SIMULATION MODEL DESIGN OF REFUELING SYSTEM AT PERTAMINA ALAM SUTERA GAS STATION

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ABSTRACT

In this study, the queue at Pertamina Alam Sutera Gas Station was observed. The purpose of the research is to design a model for this gas station in order to improve the utilization rates, reduce queue time and system time. The proposed model was carried out by simulation using Promodel. Three different schemes with three different queue capacities were simulated. The third proposal with queue capacity of five cars gives utilization rates increase by 10.8% compare to the present system. Moreover, the queue and system time has lowered by 65% and 11%, respectively. It also can serve 17% more cars.

Keywords*: Queue, Promodel, Simulation.*

1. INTRODUCTION

Queue is a common thing and often found in many public places. The existence of queue itself has a goal of keeping customers served in a comfortable and orderly, so that no problems arise in the process of service delivery to customers. However, the long queue time makes people so uncomfortable and cause many ineffectiveness and inefficiency. A few cases of queue such as queue at Karang Tengah tol gate (Tendean, 2006), cashier of hypermarket (Rahmadani, 2011), have been studied. In this paper, the queue at Pertamina gas station Alam Sutera, Tangerang is studied. The observation is done at this gas station and it appeared the utilization of the station is not producing maximum output. In addition, the queue time seems quite long. The purpose of this research is to construct a model for Pertamina Alam Sutera gas station that can improve the utility rates and reduce queue time. The proposed model will be simulated by using Promodel 2001 software.

2. THEORETICAL BACKGROUND

2.1. Definition of System and Queue

System is defined as a group containing more than one object to be in a place together where there is a relationship between one object or interaction with other objects to achieve a particular goal (Banks, 2001). Meanwhile, in Oxford dictionary, queue can be interpreted also as a line of people or vehicle waiting to be served or proceed. People are accustomed to the culture of queuing up in almost every place, such as teller in a bank, an ATM (Automatic Teller Machine), cinemas and other public places. The important parts in the queue are both a consumer and a server. There are several elements in a queue system namely Customer, Facility or Server, Inter arrival Time, Service Time, Queue Size and Queuing Discipline (Taha, 2003). Also, there are several queuing disciplines, including FCFS (First Come First Serve), LCFS (Last Come First Serve) and SIRO (Service In Random Order).

2.2. Simulation

According to the Oxford American Dictionary, simulation can be defined as a method or a way to build a real situation or a situation becomes a model aimed for the study, research, and training. There are some benefits with the implementation of the simulation process. Here are some benefits from the use of simulations (Harrell, 2003):

1. Trial and error process that is used to evaluate a system is extremely inefficient. The process requires high cost, long lead time, and can cause problems or sometimes permanently damage the system. Simulation can reduce all the cost and risk in order to implement changes to the system.

2. Process of simulation can accurately predict the method even for very complex systems though. This is due to the use of computers in the simulation process.
3. The model is the object for simulation process, can be modified into different types depending on the needs of researchers.
4. Simulation by using computer can give a better visualization, so it can be understood easily.

There are few steps need to be done in order to have a good simulation process, namely determining objectives, limitations and various other resources, data collection and analysis, modeling, verification and validation model, Data Verification, and finally Data Validation. In this research, Promodel 2001 software is used in constructing a model of the system of Pertamina Alam Sutera Gas Station. Promodel is categorized as one of the most complete simulation program and robust to resolve the various problem which are often found, especially in the event of a discrete event processing system (Benson, 1997). Although regarded as a very powerful program, but the usage of Promodel is easy and user friendly for the beginners. The program also comes with other programs namely Statfit. The function of Statfit is to be able to determine the type of distribution of the data that has been collected or held, so that the data can be used in the model improvement process.

3. RESEARCH METHOD

There are 9 fueling stations at Pertamina Alam Sutera gas station, as shown in Figure 1. These are arranged into 3 (three) lines with 3 (three) stations per line. The details of arrangement as follows the first line consists of 3 (three) stations that each can serve Premium fuel types and Solar, the second line consists of 3 (three) stations that each can serve fueling Premium type and Pertamax, and the third line consists of 3 (three) stations that each can serve fueling Premium type and Pertamax. Each server station has two (2) sides, the left and right. Fueling capacity for each operation is 1 (one) for each side of the car. Generally, the capacity of the queue for each side is 1 (one) car. This is because the distance between adjacent stations with each other stations are on one line. However, there is a queue of events with capacity of up to 3 cars. This incident can create a charging station which is right behind the station cannot serve cars which come to the station. These events can occur in the absence of the officer at the refueling stations. There are officers who typically drive the car to side of the stations. Therefore, the car cannot freely line up up at the desired station.

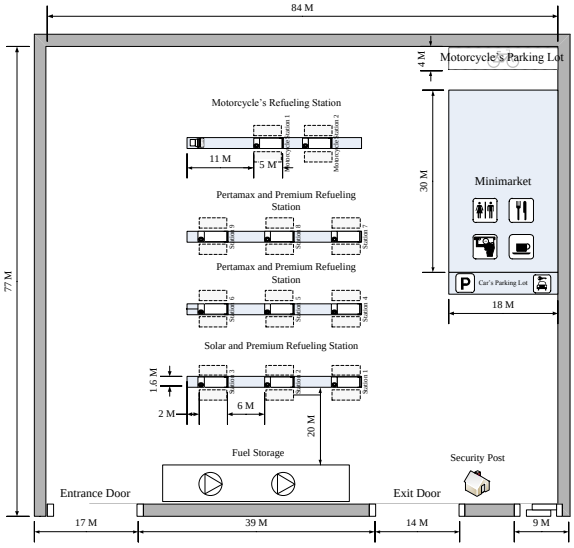

Figure 1. Layout of gas stations at Pertamina Alam Sutera

In the preliminary study, the station 7 (seven) and 8 (eight) were damaged or was in the repair, so the station 7 (seven) and 8 (eight) will not be included into the simulation model. The time chosen for collecting data are Monday, Wednesday, and Friday. Observations conducted from 18:00 until 20:00. Observations made during the two weeks of the date of October 8, 2012 until the date of October 19, 2012. This time is chosen based on the consideration of the results of an earlier study, supported by the testimony from the Head Branch of Alam Sutera Pertamina gas station, who confirmed that it was the peak period. Observations were made per station for each side, both the left and right side. Two sets of data were collected namely serving time and inter arrival time. Serving time is measured when the car began to be filled until the payment is done. The inter arrival

time is time elapse between arrival time of one car and the next one. Both serving time and inter arrival time were tested by using StatFit to determine the type of distribution of each set of data. We obtain that the inter arrival time data has either exponential or lognormal distribution. Meanwhile the service time shows no difference from one station to another station and it has lognormal distribution with mean 142.6 seconds and standard deviation of 33.6 seconds. These data and the type of distribution were needed for simulation using Promodel. Once the distribution of each data was known, then we used Promodel to simulate the current system in order to get waiting time, system time (where the car within the system), utilization rate and idle rate. We proposed three different schemes to improve the utilization rate. All the proposed schemes were simulated by using Promodel. All model are simulated by the replication with 8 times and the simulation time of 2 hours in each replication.

4. RESULT AND DISCUSSION

The simulation by using Promodel obtained that the average waiting time and system time from the current system are 95 s and 228 s, respectively. The utilization rate of the current system for each station is shown in Figure 2. The average value of the utilization rate is only 65 %.

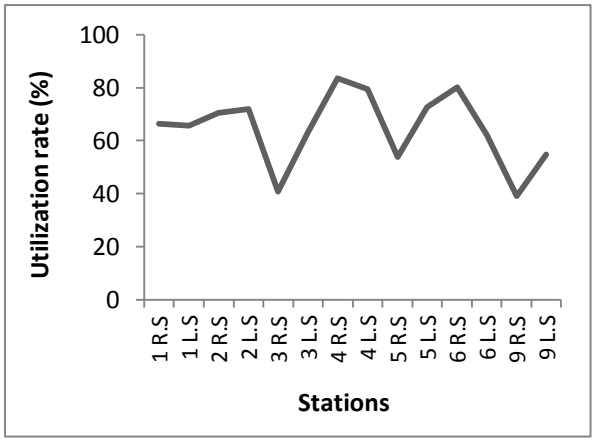

Figure 2. The Utilization rate of each station for the current system. (R.S = right side ; L.S = left side)

In order to improve the utilization rate, we propose three different schemes that will be simulated using Promodel. The first scheme can be explained as follows, ensure that there are operators at each station to manage the queue line. The queue capacity of each station is one car (the car directly goes to the queue line from the entrance, first come first serve), except for station 3, 6, and 9. The simulations are done for queue capacity station 3, 6, and 9 are 3, 4, and 5 cars, as shown in Figure 3. This is because the station is located at the rearmost position.

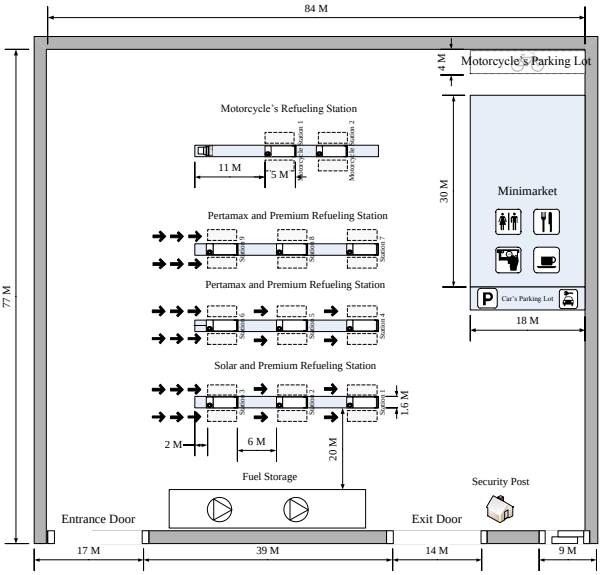

Figure 3. The layout of queue line for Scheme 1.

For scheme 2, the queues at every station are omitted except the queues at the rearmost stations as shown in Figure 4. Later the input for every station comes from these queues. Rules of the queue are as follows: For stations 1, 2, and 3, both left and right side has their own queue, which is right behind the station 3. Same situations for stations 4, 5, and 6 (both left and right side) has its own queue, which is right behind the station 6. For station 9, both sides have their own queue, as the current system. Both sides of station 9 received entity arrivals when the queue on the second line stations 4, 5, and 6 have already exceeded the capacity of the queue that can be accommodated. The queue capacity of the station 9 has the same as

those of station 4, 5, and 6. The service order for stations 1 to 6, both left and right sides are First available; it means that the first station that is empty will be the destination station for the next entity. For station 9 both left and right, the car will be served the queue based on first come first serve basis. With these scheme, there are total 6 (six) queues available.

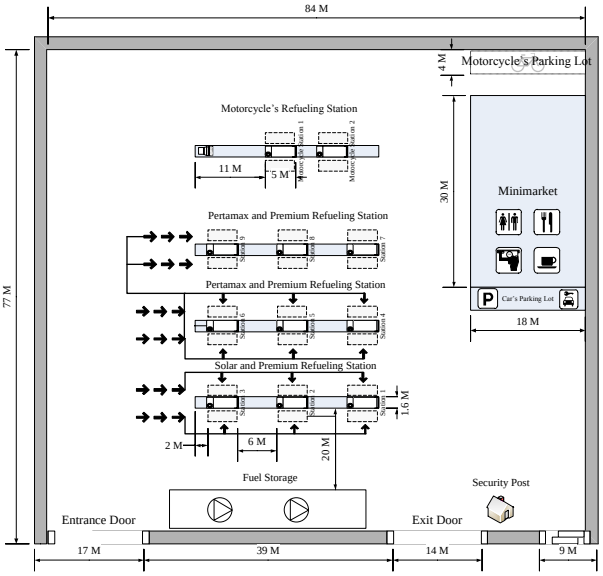

Figure 4. The layout of queue line for Scheme 2

The last scheme, as shown in Figre 5, does not really differ from scheme 2. The rules for scheme 3 can be explained as follows.

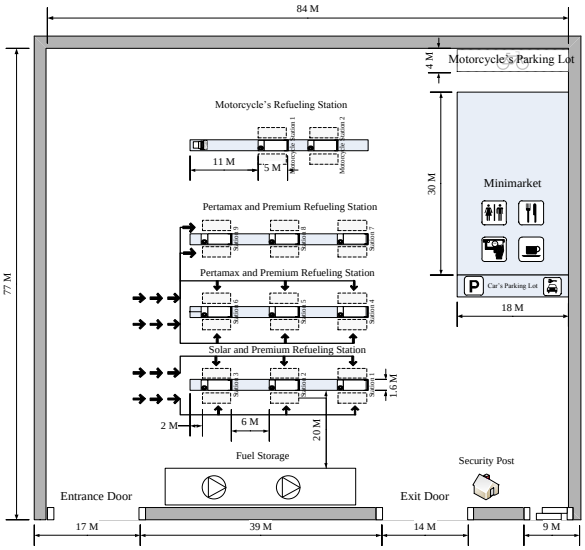

Figure 5. The layout of queue line for Scheme 3

Queues at station 1, 2, and 3 are the same as the proposed in scheme 2 with 3 station queues behind both the left and right with the rules of the First Available for each station sides. Queue at station 9, both left and right sides merged with queue station 4, 5, and 6 both left and right sides. Thus, the left side of station 9 receives input from left side queue and the right side receives entity from right side queue. The order of service for stations 4, 5, 6 and 9, both the left and right sides are first available, so that the any empty station will be the destination for the next entity from the queue, according which side has been chosen. For this scheme, there are only 4 (four) queues available. Queues behind station 9 are prohibited, since this station receives entity from the merged queue between queues from behind station 6 and queues behind station 9 from scheme 2.

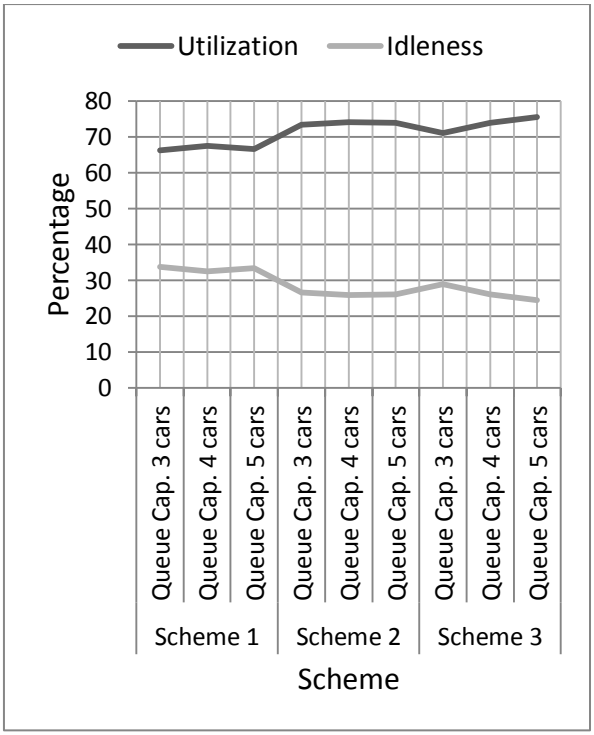

Figure 6. The average of Utilization and idleness rate for each scheme with different queue capacities.

After the simulation for all three schemes with different queues capacities, the best result is scheme 3 with queue capacity as many as 5 cars. Figure 6 shows the average of utilization and idleness rate for each scheme with different queue capacities. The selected scheme can increase the utilization rate by 10.8% compare to the current system. With this improvement of the

utilization rate then it will reduce the queue time and system time for each car as shown in Figure 7. The average queue time for the selected proposal is 33 s, which is reduced by 65% from the current system. Meanwhile the average of the time of a car is in the system is reduced by 11%. This will effect to the number of cars that can be served in this gas station. Based on the simulation, the number of cars that can be served is increase by 17%.

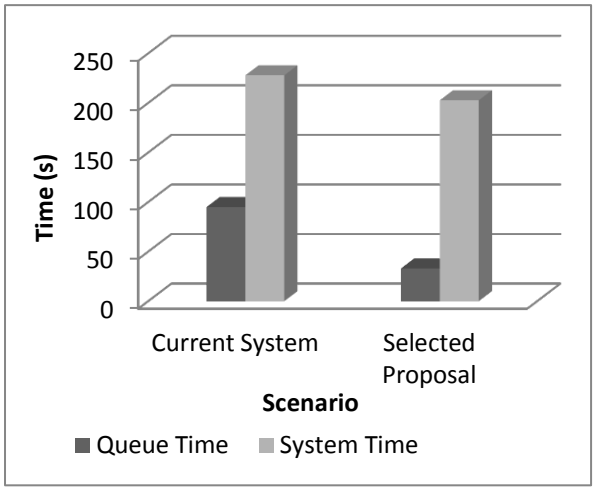

Figure 7. *Comparison of Queue time and System time for current system and selected system*

The selected scheme, namely scheme 3 has only 4 queue lines and for the other two schemes have 6 queue lines. It means that more queue lines do not always increase the utilization rate, unless the number of server is increased. However, the selected scheme 3 has queue capacity for 5 cars, which means more number of queue capacities definitely increases the utilization rate.

5. CONCLUSION

Some conclusions from this study can be stated as follows. The simulation for the current system gives the average utilization rate is 64.6%, the average time in the system for each car is 223 seconds, the average queue time is 95 seconds, and the number of cars served is 454 cars. Three different schemes were proposed to improve the utilization rate, reduce the queue and system time, and to increase the number of served cars. Scheme 3 with queue capacity 5 cars is selected as the best scheme that can increase the average rate of utilization by 10.8% from current system. Moreover, this scheme also reduces the system time and queue time for each car by 11% and 65%, respectively. This scheme also serves 17% more cars than the current system.

6. REFERENCES

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AUTHOR BIOGRAPHIES

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