Modeling and Simulation of Student Registration Process by Using ARENA

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Abstract

This paper presents the work of analyzing the process of registering new student candidates at University *X* through modeling and simulation by using ARENA software. The layout of the student candidates' registration process at the university was observed and analyzed. The data taken is the processing time in each process counter sequence, the number of workers, and the layout arrangement by direct observation using a stopwatch. There are three layout models analyzed, namely the initial layout and two alternative layouts as the development of the initial layout. The results of the simulation for the initial layout model succeeded in reaching the number of enrollments of 443 new students at the same time as the real system, which was 4 hours 30 minutes. The first alternative layout model is simulated by reducing the number of workers less than that in the initial layout model. Furthermore, the second alternative layout model is simulated for the number of new student candidates increased by 20% from that of the initial model. The results of this study indicate that modeling and simulation using ARENA is very useful in analyzing the registration process of new student candidates to get smoothly, efficiently, and quickly process.

Keywords
Modeling, simulation, student registration, time study, utilization

1. INTRODUCTION

Simulation is defined as the process of creating existing or proposed system models to identify and understand the factors that control the system or to predict (predict) the future behavior of the system. Nearly all systems that can be described quantitatively using equations or rules can be simulated. The simulation helps the analyst understand how well the system is performing under a set of parameters. The scope of simulation is now extraordinarily broad, including the manufacturing sector, supply chain, transportation systems, computer information systems, service systems, and others. One of the service systems is the education sector, and the example of this is the new student registration process at a university. There are many studies relating to modeling and simulation, but the study of this topic is always relevant to discuss. One study will add a reference to other studies.

This working paper will present a case study of the registration process of new students at University X in Malaysia. Many procedures and counters must be passed by new student candidates to change their status from 'new student candidate' to be 'new student'. At each counter, these new student candidates need a few minutes to complete their administration process. At University X there are 10 counters which are Checking, Bank, Bursary, Academic Management Office, University Health Center, Student Affairs, Student Identity (Matrix) Cards, Co-Curricular Sports and Culture, Center for Humanities and Communications Studies, and Course Registration counters. The flow diagram of registration process is shown in Figure 1.

The purpose of this study is to model and simulate the registration process of new student candidates at University X by using ARENA software. Several alternative processes and the number of manpower in each counter will be identified. However, it should also be remembered that the registration process discussed in this paper is only for the registration of new student candidates, while the registration of old students is not discussed because this usually is processed online.

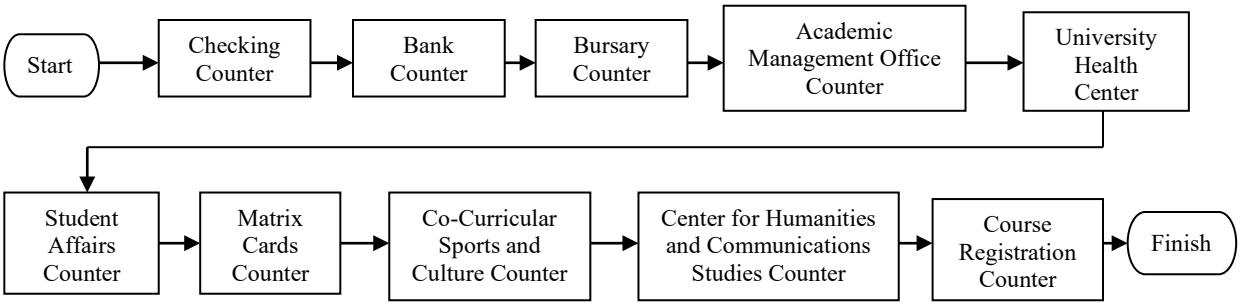

Figure 1. The flow diagram of registration process

2. PROBLEM STATEMENT

As previously stated, the registration process of new student candidates at University X is through several counters. The Check counter aims to ensure that all documents have been filled in completely by the students before these documents are submitted to the next counter. The Bank and also Bursary counters are where the students are required to pay their fees. The Academic Management Office counter is responsible for activating the accounts of the students. All the students are required to submit their medical examination reports to the University Health Center counter. At the Student Affairs counter, the students are given some stuff such as bags, t-shirts, and others, and they are also informed about their dormitory that they will occupy during their first-year study. After that, the students need to make their ID cards. They are required to submit their photos first and wait until their Student ID completely processed. Finally, the students proceed to the three counters namely the Co-Curricular Sports and Culture counter, the Center for Humanities and Communications Studies, and the Course Registration counter. After they have gone through all the procedures above, the students must then go and register at their respective dormitories. There are 5 dormitories at University X that are available to be occupied by all students during the first year of their study, and after one year ends they must find their place to live outside the dormitory.

From the description of the student's registration process above, it is clear the process should be identified clearly to get the best registration process that in turn will save time, cost, and manpower required.

3. LITERATURE REVIEW

Simulation modeling is a general paradigm for analyzing complex systems. In short, this paradigm creates a simplified representation of a system that is being studied. The paradigm then starts experimenting with a system, guided by a set of determined objectives, such as improving system design, cost-benefit analysis, sensitivity to design parameters, and so on (Tayfur and Benjamin 2007). Simulation modeling and analysis can also be defined as the process of creating and experimenting with a computerized mathematical model of a physical system. A system itself is defined as a collection of interacting components that receives input and provided an output for some purpose (Chung 2004).

A simulation of a workflow management system has been presented by Greasley (2003). He concluded that the simulation of the workflow component of a computer-supported co-operative work (CSCW) system has the potential to reduce the costs of system implementation, while at the same time improving the quality of the delivered system. The use of simulation tools can help to quantify the impact of suggested changes on the existing file and workflow and resource allocation (Sharma et al. 2007). The simulation model has certainly helped to improve communication among people who are interested in the modeled product and process design. It was reported that people are very impressed with the simulation models and keen to participate in the design process (Chan 2003). Office administrative costs can be escalated if they are not carefully controlled. A discrete event simulation is an effective tool that can be used to find more efficient ways of managing the office (Proctor 1997), and ARENA is software which is a discrete event simulation (Kelton et al. 2015). The application, such as ARENA software to improve the student registration process, will allow students and all related parties to view and make changes to the registration process issues for a specific semester (Chaka and Mungadzi 2013). The study of the prospective student registration system has been conducted at UNIKOM (Indonesian Computer University) which aims to analyze the level of utility manpower in each counter, and the length of the waiting process for registering students in each

counter. By using a quantitative method, the simulation results are as expected but the problem of the size of the room for each registration counter becomes something that needs to be further analyzed (Soegoto 2019).

An Information and Technology (IT) based simulation system to reduce the percentage of errors in registration of courses by students has been tested on the Faculty of Computer Sciences of the Benemérita Universidad Autónoma de Puebla. This system aims to help tutors and coordinators of courses and students in the process of course registration. The simulation system created is displayed on the faculty website so that each user can carry out simulations easily (Laura et al. 2019). The same thing about the use of IT for the development of the student registration system was also carried out at Northeastern University in China (Liu and Fuxiang 2012). Although these two studies are not a process of registering new student candidates, these show the importance of using the technology and simulations especially in improving the student registration process.

The use of technology to attract prospective new students who are interested in entering higher education has been developed at the University of Malaysia Pahang (UMP). The developed Online New Student Intake System (ORNSIS) is intended to facilitate the registration process of taking UMP entrance exams for high school graduates who interested in studying at UMP. The use of barcodes in ORNSIS is believed to reduce human involvement and save time and money (Noraziaha et al. 2011). But unfortunately, this system has not been developed for the registration of new student candidates who have been declared graduated to study at UMP after they take the entrance exams.

Overview of the Student registration process at IT Telkom has been carried out with the 'Fuzzy Mining Approach'. This approach is then compared its effectiveness with Alpha algorithms (Imelda and Angelina 2014). Both compared approaches can be classified as mathematical modeling. This mathematical modeling should be followed by modeling using the software so that the validity of the results of the mathematical simulation can be validated. The student registration process can be linked to queuing theory based on mathematical models. Queuing theory is a simulation solution by using an analytical approach (Marsudi and Shafeek 2014).

4. METHODOLOGY

In conducting this modeling and simulation study, several steps must be followed as shown in Figure 2 below.

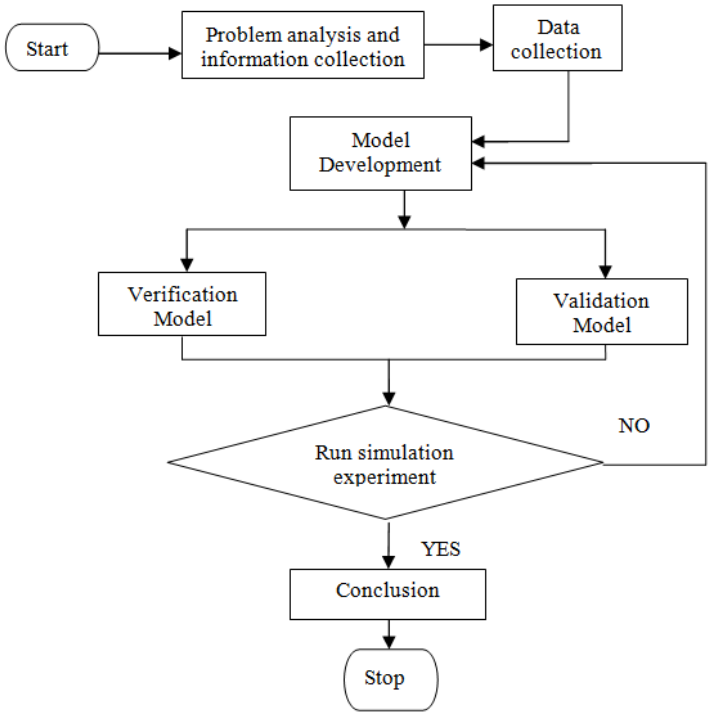

Figure 2. Methodology flowchart

4.1. Analyzing problems and gathering information

Problems in this study relating to the modeling and simulation of the new students' registration process must be clearly understood. For this reason, information needs to be collected from various relevant parties either by contacting the unit/institution or by contacting the individual personally. Problems in certain studies correlate with the objectives of the study itself. By understanding the purpose of the study the next steps or stages in the study can be carried out correctly.

4.2. Data collection

Data is needed to estimate the input parameters of the model. For this study, the data to be collected is the processing time for each activity in each counter, and the number of manpower in each counter during the registration process. Data collection is done manually with direct observation during the registration process, as well as conducting interviews with the relevant personnel.

4.3. Development of the model

An initial model that represents all activities involved in the registration process is developed to emulate a real system. The development of the model begins with the declaration of the entity, the location of the counter, the declaration of arrival, the declaration of the manpower in charge, and the programming of the process by using ARENA.

The simulation model developed in this case study consists of ten counters, all of which need to be modeled based on ARENA software modeling. The registration process is operated for 4 hours 30 minutes on this ARENA simulation. In developing this model, it can be explained about the input specifications and output specifications. Input specifications for modeling are related to the processing time for each counter, the capacity of manpower at each counter, the length or duration of the simulation, and the number of replications. While the output specifications which are the results obtained after running ARENA simulations are the parameters of the total number of the students who have finished registering, the utilization of each counter, and the average total time in the system. The ARENA model developed in this study is shown in Figure 3, and input data distribution is shown on Table 1.

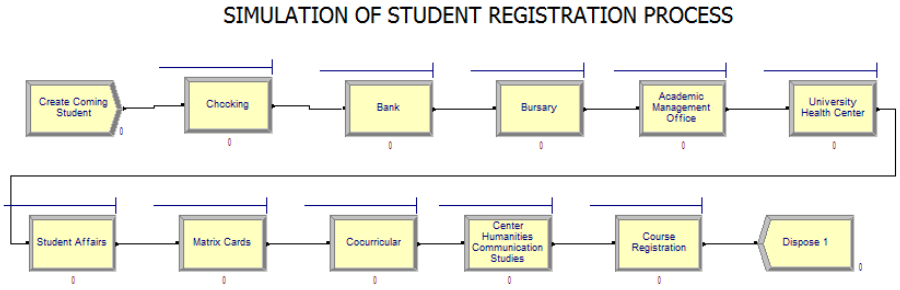

Figure 3. ARENA model for student registration process

Table 1. Input data distribution on the developed ARENA model

Process Name	Input Distribution
Checking	2 + 4.65 * BETA(0.573, 0.73)
Bank	1.26 + 1.31 * BETA(0.514, 0.4)
Bursary	0.999 + 1.43 * BETA(0.539, 0.799)
Academic Management Office	1 + 1.42 * BETA(0.663, 0.446)
University Health Center	1.15 + 1.48 * BETA(0.563, 0.46)
Student Affairs	1.15 + 1.47 * BETA(0.702, 0.903)
Matrix Cards	2.18 + 1.23 * BETA(0.829, 0.942)
Co-curricular	2.22 + WEIB(0.737, 1.57)
Center Humanities Communication Studies	3.22 + 0.87 * BETA(0.46, 0.928)
Course Registration	TRIA(3.24, 4.08, 4.29)

4.4. Model verification and validation

Verification assesses the correctness of the formal representation of the intended model by inspecting computer code and test runs and performing consistency checks on their statistics. The purpose of model verification is to make sure that the model is correctly constructed. In other words, verification makes sure that the model conforms to its specifications and does what it is supposed to do. On the other hand, validation is done to ensure that the modeling of a system is expected to be close to the real system of the model. Validation is generally done by comparing the results obtained based on simulation with those previously available data. Previous data is usually from the company's management database or from the database unit that responsible for collecting data (Marsudi and Firda 2018).

5. RESULTS AND DISCUSSION

Output analysis is the modeling stage that is concerned with designing replications and calculating statistics in textual or graphic format. Output analysis focuses on analyzing simulation results. The purpose of the output analysis is to predict the performance of a system or to compare the performance of two or more alternative system designs. The output analysis also predicts the performance of the initial model and to overcome the problems that occur in the initial model. The results of the model simulation are the counter utilization, the average total time in the system, and the total of entities exit.

5.1. Analysis of the counter utilization

There are 10 counters in this model from Check counters to Course Registration counter. After running the model, the most widely used counter is the Check counter at the 99.18% level. The lowest utilization of the counter is the Academic Management counter with a level of 41.09% as shown in Table 2. Figure 4 shows the average percentage of utilization for the initial and alternative models.

5.2. Analysis of the average total time in the system

In this model, the average total time in the system is represented as the time taken by the system to complete the entire registration process starting from the Check counter to the Course Registration counter. The average total time in the system after 5 replications is 1855.00 seconds as shown in Figure 5.

Table 2. Counters utilization for each model

Counter Name	Utilization (%)		
	Initial Model	1st Alternative Model	2nd Alternative Model
1. Checking	99.18	99.31	99.29
2. Bank	90.27	86.52	90.48
3. Bursary	76.44	87.81	76.61
4. Academic Management office	41. 09	44.99	41.34
5. University Health Centers	69.07	76.00	69.57
6. Student Affairs	56.00	66.96	57.00
7. Matrix Card	93.22	91.02	94.17
8. Co-Curricular, Sports and Sports Centers Culture	77.60	93.15	78.37
9. Center for Humanities and Communication Studies	87.13	75.53	88.27
10. Course Registration	84.10	83.85	85.02

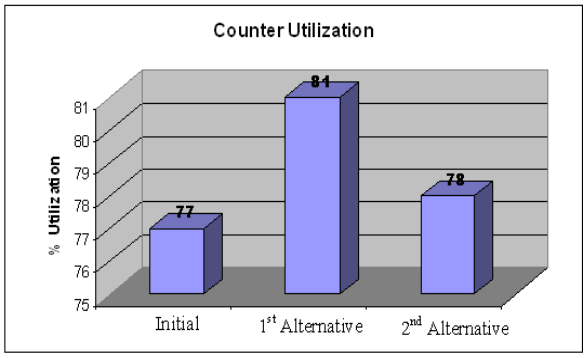

Figure 4. The average utilization percentage for each model

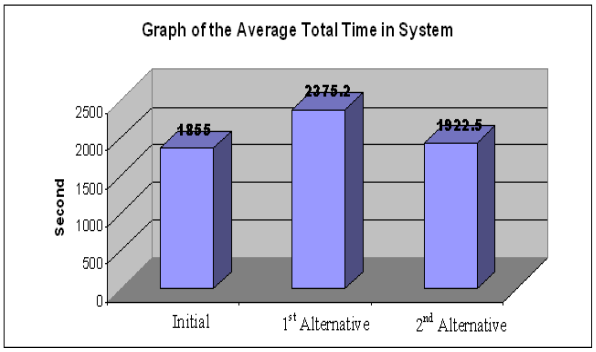

Figure 5. The average total time in the system for each model

5.3. Analysis of total exits

Total exits are defined as the new student candidates who have completed all registration processes from the Check counter to the last counter which is the Course Registration counter. For the initial model, the total number of exits is 443 as shown in Figure 6.

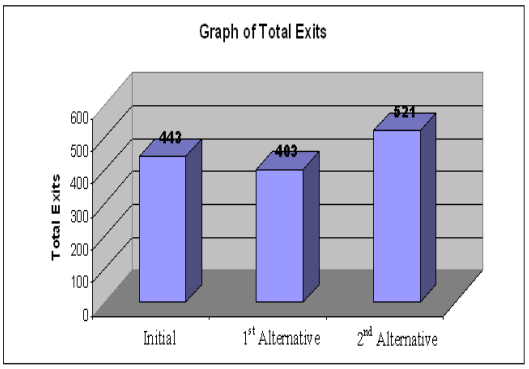

Figure 6. Total exits from the system for each model

5.4. Alternative models

Based on the initial model, the results of the simulation study have been analyzed to improve the system. The purpose of alternative models is to solve problems that occur in the initial model. In the first alternative, the layout is still the same as the current student registration process but only to reduce the amount of manpower at certain counters. This alternative is intended to show the results whether it can achieve the same target as it is a real system if the duration is still the same as the real system is. The result of this first alternative shows the target registration of

the students cannot be achieved at the periodic of the real system duration (i.e. 4 hours 30 minutes). The number coming out of the simulation result is 403. This is very different compared to the real system because the number of new student candidates registered on the registration day is 426 students. This happens because the numbers of manpower have been decreased at certain counters.

In the second alternative, the number of manpower for each counter is still the same as the initial model but the number of the new student candidates for the next semester increased by 20% from the number of the students in the initial model. This second alternative is intended to determine the results of whether the layout can reach the target within the same duration of 4 hours 30 minutes. The results of this alternative model show that it cannot process the number of students unless in about 5 hours.

5.5. Comparison between initial models and alternative models

Comparison between the outputs of alternative models and initial models is important to check whether the alternative model is better than the initial model. Three parameters are defined in comparing the initial model and the alternative model, namely counter utilization, the average total time in the system, and the total exit.

5.5.1. Utilization of counters

Figure 4 shows the average percentage of utilization for each counter for the initial and alternative models. Generally, the percentage of utilization for the first alternative shows an increase in value compared to the both initial and the second alternative models. This can be understood because the manpower for the first alternative is less than that for both the initial and the second alternative models. The reduction in the number of manpower in the first alternative is intended to check whether this first alternative can process the number of students at the same duration as the initial model has.

The different percentages of average utilization between the initial model with the first and the second alternatives are 4% and 1% respectively. It shows that the second alternative is better and can process the student registration for the case if the student intake increase of 20% but the total processing time to complete this process will be increasing to 5 hours.

5.5.2. The system time

As shown in Figure 5, the average total time in the system for the initial model and 1st alternative model is 1855 second and 2375.2 second respectively. The average total time in the system between these two models is too many different. The first alternative model shows that the processing time for a new student to complete the registration process from the first counter until the last counter is longer than the initial model has. However, the average total time in the system for the second alternative model is 1922.5 second. This value is higher than the initial model but not too many different, and therefore this second alternative is a suitable model to process the student registration if the number of the students increases by 20% in the next semester.

5.5.3. Total Exit

Figure 6 shows the total number of exits for each workstation for three models which are the initial model, the first alternative model, and the second alternative model. The present number of students registered on the registration day is 426 students. For the initial model, the simulation result shows that the total exit of the students is 443 with the duration time of 4 hours 30 minutes. Therefore, it can be said that the simulation is valid if this initial model is compared to the real system. For the first alternative model, the simulation result of total exits is 403 students. This means the first alternative model cannot achieve the target of the real-life system at the amount of 426 students. For the second alternative model, the simulation result of total exit is increasingly to be 521 students with a duration time of 5 hours although the number of manpower at each counter is the same as in the initial model is.

5.6. Statistical analysis

A statistical hypothesis has been conducted for the validation process of the developed simulation model. For this purpose, both Null hypothesis (H_o) and alternative hypothesis (H_a) were applied for One Side and Two Sides hypothesis tests. The calculated mean ($\vec{x}$) and the actual mean (μ_o) values are 443.2 and 426 respectively. Standard deviation (S) is 1.323 for n is equal to 5. Confidence interval CI 95% (α =0.05) for both sides and (α =0.025) for one side.

- One side hypothesis test: $H_o, \mu_o = 426$; $H_o, \mu_o < 426$
  T value based on Table is $t = 2.776$
  Calculated T value: $t_c = \frac{443.2-426}{\frac{1.323}{\sqrt{5}}} = 29.073$

  If the $-t_c < -t$ value then H_o will be rejected. In this case, this is true because - 29.073 < -2.776. Therefore alternative hypothesis will be accepted.

- Two sides hypothesis test: $H_o, \mu_o = 426$; $H_a, \mu_o \neq 426$
  T value based on Table is $t = 2.132$
  Calculated T value: $t_c = \frac{443.2-426}{\frac{1.323}{\sqrt{5}}} = 29.073$

  If the $|t_c| > t$ value then H_o will be rejected. In this case, this is true because 29.073 > 2.776. Based on this result, alternative hypothesis will be accepted.

6. CONCLUSION

Based on the analyzed results, it can be concluded that all the models show their characteristics. The second alternative model is appropriate to be used when the student intake increases by 20% more than the number of student intakes in this semester. Overall, the entire alternative models show better results compared to the initial model and it can be proved that the initial model can be improved.

Throughout this study, valuable experiences from various aspects are gained. Simulation modeling and analysis is becoming increasingly popular as a technique for improving or investigating process performance. The experiences from this study have provided knowledge in managing and handling the student registration process system in the future.

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Biography

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