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Student Flow Scheduling System for Student Affairs by Using Queuing Theory

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ABSTRACT

This Student registration at University involved students being registered in Student Affairs Department and make a deposit in Finance Department within the University, where they would present a form which had previously been filled in by the student. Students often wait for minutes, hours, half day or days to receive registration service for which they were waiting. Delays in the registration may result in difficulties of scheduling at speciality units and decrease in student satisfaction. This system examines the wide-spread problem of extended waiting times for registration. This system implements as student flow scheduling system and can help staff of student affairs department to reduce student congestion in department. This system uses Queuing analysis and Computer Simulation in Operation Research (OR) field. OR is a scientific approach to analyse problem and reduce waiting time. Simulation is the use of a system model that has the mapped characteristics of existence in order to produce the essence of actual operation. This system presents stand-alone application to help student registration using queuing analysis and computer simulation whose are finding appropriate waiting time for student affairs department.

Keywords : Student Affairs, Operation Research, Simulation, Queuing analysis

I. INTRODUCTION

The registration process is exceptionally critical to the University and the students: the University cannot accept payment for teaching the students, and students cannot sustain their grants or be lecture until they have been registered. The computerised registration system was proposed to tolerate machine and network failures. It was hoped that most human errors, such as inexactly inputting data, would be became aware of by the system as they happened, but it was await that some "off-line" data usage would be required for errors which had not been predicted. Therefore, the accomplishment of any strive to computerise this activity contingents on the reliability, availability and integrity of the computer systems, both software and hardware, on which the registration programs are run. Because many of the University departments already had remarkable investments in computer hardware, it was determined that no specialised hardware should be provided. Therefore software fault-tolerance was to be used.

Nowadays, many universities use computer software to overcome this congestion problem.

Computer software can help student affairs department how to manage the student flow in their universities for registration. Simulation software is mostly used in this case of universities because simulation is the imitation of the operation of a real-world process or system over time. This system presents as simulation software to help the student affairs department' staff to manage student flow by defining suitable waiting time for each student who pass through the student affairs department.

The system presents scheduling system for registration by using Queuing Analysis and Computer Simulation. And this applies two queue model: Model I {(M/M/I):(∞/FCFS)} Single Server, Unlimited Queue Model and Model IV (A) {M/M/s : ∞/FCFS} Multiple Servers, Unlimited Queue Model. The inputs of the system are arrival rate (λ), service rate (μ), and the number of servers (s). The system firstly records student's information that passes through the student affairs department. The system calculates the current average waiting time for each student in the department. And then, the system calculates again and again until reaching the waiting time that the administration wants. Finally, the system produces the possible schedules for the Student Affairs Department' Registrar with desired waiting time.

II. BACKGROUND THEORY

In the service process of daily work and life, there's lots of tangible and intangible queuing or congestion situation. For example, terminal box office customers queuing to wait for tickets, garage vehicles queuing to wait for maintenance, loading and unloading of ships at the port waiting for berths in the queue, telephone exchange receives the call message queue waiting for the computer center processing, registration service case etc. How to clinch the essence of the phenomenon through the queuing phenomenon, revealing the inner law general law, to optimize the queuing behaviour, so that can improve service efficiency and effectiveness is a concern of most people[3,1]. Queuing theory definitely provides an effective solution to settle this kind of optimization problem.

Queuing is common in daily work and life. Because people often have to queue to get some public service, such as road traffic light system, university cash register system, telephone communication system, etc. Davis MM and Heineke is discussed speed of service to provide businesses a competitive advantage in the marketplace [2]. The organization of some queuing system is obvious, while some maybe not [5, 4]. A queuing model is composed so that queue lengths and waiting time can be predicted. Queuing theory is generally treated a branch of operation research because the results are often used when making business decisions about the resources desired to implement a service [8].

A. *Operation Research*

Operation Research (OR) is a scientific approach to analysing problems and making decisions. OR professionals focus to bring rational bases for decision making by searching to recognize and structure complex situations and to utilize this consideration to predict system behaviour and upgrade system performance. Much of this work is done using analytical and numerical techniques to expand and manipulate mathematical and computer models of organizational systems composed of people, machines, and procedures.

At the point of operations research practice and theory is a distinct set of mathematical models that are acclimated to abduction and analyze a wide-range of real-world settings. An operations research model is a mathematical arbitration or adaptation of reality. The degree of simplification is a function of data availability, time and resources available to grow the model and the situational issues and decisions that the model is invented to address. With a mathematical model in hand, the operations researcher can work with managers and decision makers to assess decision alternatives or system rebuild. These studies are typically performed in a computer implementation of the model that enables the decision makers and managers to analyze changes in the mathematical representation without growing the actual system. G.D.Eppen and others (1998) examine the role of a mathematical model in decision making [6].

- Make objectives explicit
- Recognize decisions that influence objectives
- Purify trade-offs amongst decisions objectives
- Require identification and definition of quantifiable variables
- Explore the interaction between variables
- Help analyze critical data elements and their roles as model inputs
- Abet in recognizing and clarifying constraints on decision and operations
- Facilitate communication

By using techniques such as mathematical modelling to analyse complex situations, operations research gives executives the power to make effective decisions and build more productive systems based on more complex data, consideration of all available options, careful predictions of outcomes and estimates of risk.

B. *Models of Operation Research*

The mathematical models of the field of operations research can be articulated as deterministic and probabilistic. Often the deterministic models reflect complex systems containing large numbers of decision variables and constraints and are broadly labelled mathematical programming models. Some of the supremely complex repressed optimization models implicate tens of thousands of constraints and hundreds of thousands of decision variables. Operation researchers not only model these complex systems but also have matured algorithms that can expertly hunt for optimal or adjacent optimal solutions. Class of deterministic models contains: (i) Linear Programming, (ii) Queuing Theory, (iii) Network Routing, (iv) Decision Analysis-Decision Trees, and (v) Multi-Attribute Utility Theory (MAUT) etc.

C. *Queuing Theory*

Queuing theory is the mathematical study of the traffic jam and lags of waiting in line. Queuing theory (or “queueing theory”) scrutinizes every component of waiting in line to be provided, in addition to the arrival process, service process, number of servers, number of system places, and the number of customers- which might be people, data packets, cars, etc. As a branch of operations research, queuing theory can help users make informed business decisions on how to build efficient and cost-effective workflow systems [9].

The world queue comes, via French, from the Latin cauda, meaning tail. The spelling “queuing” over “queuing” is typically catched in the academic research field. In fact, one of the flagship journals of the profession is named Queuing Systems.

Queuing theory is generally expressed a branch of operations research because the results are often used when making business decisions about the resource needed to grant service [8]. Applications are frequently stumbled in customer service situations as well as transport and telecommunication.

Memorandum for representing the characteristics of a queuing model was first advised by David G.Kendall in 1953. Kendall’s notation introduced an A/B/C queuing notation that can be found in all standard modern woks on queuing theory, for example, Times.

The A/B/C notation designates a queuing system having A as interarrival time distribution, B as service time distribution, and C as number of serves. For example, G/D/1 would reveal a General (may be anything) arrival process, a Deterministic (constant time) supply process and a single server. More details on this notation are given in the article about queuing models.

D. *Computer Simulation*

A computer simulation is a struggle to model a real-life or hypothetical situation on a computer so that it can be considered to see how the system works. By dynamic variables in the simulation predictions may be made round the behaviour of the system. It is a tool to essentially explore the behaviour of the system beneath the study.

Habitually, the precise modelling of the systems has been via a mathematical model, which pursuits to find analytical solutions enabling the prediction of the behaviour of the system from a set of parameters and introductory conditions. Computer simulation is repeatedly used and appendage to, or substitution for, modelling systems for which elementary closed from analytic solutions are not possible. There are many distinct types of computer simulation, the universal feature they all contribution is the attempt to set up a sample of representative scenarios for a model in which a finalize enumeration of all possible states would be prohibitive or impossible.

A computer simulation, a computer model, or a computational model is a computer program, or network of computers, that attempts to simulate an abstract model of a particular system. Computer simulations have become a useful part of mathematical modelling of many natural systems. Simulation of a system is constituted as the running of the system's model. It can be utilized to explore and obtain new insights into new technology, and to evaluate the performance of systems too complex for analytical solutions [7].

III. SYSTEM DESIGN AND IMPLEMENTATION

Nowadays, most of universities face student congestion in their student affairs department. It is important to manage the student flow in university. One of the major elements in improving efficiency in the delivery of registration service is student flow. Equally important, an understanding of student flow is also needed to support a registration facility's operational activities. From an operational perspective, student flow can be thought of as the movement of students through a set of locations in a registration facility. Then, effective resource allocation and capacity planning are contingent upon student flow because student flow in the aggregate is equivalent to the demand for registration services.

In this system, there was little incentive to concentrate on efficiency in delivering registration services. Not surprisingly, this situation was accompanied by rapid increase in the cost of registration services. This study aims to analyse the registration systems for university students and its implications for the level of utility registration service officer, expected number of units in the system and expected waiting time of an arrival.

A. Operating Characteristics of Queuing System

Some of the operational characteristics of queuing system, that are of a general interest for the simulation of the performance of a current queuing system and to construct a new system are listed below.

1. Expected waiting time in queue: It is the average time spent by a customer in the queue before the commencement of his service and can be used to evaluate the quality of service.

2. Expected waiting time in system: It is an average amount representing the total time spent by a customer in the system. It is generally taken to be the waiting plus servicing time. It can be used to make economic comparison of alternative queuing system.

3. Expected number of customers in the queue (queue length): It is the number of customers waiting to be serviced.

4. Expected number of customers in the system: It is the number of customers either waiting in queue or being serviced. It can be used for finding the mean customer time spent in the system.

5. The Sever utilization factor (or busy period): It is proportion of the time that a server actually spends with the customers. It gives an idea of the expected amount of idle time which can be used

for some other work not directed involved with service. To describe the distribution of these variables, we should specify its average value, standard deviation and the probability that the variable exceed a certain value.

B. Simulation

A simulation is a method for implementing a model. It is the process of conducting experiments with a model for the purpose of understanding the behaviour of the system modelled under selected conditions or of evaluating various strategies for the operation of the system within the limits imposed by developmental or operational criteria. Simulation may include the use of analogue or digital devices, or laboratory models. Simulations are usually programmed for solution on a computer; however, in the broadest sense, military exercises, and war-game are also simulations. Simulation is the imitation of the operation of a real-world process or system over time. The act of simulating something first requires that a model be developed; this model represents the key characteristics or behaviours of the selected physical or abstract system or process. The model represents the system itself, whereas the simulation represents the operation of the system over time.

C. Calculation for Student Flow Scheduling System

This system applies Multiple Server Unlimited Queue Model (Model IV (A)) and Single Server Unlimited Queue Model (Model I). Using these models, waiting time and queue length can be calculated. Multiple Server Characteristics:

$$\rho = \frac{\lambda}{s\mu}$$

$$P0 = \left[\sum_{n=0}^{s-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^2 + \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s \frac{s\mu}{s\mu-\lambda}\right]^{-1}$$

$$Lq = \left[\frac{1}{(s-1)!}\left(\frac{\lambda}{\mu}\right)^s \frac{\lambda\mu}{(s\mu-\lambda)^2}\right] P0$$

$$Ls = Lq + \frac{\lambda}{\mu}$$

$$Wq = \frac{Lq}{\lambda} = \frac{1}{(s-1)!}\left(\frac{\lambda}{\mu}\right)^s \frac{\lambda\mu}{(s\mu-\lambda)^2} \cdot P0$$

$$Ws = Wq + \frac{1}{\mu} = \frac{Lq}{\lambda} + \frac{1}{\mu}$$

$$P(n \geq s) = \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s \frac{s\mu}{s\mu-\lambda}.\ P0$$

Single server characteristics:

$$\rho = \frac{\lambda}{\mu}$$

$$Ls = \frac{\rho}{1-\rho} = \frac{\lambda}{\mu-\lambda}$$

$$Lq = \frac{\lambda^2}{\mu(\mu-\lambda)}$$

$$Wq = \frac{\lambda}{\mu(\mu-\lambda)} = \frac{Lq}{\lambda}$$

$$Ws = \frac{1}{\mu-\lambda} = \frac{Ls}{\lambda}$$

$$P(n \geq k) = \left(\frac{\lambda}{\mu}\right)^k ; p(n > k) = \left(\frac{\lambda}{\mu}\right)^{k+1}$$

$$P0 = 1 - \rho$$

Where,

ρ = utilization factor

λ = service rate

μ = arrival rate

s = number of servers

Ws = average waiting time in the system

Wq = average waiting time in the queue

Ls = mean number of students in the system

Lq = mean number of students in the queue

P(n ≥ s) or P (n ≥ k) = Probability of a student has to wait

P0 = Probability of number student in the system (or) server idle time is generally taken to be the waiting plus servicing time

TABLE I

QUEUING ANALYSIS OF THE SYSTEM WITH CURRENT NUMBER OF REGISTRATION STAFFS

Current Model	8:00-8:30 AM	8:30-9:00 AM	9:00-9:30 AM	9:30-10:00AM	10:00-10:30AM	10:30-11:00AM	11:00-11:30AM	11:30-12:00AM	12:00-12:30PM	12:30-1:00 PM	1:00-1:30 PM	1:30-2:00 PM	2:00-2:30 PM	2:30-3:00 PM	3:00-3:30 PM	3:30-4:00 PM	4:00-4:30 PM	4:30-5:00 PM
Inputs																		
Number of Servers	1	1	1	3	3	3	3	3	3	3	2	1	1	3	2	3	2	2
Arrival Rate (units/hour)	1.0	1.9	5.1	10.1	9.2	7.4	5.7	5.8	5.2	4.1	3.4	9.3	10.2	1.2	3.5	5.3	4.3	2.5
Mean Service Time (min/server)	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Output																		
Average Time in the System	25.714	41.860	NaN	NaN	73.645	27.593	21.473	21.666	20.663	19.505	24.205	NaN	NaN	18.224	24.533	20.807	28.476	22.114
Average Time in the Queue	7.714	23.860	NaN	NaN	55.645	9.593	3.473	3.666	2.663	1.505	6.205	NaN	NaN	0.224	6.533	2.807	10.476	4.114
Average Number in System	0.4285	1.3255	NaN	NaN	11.292	3.4032	2.0399	2.0944	1.7908	1.3328	1.3716	NaN	NaN	0.3644	1.4311	1.8379	2.0407	0.9214
Average Number in Queue	0.1285	0.7555	NaN	NaN	8.5322	1.1832	0.3299	0.3544	0.2308	0.1028	0.3516	NaN	NaN	0.0044	0.3811	0.2479	0.7507	0.1714
Probability of a wait	0.7042	0.6710	NaN	NaN	0.7419	0.4157	0.2489	0.2566	0.2131	0.1480	0.3378	NaN	NaN	0.0329	0.3448	0.2199	0.4132	0.2857

Student As shown in Table 1, number of servers is 1, arrival rate is 5.1 and service time is 9 minutes per student in time period 9:00-9:30 AM. Arrival rate is more than service rate and waiting time for each student is too much in this period. The system computes average waiting time by using queuing theory. The table shows NaN (Not a Number) in column 9:00-9:30 AM because arrival rate is more than efficiency of number of server and service rate. Therefore, the system increases number of server to get average waiting time for this period.

The system increases the number of server 1 to 2 for time period 9:00-9:30 AM and uses to simulate waiting time with Model IV(A) because the number of server are more than 1.

λ = 5.1 students per half an hour

μ = 3.33 students per half an hour

s = 2

$$\rho = \frac{\lambda}{s\mu}$$

$$= \frac{5.1}{2x3.33} = 0.7950765077$$

$$P_0 = \left[\sum_{n=0}^{s-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^2 + \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s \frac{s\mu}{s\mu-\lambda}\right]^{-1}$$

$$= \left[\sum_{n=0}^{2-1} \frac{1}{n!}\left(\frac{5.1}{3.333}\right)^2 + \frac{1}{2!}\left(\frac{5.1}{3.333}\right)^2 \frac{2 \text{ x } 3.333}{2 \text{ x } 3.333-5.1}\right]^{-1}$$

$$= 0.1034554809$$

$$L_q = \left[\frac{1}{(s-1)!}\left(\frac{\lambda}{\mu}\right)^s \frac{\lambda\mu}{(s\mu-\lambda)^2}\right] p_0$$

$$= \left[\frac{1}{(2-1)!}\left(\frac{5.1}{3.333}\right)^2 \frac{5.1 \text{ x } 3.333}{(2 \text{ x } 3.333-5.1)^2}\right] \text{ x}$$

0.1034554809

$$= 1.6779$$

$$L_s = L_q + \frac{\lambda}{\mu}$$

$$= 1.6779 + \frac{5.1}{3.333}$$

$$= 3.2079$$

$$W_q = \frac{Lq}{\lambda}$$

$$= \frac{1.6997}{5.1}$$

$$= 0.3332 \text{ hr}$$

$$= 19.741 \text{ min}$$

$$W_s = W_q + \frac{1}{\mu}$$

$$= 0.3332 + \frac{1}{3.333}$$

$$= 0.6332 \text{ hr}$$

$$= 37.741 \text{ min}$$

$$P(n \geq s) = \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s \frac{s\mu}{s\mu-\lambda} \cdot p_0$$

$$= \frac{1}{2!}\left(\frac{5.1}{3.333}\right)^2 \frac{2 \text{ x } 3.333}{2 \text{ x } 3.333-5.1} .0.1034554809$$

$$= 0.5141$$

Now, the system produces the new waiting time in some column including time period 9:00-9:30 AM. In Table 1, column 9:00-9:30 AM, 9:30-10:00 AM, 1:30-2:00 PM and 2:00-2:30 PM do not produce average waiting time for each student because the arrival rate of these columns are very high and service rate and number of servers are less than needs. They system fixes this problem by increasing number of servers for those periods.

TABLE II

QUEUING ANALYSIS OF THE SYSTEM WITH NEW NUMBER OF REGISTRATION STAFFS

Current Model + Revised staff	5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 8:00 AM	8:00 - 9:00 AM	9:00 - 10:00 AM	10:00 - 11:00 AM	11:00 - 12:00 PM	12:00 - 1:00 PM	1:00 - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 5:00 PM	5:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 - 11:00 PM	11:00PM - 2:00 AM	2:00 - 5:00 AM
Inputs																		
Number of Servers	1	1	2	4	3	3	3	3	3	3	2	4	4	3	2	3	2	2
Arrival Rate (units/hour)	1.0	1.9	5.1	10.1	9.2	7.4	5.7	5.8	5.2	4.1	3.4	9.3	10.2	1.2	3.5	5.3	4.3	2.5
Mean Service Time (min/server)	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Output																		
Average Time in the System	25.714	41.860	37.741	26.182	73.645	27.593	21.473	21.666	20.663	19.505	24.205	23.191	26.685	18.224	24.533	20.807	28.476	22.114
Average Time in the Queue	7.714	23.860	19.741	8.182	55.645	9.593	3.473	3.666	2.663	1.505	6.205	5.191	8.685	0.224	6.533	2.807	10.476	4.114
Average Number in System	0.4285	1.3255	3.2079	4.4073	11.292	3.4032	2.0399	2.0944	1.7908	1.3328	1.3716	3.5947	0.3644	0.3644	1.4311	1.8379	2.0407	0.9214
Average Number in Queue	0.1285	0.7555	1.6779	1.3773	8.5322	1.1832	0.3299	0.3544	0.2308	0.1028	0.3516	0.8047	0.0044	0.0044	0.3811	0.2479	0.7507	0.1714
Probability of a wait	0.7042	0.6710	0.5141	0.4409	0.7419	0.4157	0.2489	0.2566	0.2131	0.1480	0.3378	0.3489	0.0329	0.0329	0.3448	0.2199	0.4132	0.2857

In table 2, average waiting time of some columns is still too much. The system reduces waiting time for these columns by specifying minutes that the administrator desires. For example, the administrator wishes that the waiting time for each student to be most 20 minutes. Therefore, the average waiting time of the column 8:30-9:00 AM and 10:00-10:30 AM are more than 20 minutes. The system simulates again to get the best schedule. In column 9:00-10:00 AM, the average waiting time in the queue is 55.645. The system simulate again this column to reduce the waiting time and to get the target waiting time.

λ =9.2 students per half an hour

μ = 3.33 students per half an hour

s = 4

$$\rho = \frac{\lambda}{s\mu}$$

$$= \frac{9.2}{4 \times 3.333} = 0.6900690069$$

$$P_0 = \left[\sum_{n=0}^{s-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^2 + \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s \frac{s\mu}{s\mu-\lambda}\right]^{-1}$$

$$= \left[\sum_{n=0}^{4-1} \frac{1}{n!}\left(\frac{9.2}{3.333}\right)^2 + \frac{1}{4!}\left(\frac{9.2}{3.333}\right)^4 \frac{4 \times 3.333}{4 \times 3.333-9.2}\right]^{-1}$$

= 0.0.04339798442

$$L_q = \left[\frac{1}{(s-1)!}\left(\frac{\lambda}{\mu}\right)^s \frac{\lambda\mu}{(s\mu-\lambda)^2}\right] p_0$$

$$= \left[\frac{1}{(4-1)!}\left(\frac{9.2}{3.333}\right)^4 \frac{9.2 \times 3.333}{(4 \times 3.333-9.2)^2}\right] \text{x}$$

0.6900690069

= 0.753 = 0.6900690069

$$L_s = L_q + \frac{\lambda}{\mu}$$

$$= 0.753 + \frac{9.2}{3.333}$$

= 3.513

$$W_q = \frac{Lq}{\lambda}$$

$$= \frac{0.753}{9.2}$$

= 0.0819 hr

= 4.915 min

$$W_s = W_q + \frac{1}{\mu}$$

$$= 0.3332 + \frac{1}{3.333}$$

= 0.3819 hr

= 22.915 min

$$P(n \geq s) = \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s \frac{s\mu}{s\mu-\lambda} \cdot p_0$$

$$= \frac{1}{4!}\left(\frac{9.2}{3.333}\right)^2 \frac{4 \times 3.333}{4 \times 3.333-9.2} \text{ x}$$

0.6900690069

= 0.5141

TABLE III

QUEUING ANALYSIS OF THE SYSTEM WITH NEW NUMBER OF REGISTRATION STAFFS

Current Model + Revised staff	8:00-8:30 AM	8:30-9:00 AM	9:00-9:30 AM	9:30-10:00AM	10:00-10:30AM	10:30-11:00AM	11:00-11:30AM	11:30-12:00AM	12:00-12:30PM	12:30-1:00 PM	1:00-1:30 PM	1:30-2:00 PM	2:00-2:30 PM	2:30-3:00 PM	3:00-3:30 PM	3:30-4:00 PM	4:00-4:30 PM	4:30-5:00 PM
Inputs																		
Number of Servers	1	2	2	4	4	3	3	3	3	3	2	4	4	3	2	3	2	2
Arrival Rate (units/hour)	1.0	1.9	5.1	10.1	9.2	7.4	5.7	5.8	5.2	4.1	3.4	9.3	10.2	1.2	3.5	5.3	4.3	2.5
Mean Service Time (min/server)	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Output																		
Average Time in the System	25.714	21.260	37.741	26.182	22.915	27.593	21.473	21.666	20.663	19.505	24.205	23.191	26.685	18.224	24.533	20.807	28.476	22.114
Average Time in the Queue	7.714	3.260	19.741	8.182	4.915	9.593	3.473	3.666	2.663	1.505	6.205	5.191	8.685	0.224	6.533	2.807	10.476	4.114
Average Number in System	0.4285	0.673	3.2079	4.4073	3.513	3.4032	2.0399	2.0944	1.7908	1.3328	1.3716	3.5947	0.3644	0.3644	1.4311	1.8379	2.0407	0.9214
Average Number in Queue	0.1285	0.1032	1.6779	1.3773	0.753	1.1832	0.3299	0.3544	0.2308	0.1028	0.3516	0.8047	0.0044	0.0044	0.3811	0.2479	0.7507	0.1714
Probability of a wait	0.7042	0.259	0.5141	0.4409	0.339	0.4157	0.2489	0.2566	0.2131	0.1480	0.3378	0.3489	0.0329	0.0329	0.3448	0.2199	0.4132	0.2857

Now, the system produces the new waiting time for this column with 4.915 minutes in Wq are more than input threshold minutes, the system simulates these columns to get possible schedules of number of servers as the same way of time period 8:30-9:00 AM by increasing number of servers one by one. Finally, average time in the queue (Wq) for each time period is less than input threshold minutes that is defined by administrator.

If the administrator wants to change number of servers in addition to also average arrival rate and average service rate, the system will allow him to simulate with desire data in Other Testing form in the system. This is intended for administrator to know waiting time of each student when input data are changed variously.

IV. SYSTEM FLOW DIAGRAM

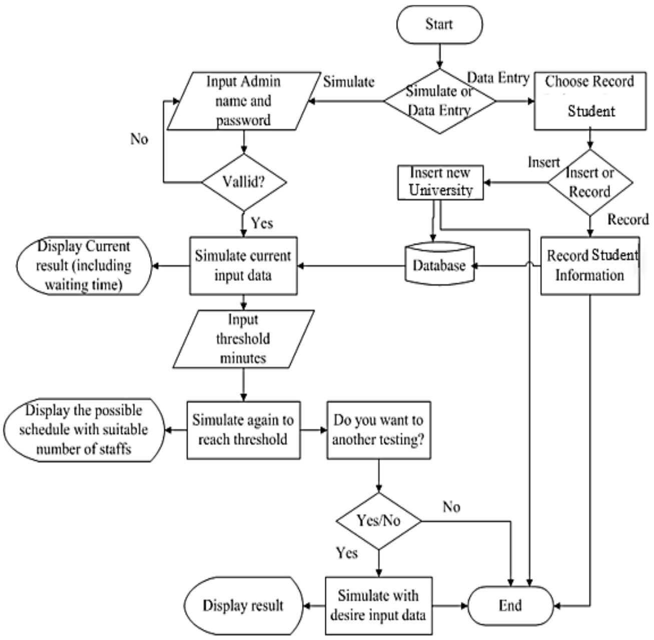

Figure 1: System Flow Diagram

In Figure 1, the process of this system is describe. The system allows to record students' information, to register the university and to simulate the waiting time. In the site of data entry, the staffs of student affairs department records students' information in database to use these records in simulation process as arrival rate and they can view all students' information. The registration can be done both registrar and registration staffs. If the user is an admin he/she has the highest authority in the system. He/She can view current data such as arrival rate, service rate, and number of servers and calculates the waiting time. The system simulates to produce the possible schedule and allows to do another test. And then if he wants to do another test, he/she can test to know the waiting time of each student by changing the current input data. Thus, this system can support the registrar to manage the student flow in university to be smooth in Student Affairs Department.

V. CONCLUSION

Student flow scheduling improves the facilities of student affairs department. This system provides the different schedules to reduce waiting time for student affairs department and supports the registrar for simulating waiting time for student. The aim of this system is to design, implement, and simulate the student flow scheduling system which is able to deal with the complexity of student information.

The system calculates the waiting time problems by using queuing model and computer simulation. Queuing theory includes many queuing models but this system uses Model I and Model IV (A) to solve the problem. This system reduces the waiting time and improves the servers only for student affairs department in university.

This system can be developed as web based supporting system. Queuing can be applied to various fields of study. It is used most extensively in waiting time, but can also be utilized for finding queue length problems.

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