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Modeling and Simulation of Shortest Queue System with Kolmogorov-Smirnov Method

Halifia Hendri [1*], Sarjon Defit[1], and Mardison[1]

[1]Universitas Putra Indonesia YPTK
Padang,Sumatera Barat, Indonesia

*halifia_hendri@upiyptk.ac.id

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Abstract

Long queue always happen as main problem in re-registration of new students who passed the New Registration Student (NRS).The long queue makes the queueing system crowded and cannot be controlled properly. This research is aimed in knowing themodel, processsimulationmodel and how to use themethod ofKolmogorov-Smirnov ofsystem forre-registrationof new students.This method is suitable on how to solve long queue system with new model and simulation. The proposed method is implemented in Senior High School in Padang, West Sumatera, Indonesia. The result of this research shows that after we divided queuing post 1 into two sub-posts namely post 1a and 1b on the first day and we note that average long applicants waiting at post 1a and 1b are smaller i.e. 2.3 minutes and 2.8 seconds as previously for 15 minutes. Furthermore, we divided queuing post 2 into 2 sub-posts namely post 2a and 2b on first day note that average long applicants wait at post 1a and 1b are smaller i.e. 0.2 minutes and 0.2 minutes as previously for 32 minutes.It can be concluded that the solution to the registration posts can make an average registration time waiting to be smaller.

Keywords: Modeling;Simulation;Shortest queuesystem; Kolmogorov-Smirnov method.

1. Introduction

The process of New Registration Student (NRS)On-Line performed during 6 days.That system sorting and selecting appropriate against students who register based on the results of Final SchoolScore (FSS) of students and also a selection of the school was chosen by the students. After the students is stated received in that school, the students are required to re-register at that school. Re-registration process conducted at the school where the students were accepted with supplement the terms set by each school.State High School(SHS) 4 Padang is one of the high schools are public schools that are in the city of Padang is one of the organizers of NRS On-Line. The SHS 4 Padang also holdsre-register for the students who are accepted at SHS 4 Padang. The SHS 4 Padang set several conditionswhich should be met by students who re-register. Requirements to re-register them are as follows:

a. Submit the proof of registration ofNRS On-Line in the form of a print-out NRS on-line
b. Pay for the construction fee of schools and Emotional Spiritual Quotient (ESQ) training
c. Pay for the school uniform including uniform white and gray, scout, batik, religion clothes and sports
d. Select the size of the clothes that have been ordered

To simplify and speed up the re-registration process in SHS 4 Padang, the schools provide 4 post. The first postis used toreceive the proof of registration of NRS On-Line in the form of a print-out NRS on-line, The second postis used to serve the construction fee of schools and ESQ training, The third post is used to serving the school uniform including uniform white and gray, scout, batik, religion clothes and sports, and the fourth post is used to select the size of the clothes that have been ordered. Every student must do the registration by sequence with complete terms on post one

then continued to post two and then post three and the last post four without any post that check is bypassed.The re-registrationof new students of SHS 4 Padang in 2013 was serving the studentfor 280 students. Re-Registration process opened for 4 days starting from 09.00 am until 15:00 am. On any post registration placed 1 person officer re-registrationthat will serve students. Because of the time to register is very short and the officer of registration is limited and many students perform re-registrationthen definitely would happen long enough queue in registration process restarted.One of the ways can to resolve the problem of these queues is to create models that can describe the real system of new student re-registration. By trying a variety of models and simulateeach model so the school could find out the weaknesses of the system so that it can take the most appropriate actions that the queue happens to be minimal possible.Based on real conditions, the situation that has happened so far and wishes the author to seek a way out of the problem then the writers will conduct research under the titleModeling and Simulation of Shortest Queue System with Kolmogorov-SmirnovMethod [1,2].
Based on the issues raised in the background above, the formulation of the problem in this research are: First, how to make a proper model for the system of new re-registration student, second how to simulate the model that corresponds to the real system at new students re-registrationqueue and third how to use the method of Kolmogorov-Smirnov to simulate queueing system at new students re-registration.In summary, the contributions of this work are given as follow:

a. Firstly, this research proposed a model that is created by using a computer that represents the real system queuing symbol.
b. Secondly, the model proposed and simulation on the study carried out using the computer used Pro-model software 7.5.
c. Thirdly, the method used in this simulation is the Kolmogorov-Smirnov method.
d. Finally, themodeling and simulation on the study specifically on the system queues the new students re-registrationNRSon-line at SHS 4 Padang.

This paper is organized as follows: Literature review of this paper is discussed in section 2.Methodology used in this paper discussedin section 3. The result and discussion of research of this paper are discussed in section 4. Finally the conclusions of his paper are given in Section 5.

2. Literature Review

In general, queueing phenomena occur when some kind of customers, desiring to receive some kind of service, compete for the use of a service facility (containing one or multiple servers) able to deliver the required service. Most queueing models assume that a service facility delivers exactly one type of service and that all customers requiring this type of service are accommodated in one common queue. If more than one service is needed, multiple different service facilities can be provided, i.e., one service facility for each type of service, and individual separate queues are formed in front of these service facilities. In all such models, customers are only hindered by customers that require exactly the same kind of service i.e. that compete for the same resources [1].Appointment delay is the time elapsed from the moment a customer requests an appointment until the actual appointment time scheduled for that customer. Service delay is the time elapsed from the time a customer arrives at the service facility (the appointment time if he is punctual) until the time when he is actually served. Service providers prefer to keep appointment intervals short in order to minimize the server idle time. However, short appointment intervals tend to cause congestion in the waiting room, which results in long direct waiting times. On the other hand, if appointments are scheduled sparsely, customers may encounter long indirect delays. One of the main problems associated with long indirect delays is that they typically lead to high no-show rates [2].Queueing models for servers with interruptions have been previously studied. However, all those works have considered a server with a time-invariant service rate and server interruption rate. Two-class preemptive queueing models have been proposed for OSA networks where the CR server interruptions are modelled as the busy periods of the preemptive primary traffic. With this approach, the server is considered time-invariant with a constant service rate and interruption rate. Furthermore, it is not straightforward to use those models to study OSA networks with generally distributed operating and interruption periods [3].A more elementary solution of the Shortest

Queuing problem was obtained by Adan, Wessels and Zijm, first for the symmetric case and later for the asymmetriccase. They obtained in both cases the solution as an infinite mixture of geometric distributionsas described in [4]. The appropriate "mixture" is chosen so that all the boundary conditions are satisfied for the forward Kolmogorov equation for this Markov chain. The basic method used in and is called the "compensation approach", which is surveyed more thoroughly in and has been used also on many other models [4].Modeling such a process can help answering the question of how a system should be designed, in which requests arrive at random time points. If the system is busy, then the requests queue up, therefore, if the queue gets too long, the users might experience bad delays or request drops, if the buffers are not big enough. From a capacity planner point ofview, it is important to know how build up a system that can handle requests that arrive at random and are unpredictable, except in a probability sense [5].There are some other aspects that are necessary for business process simulation. The simulation requires a more detailed business process analysis, investigation in the duration of activities and incoming workflow, which is not described in the standard business process model. It is necessary to investigate the duration of the activity and to explore a workflow. Activities of programmatically submitted simulation models need to be represented as processes with certain parameters, resources, attributes, and relationships. It must contain all relevant information about the activities because simulation is a representation of the mathematical calculations to a certain level. It requires the simulation engine and tool or software code, which can use this engine in order to simulate the model [6].The Kolmogorov–Smirnov test (hereafter the KS test) is a much used goodness-of-fit test. In particular, it is often employed to test normality, also in climate research. Normality tests are important for at least two reasons. First, nonlinearity and interacting physical processes usually lead to non-Gaussian distributions, andthe generating mechanism of the processes can therefore be better understood by examining the distributionof selected variables. For instance, Burgers and Stephenson (1999) test for the normality of the amplitude of the El Niño–Southern Oscillation (ENSO) using moment estimates of skewness and kurtosis. Such moments can be used to diagnose nonlinear processes and to provide powerful tools for validating models [7]. A second reason for implementing normality tests is that many statistical procedures require or are optimal under the assumption of normality, and it is therefore of interest to know whether or not this assumption is fulfilled. A recent example of such a use of a normality test is given in Sanders and Lea (2005) in their study of hurricane activity. Of course it may also be of interest to test for the presence of other specific distributions, as in Mohymont*et al*. who has studied extreme value distributions [7].The Kolmogorov–Smirnov test (K–S test) is a nonparametric test which can be modified to test goodness of fit. A Pareto distributed random variable can be transformed to an exponential distributed variable. The specific case of testing for an exponential distribution using the K–S test has been thoroughly investigated also when the parameter is unknown and estimated. The basic concept of Kolmogorov Smirnov test for normality is to compare the distribution of the data with a normal distribution of fixed. The normal distribution is the raw data that has been transformed into the shape of a Z-Score and is assumed to be normal. So in fact a test of Kolmogorov Smirnov test is the difference between the tested data normality with normal raw data. as in a regular, if different from the test of significance below 0.05 means there is a significant difference, and if the above 0.05 significance then does not occur a significant difference [8]. Many data analysis methods depend on the assumption that data were sampled from a normal distribution or at least from a distribution that is sufficiently close to a normal distribution. For example, one often tests normality of residuals after fitting a linear model to the data in order to ensure that the normality assumption of the model is satisfied. Such an assumption is of great importance because, in many cases, it determines the method that ought to be used to estimate the unknown parameters of a model and also dictates the test procedures that analysts may apply [9].

There are several tests available to determine whether a sample comes from a normally distributed population. Those theory-driven tests include the Kolmogorov–Smirnov test [10,11], Anderson–Darling test [12,13], Cramer–von Mises test [14,15], Shapiro–Wilk test [16,17], and Shapiro–Francia test [18,19]. The first three tests are based on the empirical cumulative distribution. The Shapiro–Francia test is specifically designed for testing normality and is a modification of the more general Shapiro–Wilk test. There are also tests that exploit the shape of the distribution of the data. For example, the widely available Jarque–Bera test [20,21] is based on skewness and kurtosis of the data.Similar research has been done previously only reveals how the simulation was done and how the model is created. While in this study revealed how to manipulate data so that a known frequency distribution of data and the simulation method using the Kolmogorov-Smirnov. With this method, we can use some data to simulate with the result that the shortest queueing of a model queueing system [22].

3. Methodology

These steps include research from the beginning up to the end of the study. Research on the framework, namely:

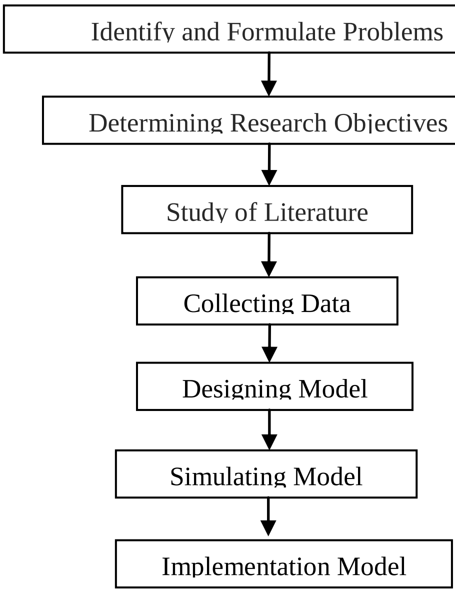

Figure 1: Framework of Research

In Figure 1, there are seven steps that are performed in this research. First step in this research is to identify, formulate and limit problems. We identify the problem that appear in the queueing system in order to this research is really discussed real problem in system. Than we formulate the problem into three formulationsin order to research can find conceptual conclusion after that we give limitation the problem in order to research is not going out of the problem.

Second step is determining research objectives. We determining research object so that it can be useful to many people. Third step is study of literature so that the research based ontheoretical background. Fourth step is collecting the data that will be process into simulation. Fifth step isdesigning the model so that the system can be simulated with computer. Sixth step is simulating the model. We simulate the model so that chose the best model from several alternative models. Seventh step is implementation the model, we implementation the best model in real system.

The technique is used in collecting data in this study was observational data and interview techniques (See Table 1).

Table1: Data Collection Form

Queue to	Service Open Time	Service Officer	Departure Time	Service Long	Service Finish Time	Service Closed Time
1	09.00	-	-	-	-	15.00
2	09.00	-	-	-	-	15.00
....	09.00	-	-	-	-	15.00
n	09.00	-	-	-	-	15.00

The data is collected from all students. The data collection form is filled by four people who was sitting on post 1, post 2, post 3 and post 4 after that they written the data in that form at time 09:00 until 15:00 for four days. The four people is the independent volunteer of this research. On column 1 there is data of queuing number, column 2 is data of service open time, column 3 is data of service officer, column 4 is departure time, column 5 is service long, column 6 is service finish time and column 7 is service closed time.The model describes the actual shape of objects/tools, systems are emulated and referenced. The model referred to in this research is a model of queuing system new students re-registrationpassedNRS on-line at SHS 4 Padang.

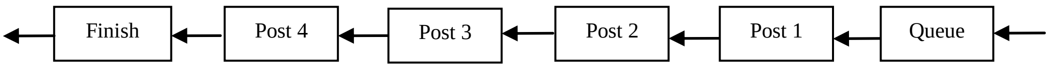

Figure 2: Model of Re-Registration of SHS 4 Padang Who's Passed NRS On-Line

In Figure 2, we can see there are four post in the real system of new student re-registration process. The four postsare post 1, post 2, post 3, and post 4. The registrant (student) should go to post 1 than post 2than post 3 than post 4 and finished the process of each post without bypassed. Before post 1 the student should take queueing,if the registrant is too many than the student should waiting for long time and then go to queueing post 2, post queueing3 and queueingpost 4. The waiting time depends on the number of registrant at same time and service time each student.The process is done on each post varies depending on to the post. Process on each post is presented in the flowchart below:

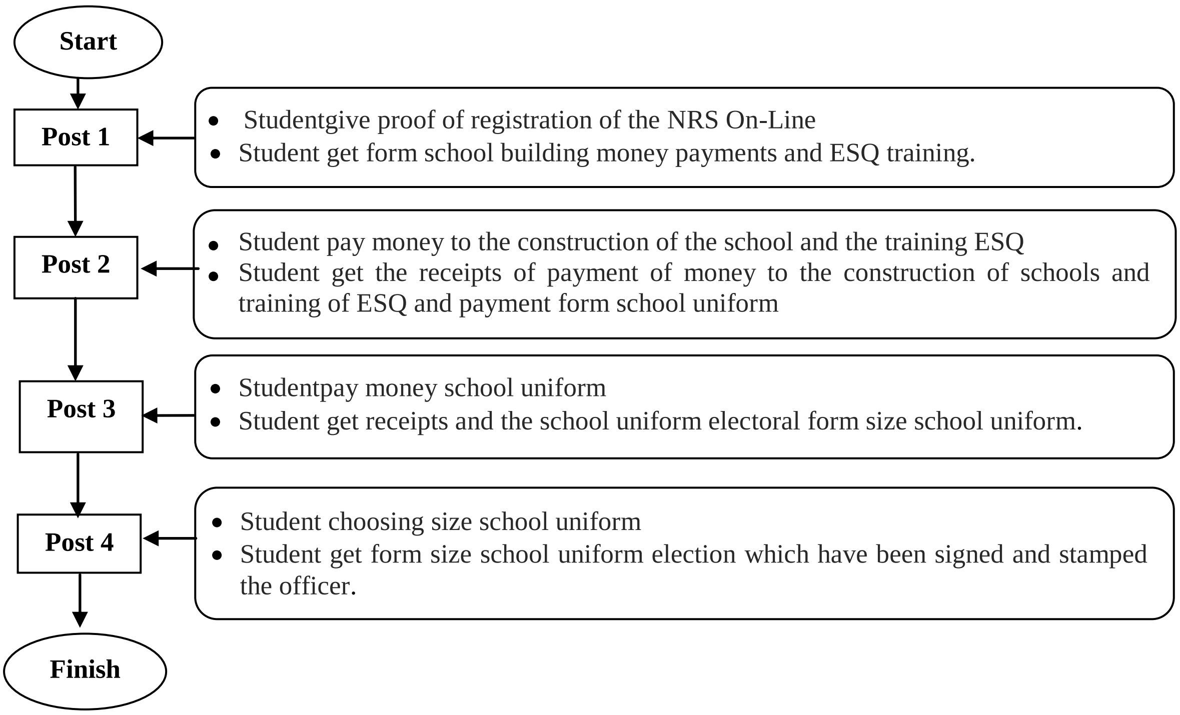

Figure 3: Flowchat of Each Post Process

From Figure 3, the process on each post is different depending on its function. Those processes are:

- Post 1:
  In post 1, student should give proof of registration of the NRS On-Line and then the student get formmoney payments of school building and ESQ training. After that the student go to the next post namely post 2 with bringing that form.
- Post 2:
  In post 2, Student should pay money payments of school building and ESQ training than student get the receipts of money payments of school building and ESQ training than the

student get form money payment of school uniform. After that the student go to the next post namely post 3 with bringing that form.

- Post 3:
  In post 3, student shouldpay money payment of school uniform than student get receipts and the school uniform electoral form size school uniform. After that the student go to the next post namely post 4 with bringing that form.
- Post 4:
  In post 4, student shouldchoosing size school uniform than student get form size school uniform which have been signed and stamped by the officer.

The data that has been collected is processed with the Kolmogorov-Smirnov method, if the data is normally distributed or not. When distributed normally then the data can be simulated.Simulate means trying to operate the model has been designed so that the model can be computerized describes conditions in the real system in field. In this study the simulation does is against the model queue new students re-registration pass on-line at PSB SHS 4 Padang. The softwre which used to simulate the model is namely Pro-model 7.5. With using this sofware the simulation can be seen in animation form and we can use the data has been collect into Pro-model 7.5.

4. Results and Discussions

Information sources of interview in this study is Headmaster of SHS 4 Padang namely Mr. Yunisra. This interview used the question as 20 questions.Graph of data distribution has been collected on first dayavailable in Figure 4 as follow:

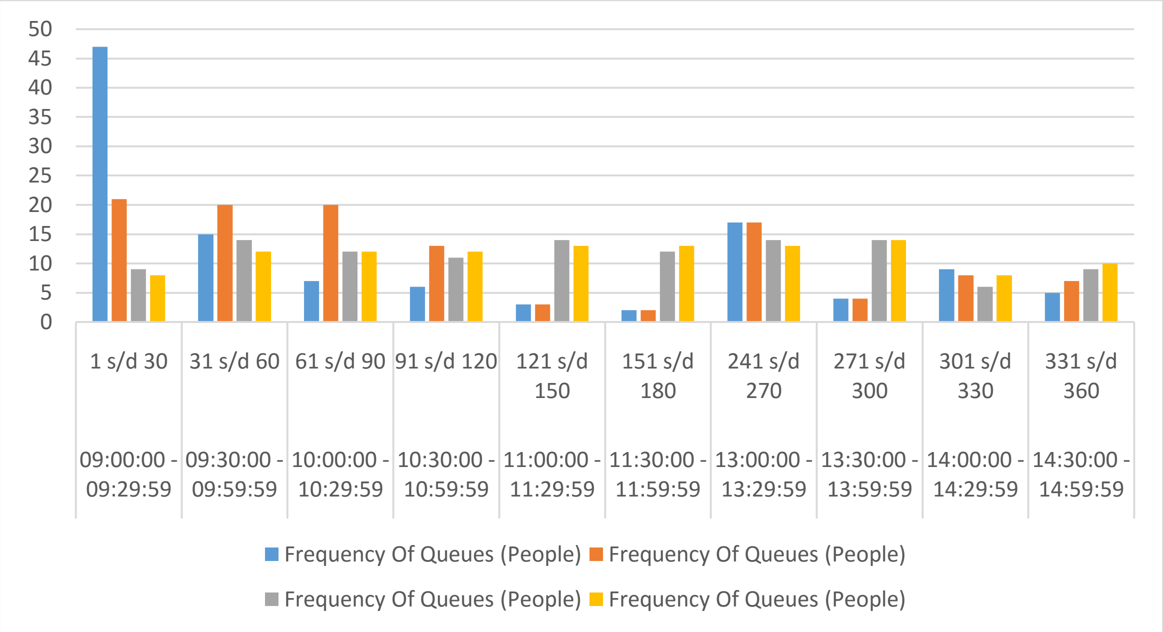

Figure 4: Graph of data distribution on the first day

According to Figure 4 above we can see that queueing frequency on post 1 is biggest than other posts at time 09:00:00 – 09:29:59 whereasqueueing frequency on post 2 is biggest than other posts at time 09:00:00 – 09:29:59, 09:30:00 – 09:59:59, and 10:00:00 – 10:29:59.Queueing frequency on post 3 is biggest than other posts at time 11:00:00 – 11:29:59 whereas queueing frequency on post 4 is biggest than other posts at time 14:30:00 – 14:59:59.The total number of applicant is 115 students. Graph of data distribution has been collected on second day available in Figure 5 as follow:

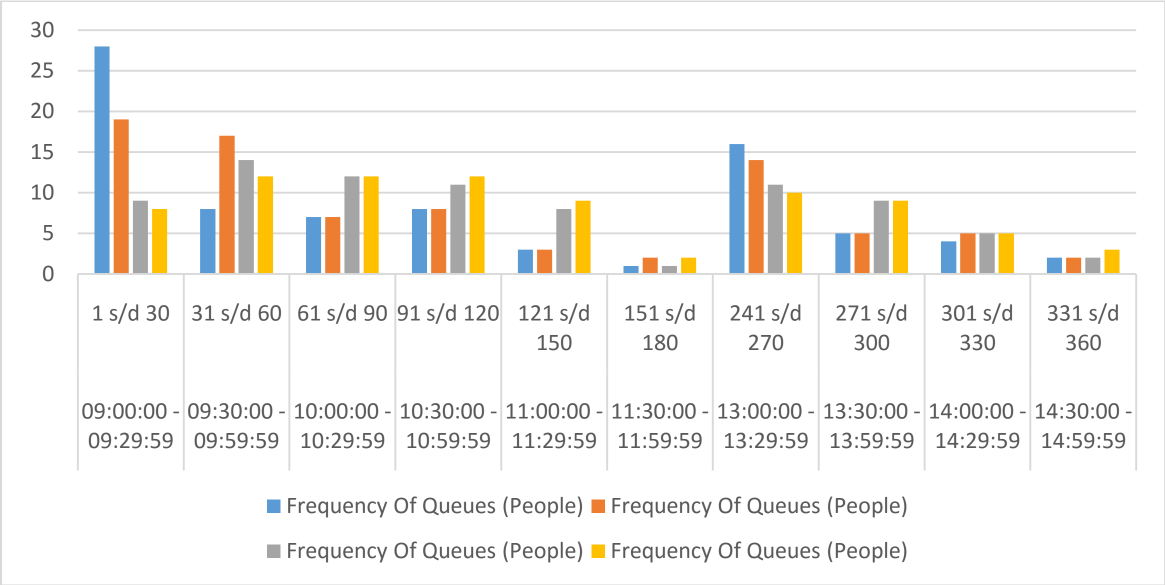

Figure 5. Graph of data distribution on the secondday

According to Figure 5 above we can see that queueing frequency on post 1 is biggest than other posts at time 09:00:00 – 09:29:59 and time 13:00:00 – 13:29:59 whereas queueing frequency on post 2 is biggest than other posts at time 09:00:00 – 09:29:59, 09:30:00 – 09:59:59, and 13:00:00 – 13:29:59. Queueing frequency on post 3 is never bigger than other posts whereas queueing frequency on post 4 is biggest than other posts at time 10:30:00 – 10:59:59. The total number of applicant is82 students. Graph of data distribution has been collected on third day available in Figure 6 as follow:

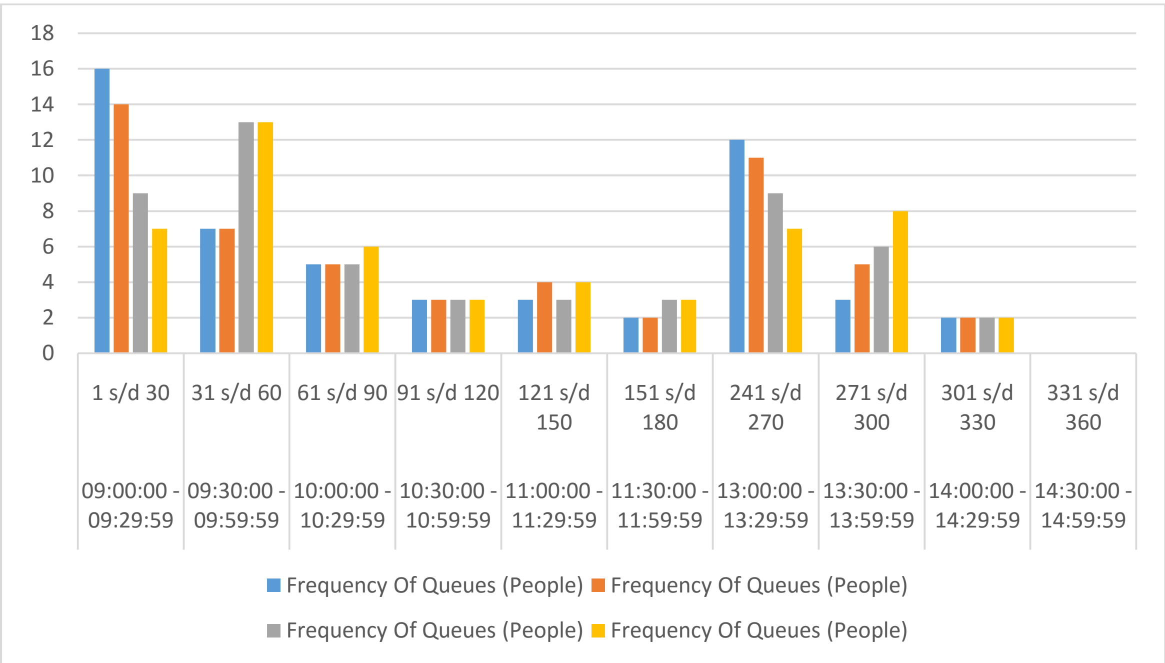

Figure 6: Graph of data distribution on the thirdday

According to Figure 6 above we can see that queueing frequency on post 1 is biggest than other posts at time 09:00:00 – 09:29:59 and time 13:00:00 – 13:29:59 whereas queueing frequency on post 2 is biggest than other posts at time 09:00:00 – 09:29:59, 09:30:00 – 09:59:59, and 13:00:00 – 13:29:59. Queueing frequency on post 3 is never bigger than other posts whereas queueing frequency on post 4 is biggest than other posts at time 10:30:00 – 10:59:59. The total number of applicant is53 students. Graph of data distribution has been collected on fourth day available in Figure 7 as follow:

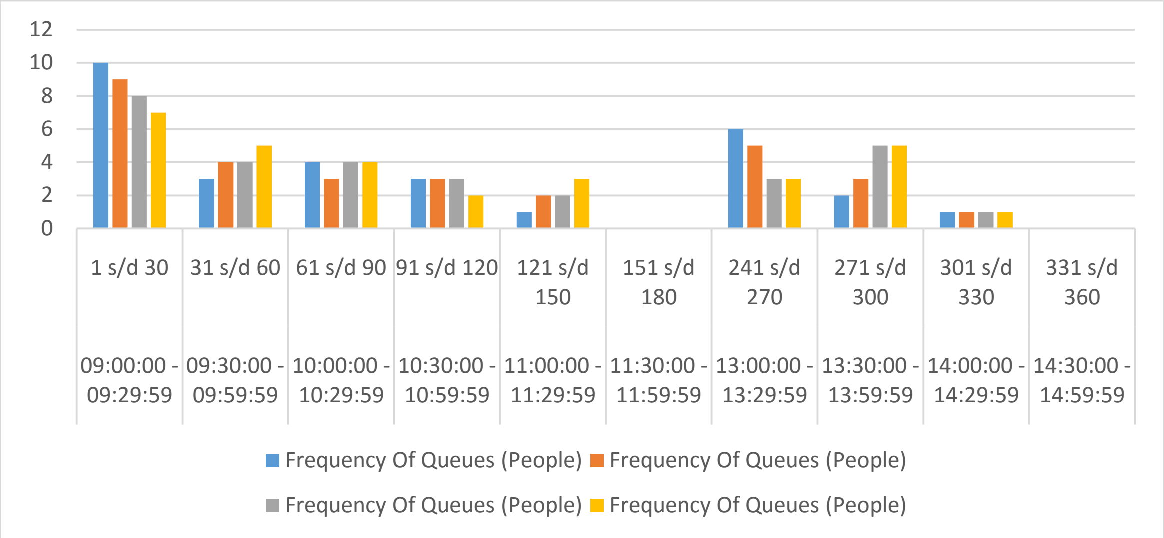

Figure 7: Graph of data distribution on the fourth day

According to Figure 7 above we can see that queueing frequency on post 1 is biggest than other posts at time 09:00:00 – 09:29:59 and time 13:00:00 – 13:29:59 whereas queueing frequency on post 2 is biggest than other posts at time 09:00:00 – 09:29:59and 13:00:00 – 13:29:59. Queueing frequency on post 3 and post 4 is never bigger than other posts. The total number of applicant is 30 students.

Based on the above distribution data above, we can conclude that:

a. On the first day the total of applicants is very much, they are 115 people with crowdedand largest registration queue occurs at post 1. In the next post 2 while queuing at post 3 and post 4 is not too long.
b. On the second day the total of applicants is less than first day, they are82 people with crowded the largest registration queue occurs at post 1 in the next post 2 while queuing at post 3 and post 4 is not too long.
c. On the third day of the number of applicants is less than first and second day53 people with crowded the largest registration queue occurs at post 1 while queuing at post 2, post 3 and post 4 is not too long.
d. On the fourth day of the number of applicants is less than another day30 people with no crowded queue occurs.

Data that has been collected on the distribution of data then tested with the Kolmogorov-Smirnov method in order to know is the distributin data normally or not. The Kolmogorov-Smirnov method have 12 steps to calculate the data result. The steps of Kolmogorov-Smirnov methods are:

a. Determine the Hypothesis which will be test. The hypothesis which will be test are:
   H0 = Data is normally distributed
   H1 = Data is unnormally distributed

b. Determine the measurement significant value (α). The measurement significant value is usually used to is 5 % or 0.05. α = 0.05

c. Calculate the number of data (n) wich will be test. In this research the data wich will be test are 280 data wich gotten by the total of data on first day, second day, third day and fourth day at registration. The details of this caculation are follows:

$n = \text{Data on first day} + \text{Data on second day} + \text{Data on third day} + \text{Data on fourth day}$
$n = 115 + 82 + 53 + 30$
$n = 280$

d. Calculate the average (mean) of the data wich will be test. To calculate the average of data we can use the formula:

$$\bar{x} = \frac{\sum xi}{n}$$

where:

$$\bar{x} = \text{Average (mean) of data wich will be test}$$

$$\sum xi = \text{Sum of all data wich will be test}$$

$$n = \text{Number of data wich will be test}$$

In this research,we have:

$$\sum xi = xi1 + xi2 + \cdots + xi280$$

$$\sum xi = 1{,}0 + 1{,}0 + \cdots + 350{,}0$$

$$\sum xi = 32{,}731.00$$

Therefore,

$$\bar{x} = \frac{\sum xi}{n}$$

$$\bar{x} = \frac{32{,}731.00}{280}$$

$$\bar{x} = 116.9$$

e. Calculate the standard deviation (SD) of the data wich will be test. To calculate the deviation standard we can use the formula:

$$SD = \sqrt{\frac{\sum(xi - \bar{x})^2}{n}}$$

Where:
$SD = \text{Standard Deviation}$

$$\sum (xi - \bar{x})^2 = \text{sum of quadrate each data which minus to average of data}$$

$$n = \text{Number of data wich will be test}$$

In this research:

$$DS = \sqrt{\frac{\sum(xi - \bar{x})^2}{n}}$$

$$DS = \sqrt{\frac{\sum((x1 - \bar{x}) + (x2 - \bar{x}) + \cdots + (x280 - \bar{x}))^2}{n}}$$

$$DS = \sqrt{\frac{\sum((1.0 - 116.9) + (1.0 - 116.9) + \cdots + (350.0 - 116.9))^2}{n}}$$

$$DS = \sqrt{\frac{3{,}731{,}510.0}{280}}$$

$$DS = \sqrt{13{,}326.0}$$

$$DS = 115.4$$

f. Sort the data by ascending than filled into Kolmogorov-Smirnov table follows:

Table2: KolmogorovSmirnov table

No	Xi	Z Score	Ft	Fs	|Ft-Fs|
1	Xi 1				
2	Xi 2				
..	……				
280	Xi 280				

g. Calculate the value of Z score of each raw of the above table than complete the empty raw of that table. To calculate the value of Z score we can use the formula:

$$Z = \frac{x - \bar{x}}{SD}$$

where:

$Z = Z\ Score$

$x - \bar{x} =$ value of each data minus average data

$x - \bar{x} =$ value of each data minus average data

$SD =$ Standard Deviation

In this research:

$$Z = \frac{x1 - \bar{x}}{SD} = \frac{1.0 - 116.9}{115.4} = \frac{-115.9}{115.4} = -1.0043 \qquad \text{(Raw 1)}$$

$$Z = \frac{x2 - \bar{x}}{SD} = \frac{1.0 - 116.9}{115.4} = \frac{-115.9}{115.4} = -1.0043 \qquad \text{(Raw 2)}$$

$$Z = \frac{x280 - \bar{x}}{SD} = \frac{350.0 - 116.9}{115.4} = \frac{233.1}{115.4} = 2.02 \qquad \text{(Raw 280)}$$

h. Calculate the value of Ft of each raw data wich will be test than filled into table 2. To calculate the value of Ft we can use formula:

a. If the value of Z is negatif than 0,5 minus the large area of Z table (Fz)

b. If the value of Z is positif than 0,5 plus the large area of Z table (Fz)

The vaue of z (Fz) can be seen in annex 2.

where:

$Ft =$ Normal comulative probabilities

$Fz =$ The value of Z on the Z table

In this research:

$$Ft = 0.5 - Fz = 0.5 - 0.3413 = 0.1587 \qquad \text{(Raw 1)}$$

$$Ft = 0.5 - Fz = 0.5 - 0.3413 = 0.1587 \qquad \text{(Raw 2)}$$

$$Ft = 0.5 + Fz = 0.5 - 0.4783 = 0.9783 \qquad \text{(Raw 280)}$$

i. Calculate the value of Fs of each raw wich will be test, We can use formula:

$$Fs = \frac{Number\ of\ data\ until\ the\ number\ to\ (ni)}{Number\ of\ all\ data}$$

where:

$Fs =$ Empiric comulative probabilities

Then we have:

$$Fs = \frac{Number\ \ of\ data\ until\ \ the\ number\ \ to\ (ni)}{Number\ \ of\ all\ data}$$

$$Fs = \frac{34}{280} = 0.1214$$

j. Calculate the absolute value of each raw wich will be test. We can use formula:

$$|Ft - Fs|$$

where:
$|Ft - Fs| = Absolute\ Value$
$Ft =$ Normal comulative probabilities
$Fs =$ Empiric comulative probabilities
In this research:

$$|Ft - Fs| = |0.1587 - 0.1214| = 0.0363 \qquad \text{(Raw 1)}$$
$$|Ft - Fs| = |0.1587 - 0.1214| = 0.0363 \qquad \text{(Raw 2)}$$
$$|Ft - Fs| = |0.9783 - 1.0000| = 0.0217 \qquad \text{(Raw 280)}$$

k. Complete all of raw of each cell data in the table 2 without an empty raw

l. Calculate the statistic test on table 2 with formula:

$$D = Maks\ |Ft - Fs| = |0.1483| = 0.1483$$

Test criteria are:

a. H0 is reject if D maks ≥ D Table

b. H0 is recieve if D maks < D Table

withα = 0.05, n = 280, D maks = 0.1483, D table = 0.2336 and D maks < D Table.

Then H0 is recieve is mean that the data has been collected is normally distribution. The full calculation is in annex 3.

Simulation models queue undertaken is simulated against 280 applicants are divided into 4 different simulation of Queuing on the first day, second day, third day and fourth day. Because many of the participants are included in the registration queue then simulated in this chapter are performed on the first day in the post registration 1 to 5 samples during registration just opened at 09.00.00 – 09.30.00. The simulation of real queueing system available in the Table 3 as follow:

Table3: Simulation of queue on first day post 1

Applicant	Arrival Hour Applicants	Arrival of Applicants	Service Start	Service Long	Service Finish	Applicants Waiting Time	Officer Status	Officer Waste Time
1	9:01:00	1.0	1.0	1.0	2.0	0.0	Busy	0.0
2	9:01:00	1.0	2.0	1.0	3.0	1.0	Busy	0.0
3	9:01:00	1.0	3.0	1.5	4.5	2.0	Busy	0.0
4	9:01:00	1.0	4.5	1.0	5.5	3.5	Busy	0.0
5	9:01:00	1.0	5.5	2.0	7.5	4.5	Busy	0.0
until	…	…	…	…	…	…	…	…
115	14:50:00	350.0	350.0	1.0	351.0	0.0	Closed	0.0
Summing ($\sum xi$)		12985.0	14768.5	163.5	14932.0	1783.5	-	186.5
Average (xi)		112.9	128.4	1.4	129.8	15.5	-	1.6
Standard Deviation		122.2	111.9	0.5	111.9	14.8	-	6.4

Base onTable 3 above, we can see that average of applicant waiting time is 15.5 minutesand average officer waste time is 1.6 minutes whereas the number of applicants is 115 students because of it the officer status on post 1 is busy from open serving until closed serving. The simulation of real queueing system available in the Table 4 as follow:

Table4: Simulation of queue on the first day of post 2

Applicant	Arrival Hour Applicants	Arrival of Applicants	Service Start	Service Long	Service Finish	Applicants Waiting Time	Officer Status	Officer Waste Time
1	9:03:00	3.0	3.0	2.0	5.0	0.0	Busy	0.0
2	9:04:00	4.0	5.0	2.0	7.0	1.0	Busy	0.0
3	9:05:50	5.5	7.0	3.0	10.0	1.5	Busy	0.0
4	9:06:50	6.5	10.0	3.0	13.0	3.5	Busy	0.0
5	9:08:50	8.5	13.0	3.0	16.0	4.5	Busy	0.0
until	…	…	…	…	…	…	…	…
115	14:52:00	352.0	352.0	2.0	354.0	0.0	Closed	0.0
Summing ($\sum xi$)		15109.0	18846.0	269.0	19115.0	3677.0	-	82.0
Average (xi)		131.4	163.9	2.3	166.2	32.0	-	0.7
Standard Deviation		112.2	106.1	0.4	106.0	26.8	-	5.6

Base on Table 4 above, we can see that average of applicant waiting time is 32.0 minutes and average officer waste time is 0.7 minutes whereas the number of applicants is 115 students because of it the officer status on post 1 is busy from open serving until closed serving. The simulation of real queueing system available in the Table 5 as follow:

Table5: Simulation of queue on the first day of post 3

Applican t	Arrival Hour Applicants	Arrival of Applicants	Service Start	Service Long	Service Finish	Applicant Waiting Time	Officer Status	Officer Waste Time
1	9:06:00	6.0	6.0	3.0	9.0	0.0	Busy	0.0
2	9:08:00	8.0	9.0	2.0	11.0	1.0	Busy	0.0
3	9:11:00	11.0	11.0	3.0	14.0	0.0	Busy	0.0
4	9:14:00	14.0	14.0	3.0	17.0	0.0	Busy	0.0
5	9:17:00	17.0	17.0	3.0	20.0	0.0	Busy	0.0
until	…	…	…	…	…	…	…	…
115	14:55:00	355.0	355.0	2.0	357.0	0.0	Closed	0.0
Summing ($\sum xi$)		19289.0	19587.5	274.0	19861.5	239.0	-	77.0
Average (xi)		167.7	170.3	2.40	172.7	2.1	-	0.7
Standard Deviation		106.2	106.5	0.40	106.4	1.5	-	5.6

Base on Table 5 above, we can see that average of applicant waiting time is 2.1 minutes and average officer waste time is 0.7 minutes whereas the number of applicants is 115 students because of it the officer status on post 1 is busy from open serving until closed serving.The simulation of real queueing system available in the Table 6 as follow:

Table6: Simulation of queue on first day of post 4

Applicant	Arrival Hour Applicants	Arrival of Applicants	Service Start	Service Long	Service Finish	Applicants Waiting Time	Officer Status	Officer Waste Time
1	9:10:00	10.0	10.0	1.0	11.0	0.0	No Job	1.0
2	9:12:00	12.0	12.0	2.0	14.0	0.0	No Job	1.0
3	9:15:00	15.0	15.0	1.5	16.5	0.0	No Job	1.5
4	9:18:00	18.0	18.0	1.0	19.0	0.0	No Job	2.0
5	9:21:00	21.0	21.0	2.0	23.0	0.0	No Job	0.0
until	…	…	…	…	…	…	…	…
115	14:58:00	358.0	358.0	2.0	360.0	0.0	Closed	0.0

Total	20035.0	20044.0	198.0	20242.0	7.5	-	152.0
Average (xi)	174.2	174.3	1.7	176.0	0.1	-	1.3
Standard Deviation	106.6	106.6	0.6	106.7	0.2	-	5.6

Base on Table 6 above, we can see that average of applicant waiting time is 0.1 minutes and average officer waste time is 1.3 minutes whereas the number of applicants is 115 students because of it the officer status on post 1 is no job from open serving until closed serving.According to the data of simulation of re-registration on first day, we know that has been long queue and each aplicant has to waiting for a long time on the post 1 and post 2. Because of that condition, we should suggest a new model for the re-registration system. We has suggest 3 models and simulate each of them. One of the three model is the best model with short queue and minimu time witing applicant. The best model than three suggest model available in Figure 8 below:

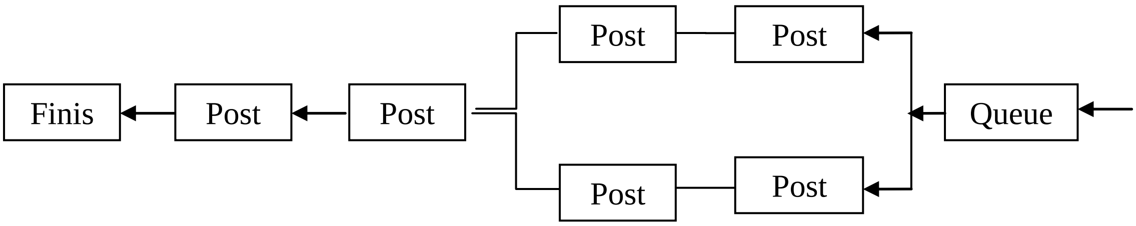

Figure 8: The design of the best suggestion model

Base on the picture above, we can see that the post re-registration has divided into six posts. At first Post 1 only one post then it is divided into two sub-postsi.e. post 1a and post 1b. In addition at first post 2 only one post then it is divided into two sub-posts i.e. post 2a and post 2b while post 3 and post 4 are not changed. After we simulated the best suggest model above the queueing long and average applicant waiting is smallest than the other models.The suggestion model about has been implementation into software namely Pro-model version 7.5. The suggested model and real model are given in Figure 9 as follow:

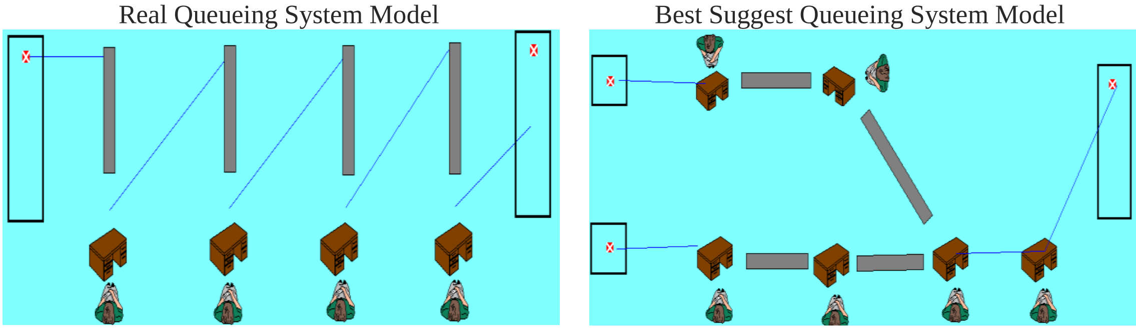

Figure 9: Comparison of real model system with best suggest model system

5. Conclusion

This paper has discussed modeling and simulation of shortest queue system with Kolmogorov-Smirnovmethod.The following conclusions have been drawn:

a. After we divided post 1 into two posts namely post 1aand 1b on first day note that average long applicants wait at post 1a and 1b are smaller i.e. 2.3 minutes and 2.8 seconds previously for 15 minutes.
b. After we dividedpost 2 into 2 postsnamely post 2a and 2b on first day note that average long applicants wait at post 1a and 1b are smaller i.e.0.2 minutes and 0.2 minutes previously for 32 minutes.

c. With the results of the simulation is done it can be concluded that the breakdown of the post registration may make the average time waiting for the registration to become smaller.

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