in queue across clinics, using the independent sample t-test for testing the equality of means. The test is implemented using the Predictive Analytical Statistical Software (PASW) Version 18. Details are given in table 4.

(e) Experimentation: Sensitivity analysis was done in order to determine the relationship between the number of planned appointments in a clinic session and the queue performance measures for the existing single block appointment simulation model over the range of number of doctors across clinics. These results were used to reveal the negative effects of the single block appointment system on the queue performance measures.

(g) The variance reduction methods: The method of antithetic variables and common random numbers were employed in reducing variance in the simulation output data. In order to implement the antithetic variable method, complimentary random numbers were used in the simulation when the random numbers produced large variance in simulation output data. In the use of the method of common random number streams, though different random numbers were used in the probability distributions for each run, they were maintained across all scenarios been experimented. One thousand different random number streams were used.

(h) Simulation language and program structure: The Pascal simulation Shell (PSIM) developed [5] is used for the simulation modelling of the workflow of the outpatient clinics. It includes the three phase and process view executives, routines for sampling from a number of probability distribution, random number generators etc. A major advantage of using PSIM is that it employs a commonly used well structured high level language (Pascal). It is easy to learn for those with some Pascal experience, very portable, allows for complete flexibility and is extremely adaptable and affordable.

The simulation structure consists of the initialization and reporting facilities as well as the events and executive as provided by PSIM.

(i) The executive: the executive of the three phase approach which has being selected for the simulation modelling is represented in PSIM as Procedure run.

(ii) Initialization procedure: The initialization procedure in PSIM incorporates the following routines for setting up the initial queues and classes; make_sim (to set up the calendar), make_class (to define classes), make_bin (to set up resources in bins), make_streams (to set up the streams for sampling) and make_histogram (to set up the histogram for collecting statistics). It is essential that the initialization phase creates at least one entity, using the new entity function, and put it in the calendar with the cause statement to start the time advance in the executive.

(iii) Report procedure: The report procedure as given by PSIM is for the presentation of statistics displayed in histograms at the end of the simulation. See appendix for sample simulation outputs.

It is important to mention that PSIM was used by [7] in the Models for the Management of Asthma.

3. RESULT

The distributions of inter-arrival time, consultation time and pre-medical examination time would not be possible without the data collected. Ground data for this research on arrival, consultation (start and finish) and pre-medical examination (start and finish) times were collected from the Paediatrics and Surgical specialist outpatient clinics of the Federal Medical center Makurdi, Benue State, Nigeria for a period of four (4) months. This was done after a written approval from the hospital ethics committee. See appendix for a scanned copy of the approval letter. The Easyfit 5.5 Professional distribution fitting software was used in fitting the distributions and estimating their parameters. This package has the ability to fit more than one distribution to the same data sample and rank the fits from the best to the poorest using the chi-square and the KS statistics. The results of these as well as those of the simulation of the existing single block appointment system across the clinics are presented in this section.

The details of the result include graphical display of a sample clinic session for each of the clinic (Figures 5 and 6), a goodness of fit summary of arrival and consultation times for each clinic including those of pre-medical examination times for Paediatrics outpatient clinic and the simulation results of the existing single block appointment system.

3.1 Sample Outpatient Clinic Sessions

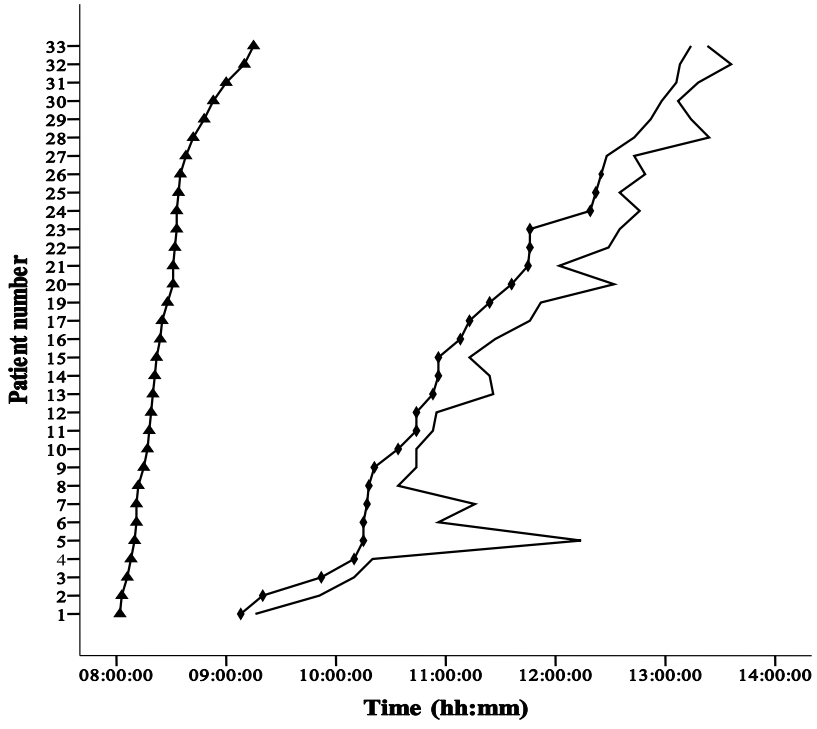

Figure 5: A sample output of operations for Paediatrics clinic session (24/04/11)

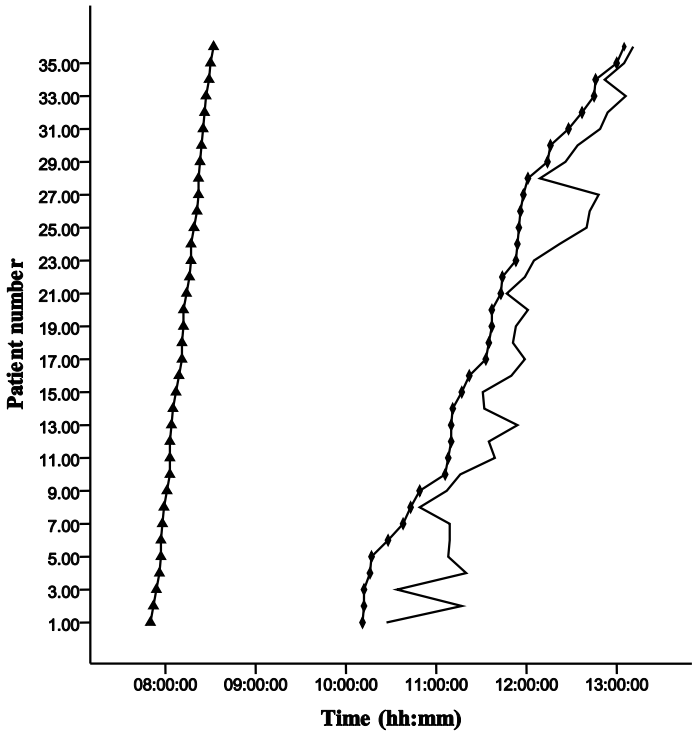

Figure 6: A sample output of operations for Surgical outpatient clinic session (06/06/11)

3.2 Goodness of fit summary

The goodness of fit of inter-arrival and consultation times for each of the outpatient clinics and that of pre-medical examination times for the Paediatrics outpatient clinic are given in tables 1, 2 and 3 respectively.

TABLE 1. GOODNESS OF FIT SUMMARY FOR INTER ARRIVAL TIME DISTRIBUTIONS

					Goodness of fit test	
Clinic	**patient type**	**Distribution**	**Parameters**	**Test**	**Statistic**	**P-value**
Surgical (general)	New	Gamma	$\alpha = 1.2163$ $\beta = 7.4664$	χ^2	7.3372	0.1191
	Follow-up	Gamma	$\alpha = 1.2622$ $\beta = 3.3558$	KS	0.1120	0.1198
Padiatrics	Nil	Exponential	$\lambda = 0.3731$	χ^2	12.6550	0.4910

TABLE 2. GOODNESS OF FIT SUMMARY FOR CONSULTATION TIME DISTRIBUTIONS

				Goodness of fit test		
Clinic	**patient type**	**Distribution**	**Parameters**	**Test**	**Statistic**	**P-value**
Surgical (general)	New	Gamma	$\alpha = 2.6226$ $\beta = 17.806$	KS	0.08668	0.81541
				χ^2	0.42537	0.98035
	Follow-up	Lognormal	$\sigma = 0.6350$ $\mu = 15.1470$	KS	0.06296	0.69009
Paediatrics	Nil	Lognormal	$\sigma = 0.7550$ $\mu = 18.1470$	KS	0.04056	0.76614
				χ^2	4.577	0.80168

TABLE 3. GOODNESS OF FIT SUMMARY OF PRE-MEDICAL EXAMINATION TIME DISTRIBUTION FOR PAEDIATRICS CLINIC.

				Goodness of fit		
Clinic	Activity	Distribution	Parameters	Test	Statistic	P-value
Paediatrics	Measurements of pulse respiration, height, temperature and weight	Lognormal	$\sigma = 0.36862$ $\mu = 1.5888$	KS	0.17071	0.9980

3.3 Simulation results of the existing single block appointment system

Details of the simulation results include the result of the validation of the Existing single block appointment models for each clinic and that of the sensitivity of the queue performance measures to increase in the number of appointments across the range of number of doctors.

Note that simulation runs where made for a range of 2-7 doctors number of doctors as reflected in each clinic but selected results are shown in this paper for illustration.

TABLE 4. RESULT OF VALIDATION OF THE EXISTING SINGLE BLOCK APPOINTMENT SIMULATION MODELS FOR EACH OUTPATIENT CLINIC

Clinic	Patient type	Number of Patients	Number of doctors	Average waiting time in queue plus average time spent before doctors arrived.		Independent sample t-test with unequal variance assumption			
						Levene's test for equality of variance		T-test for equality of means	
				Actual Clinic	Simulated Clinic	F_value	p_value	t_value	p_value
Surgical (19/04/11)	New	7	2	73.857	75.890	56.884	0.000	0.891	0.407
	Follow_up	27	7	74.519	79.658	21.421	0.000	1.996	0.056
Paediatrics (05/07/11)	Combined	26	4	183.769	190.387	22.968	0.000	0.932	0.360

Table 5. PERFORMANCE MEASURES OF PAEDIATRICS PATIENTS FOR A SIX (6) DOCTOR CLINIC

Average queue length		Average waiting time (mins)		Utilization of doctors (%)
		$\overline{w}_{q+}$	$\overline{w}_q$	
15	6	137.58	82.55	82.55
20	8	144.59	86.48	86.48
25	11	152.57	89.43	89.43
30	14	159.26	91.30	91.30
35	16	167.04	92.23	92.23
40	19	173.68	93.33	93.33
45	21	181.07	93.70	93.70
50	24	188.63	94.37	94.37
55	26	196.00	95.02	95.02
60	29	203.58	95.37	95.37
65	31	211.49	95.87	95.87
70	34	219.35	95.85	95.85
75	36	226.99	96.20	96.20
80	39	234.45	96.52	96.52
85	41	241.87	96.68	96.68
90	44	249.53	96.93	96.93

$\overline{w}_{q+}$: Average waiting time in queue plus average time spent before doctors arrive

$\overline{w}_q$: Average waiting time in queue

TABLE 6. ADDITIONAL TIME SPENT AFTER CLINIC CLOSED BY DOCTORS OF PAEDIATRICS CLINIC FOR A SIX (6) DOCTOR–CLINC.

Number of Appointments	Time last patient left the Clinic (mins)	Additional time spent after Clinic closed (mins)
15	180	0
20	196	0
25	211	0
30	225	0
35	241	0
40	256	0
45	271	0
50	286	0
55	301	0
60	317	0
65	331	0
70	347	0
75	362	2
80	377	17
85	392	32
90	407	47

TABLE 7. PERFORMANCE MEASURES OF NEW SURGICAL PATIENTS FOR A SEVEN (7) DOCTOR

Number of Appointments	Average queue length	Average waiting time (mins)		Utilization of doctors (%)
		$\bar{w}_{q+}$	$\bar{w}_q$	
10	2	138.27	28.95	65.43
15	5	154.36	45.57	75.03
20	8	166.08	55.68	85.36
25	10	183.51	73.73	85.64
30	13	200.49	91.11	87.01
35	16	214.50	104.51	90.60
40	18	231.28	121.27	91.41
45	20	248.66	138.78	91.14
50	23	264.90	155.14	92.14

$\bar{w}_{q+}$: Average waiting time in queue plus average time spent before doctors arrived

$\bar{w}_q$: Average waiting time in queue

TABLE 8. ADDITIONAL TIME SPENT AFTER CLINIC CLOSED BY DOCTORS OF NEW SURGICAL PATIENTS FOR A SEVEN (7) DOCTOR-CLINIC

Number of Appointments	Time last patient left the Clinic (mins)	Additional time spent after Clinic closed (mins)
10	210.34	0
15	240.11	0
20	262.65	0
25	300.39	0
30	334.76	0
35	362.29	2
40	396.13	36
45	433.92	74
50	466.64	107

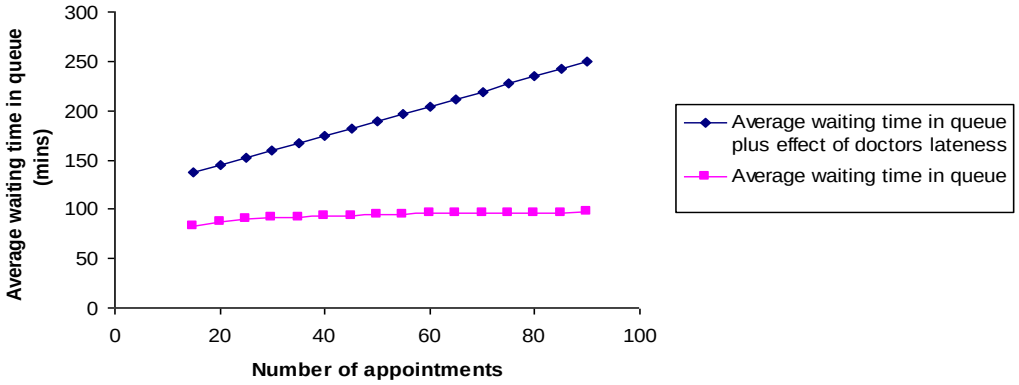

Figure 7: Average waiting time of patients in the six-doctor paediatrics clinic

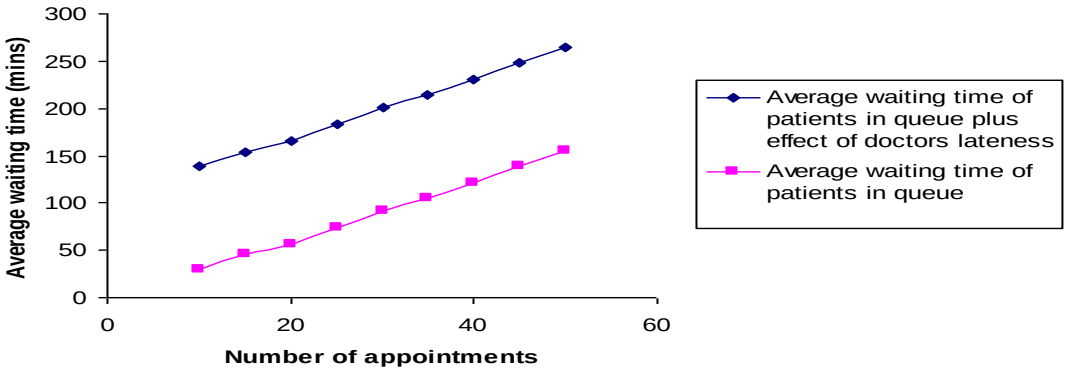

Figure 8: Average waiting time of patients in the seven-doctor new surgical clinic

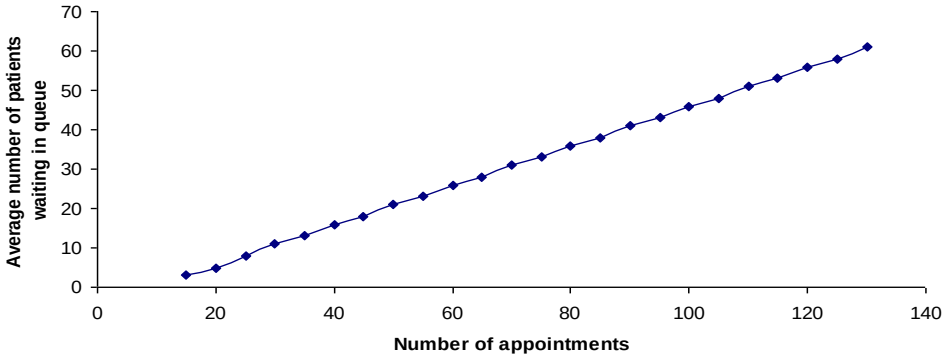

Figure 9: Average number of patients waiting in queue in the six-doctor follow up surgical clinic.

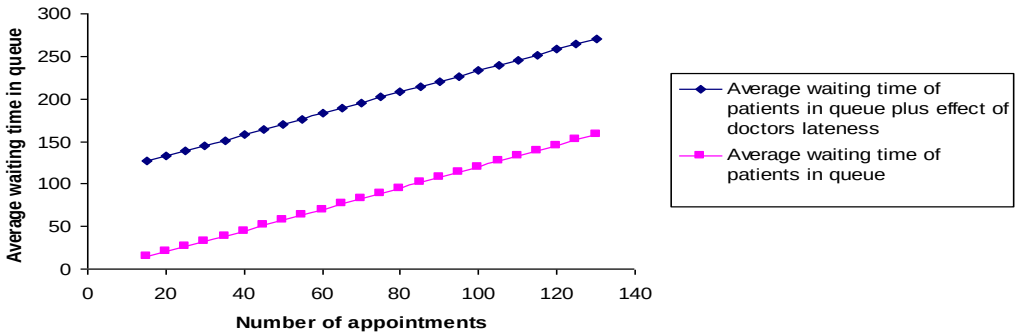

Figure 10: Average waiting time of patients in the six-doctor follow up surgical clinic

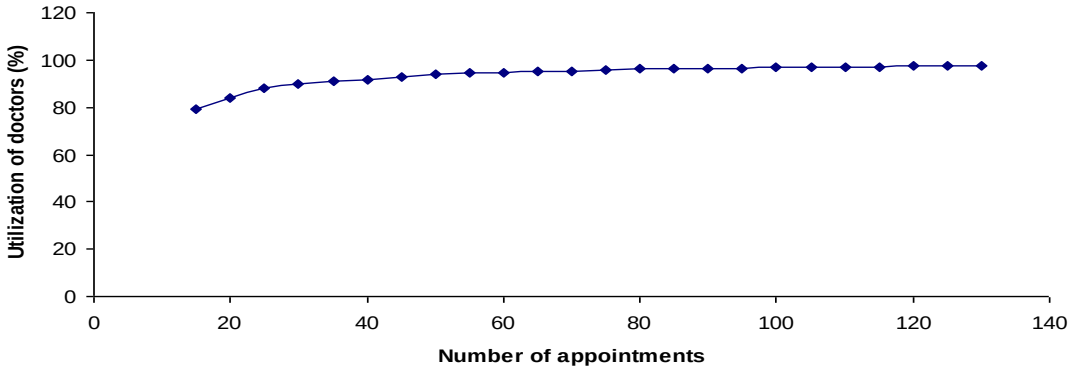

Figure 11: Utilization of doctors in the six-doctor follow up surgical clinic

4. DISCUSSION

This section focuses on the detail discussion of the results presented in the previous section. These include; the graphical representation of sample

outpatient clinics, the validation of the existing single block appointment simulation model for each outpatient clinic, simulation result of the existing single block appointment system in respect of the queue performance measures across the outpatient clinics.

4.1 Discussion on the graphical representation of sample outpatient clinics

The graphical representation depicting the negative effect of the existing single block appointment system as it causes long waiting time for patients and shortens idle time for doctors is displayed for each clinic (Figures 5 and 6). These figures capture a multiple graph of the patient arrival, consultation commencement and finish times for a selected clinic day for each clinic. Observe in these graphs that the arrival time graph does not cross the consultation commencement time graph showing that all the patients arrived before consultation commenced, this has the tendency of causing doctors over utilization. Notice also the long time interval between the arrival and the consultation commencement time graphs and the short time interval between the consultation commencement and consultation finish time graphs, these explain that patients spend longer times waiting to see the doctors and spent few minutes consulting with them.

It is this ugly situation in the specialist outpatient clinics of the tertiary healthcare institution in Nigeria that has necessitated this work with the sole aim of unveiling the situation, and advocating for a mixed block appointment system that will reduce patient waiting time and ensure doctors are not over utilized.

4.2 *Discussion on the validation of the existing single block appointment simulation model for each clinic*.

Before the existing single block appointment simulation model for each outpatient clinic is put to use, there is a need for model validation to ensure that system requirements are met and met rightly. These was ascertained by comparing the actual waiting time of patients in queue computed from data, with the simulated waiting time of patient in queue for the same clinic. The independent sample t-test with the unequal variance assumption was used (Table 4).

The levene's test for testing the equality of variance shows that the two samples of waiting times have unequal variance across the clinics, as indicated by the p-values of zero (0) which is less than the 0.05 alpha level of significance. This makes the independent sample t-test with the unequal variance assumption appropriate for comparing the two sample means of waiting times. The t-values are displayed for each clinic alongside their p-values. The p-values are all greater than the 0.05 alpha level of significance, showing that there is no significant difference between the actual average waiting time in queue and the simulated one for each clinic. The existing single block appointment simulation model for each clinic can therefore be used for experimentation.

4.3 Discussion of the existing single block simulation model results across the queue performance measures.

The result of the existing single block appointment simulation model is discussed in this section for each queue performance measure for the selected of number of doctors, though the simulation runs were made for the 2-7 number of doctors as earlier mentioned.

(i) **Average queue length**: The Paediatrics clinic indicates that 15 to 90 appointments were planned for the 6-doctor clinic and that 8 to 88 patients wait in queue on the average (Table 5). The Surgical clinic (New patients) shows that 15 to 80 range of number of planned appointments were made for the 7-doctor clinic while 2 to 23 patients wait in queue on the average. (Table 7). Similarly, the surgical clinic (Follow up) presented a 15 to 130 number of appointments for the 6-doctor clinic and 3 to 61 patients wait in queue on the average (figure 9). Observe across the clinics that the average queue length increases as the number of appointment increases revealing the negative effect of the single block appointment system on the average number of patients waiting in queue.

(ii) **Average waiting time**: The Paediatrics clinic revealed for the 6-doctor clinic, a 24 to 136 minute wait in queue on the average (Table 5 and figure 7). The Surgical clinic (New patients) shows that the average waiting time stretch between 29 and 155 minutes for the 7-doctor clinic (Table 7 and figure 8), while the Surgical clinic (Follow up patients) shows 14 to 158 minutes wait in queue on the average for the 6-doctor clinic (figure 10). Observe the long waiting time of patients across the clinics; this depicts the negative effect of the single block appointment system on the average waiting time of patients in queue.

(iii) **Average waiting time in queue plus average time spent before doctors arrived**: The average waiting time of patients in queue plus the average time they spent waiting before doctors arrive for consultation depict the effect of doctor's lateness in addition to the effect of the single block appointment on patients waiting time. In the Paediatrics clinic, the 6-doctor clinic revealed 138 to 250 minutes wait (Table 5). The Surgical clinic (New patients) shows that patients wait for 138 to 265 minutes for the 7-doctor clinic (Tables 7).

(iv) **Utilization of doctors:** The 6-doctor Paediatrics clinic revealed 75 to 99 percent doctors utilization (Table 5). In the Surgical clinic (New patients), we have for the 7-doctor clinic a 65 to 97 percent utilization (Table 7), while the Surgical clinic (Follow up patients) shows for the 6-doctor clinic a 79 to 98 percent doctors utilization (figure 11). The tendency of doctors over utilization across the clinics is revealed by the high doctor's utilization values.

(v) **Additional time spent after clinic closed:** As earlier mentioned the closing time of each outpatient clinic is 2.00 p.m. The additional time spent by doctors in attending to patients after official closing hours and the corresponding range of number of planned appointments are discussed as follows for each clinic. The 6-doctor Paediatrics clinic shows 2 to 47 additional minutes for 75 to 90 number of planned appointments (Table 6), the 7-doctor Surgical clinic (new patients) indicates a 2 to 107 additional minutes for 35 to 50 number of planned appointment (Table 8). Observe across the clinic that the additional time spent by doctors after clinic close increases as the number appointment increases. This explains why it is difficult to ascertain the optimal number of planned appointments for a clinic session with the existing single block appointment system been operational across the clinics.

5. CONCLUSION AND RECOMMENDATIONS

From the analysis and discussion of the simulation study results, it is evidently clear that the single block appointment system currently in place at the specialist outpatient clinics of tertiary healthcare institution in Nigeria has overwhelming negative effects on the queue performance measures and as such there is urgent need for a replacement. Work is already concluded on the construction of a mixed block appointment (individual block, fixed interval with initial block) simulation model that will remove the negative effect of the single block appointment system. We therefore conclude that the existing single block appointment system causes long waiting time for patients and shorten idle time for doctors leading to over utilization in the specialist outpatient clinics of tertiary healthcare institution in Nigeria

We strongly recommended that the Federal government of Nigeria should not hesitate in replacing the existing single block appointment system across all the outpatient clinics of the tertiary healthcare institutions and those of the Federal Medical Centre Makurdi in particular. In addition, as part of future research effort, difference in consultation time among doctors and pre-examination time among nurses which were not considered in this work should be considered.

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REFERENCES

[1] Agada, P.O. and Korve, N. (2009). A comparative analysis of two mixed congruential random number generators. Bagale Journal of Pure and Applied Science, 7: 13-22.

[2] APBN (2012).Association of Professional Bodies of Nigeria Laments Doctor-patient ratio, PunchNews paper , May 23, 2012, 1pp.

[3] Bailey, N. T. J. (1952). A study of queues and appointment systems in hospital out-patient departments, with special reference to waiting-time. J. R. Statistical Soc. 14:185-199.

[4] Babes, M. and Sarma, G.V. (1991). Out-patient queues at the ibn-rochd health centre. J. Opl. Res. Soc. 42(10): 845-855.

[5] Davies, R. M. and O'keefe, R. M. (1989). Simulation Modelling with Pascal. 1st Edition, New York, Prentice Hall. 3pp, 26pp, 84pp, 150pp.

[6] FMOH (2012). Federal Ministry of Health key performance indicator for major programmes/projects : a briefing by the honourable minister of health, Prof. C.O Onyebuchi Chukwu, July 30.

[7] Korve, N. (1993). Models for the Management of Asthma, Ph.D. Thesis, School of Mathematics, University of Southampton, U.K.

[8] Law, A. and Kelton, W. D. (1991). Simulation Modelling and Analysis. 2nd Edition, New York, McGraw-Hill, Inc. 1-8pp, 267-279pp, 307pp, 462pp ,522pp.

[9] Neelamkavil, F. (1987). Computer Simulation and Modelling, New York. John Wiley and Sons. 1pp, 12pp, 119pp, 151pp.

[10] Pidd, M. (1991). Computer Simulation in Management Science. 3rd Edition, New York. John Willey and Sons. 77pp, 225-227pp

[11] Rosen, H., Cayirli, T. and Veral, E. (2008). Assessment of patient classification in appointment system design, Production and Operations Management 17:338-353.

[12] Rising, E.J., Robert, B. and Averill, B. (1973). A system analysis of a university- health-service outpatient clinic. J. Opl. Res. Soc., 21(5):1030-1047.

[13] Wijewickrama, A. and Takakuwa, S. (2008). Outpatient appointment scheduling in a multi facility system, In Proceedings of the 2008 Winter Simulation Conference (eds S. J. Mason, R. R.

[14] WHO (2005), World Health Statistics 2005, http://www.who.int/

[15] Zhu, Z. C., Heng, B. H. and Teow, K. L. (2009): Simulation study of optimal appointment Number for outpatient clinics, Int J. Simul Modelling 8(3): 156-165.