IMPROVING THE UTILIZATION OF TELLERS USING SIMULATION AT XYZ BANK

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Abstract

Simulation is one of the techniques of operations research and management science that is most used widely. The goal of simulation is to estimate the performance measures of the evaluated system using computers. This paper provides the simulation of tellers to estimate and then improve its performance measure which is the utilization. The initial utilization of XYZ Bank is 24.13% on average. Two scenario are conducted to improve the utilization. Scenario 1 improves the utilization by 32.26% on average and scenario 2 improves the utilization by 47.84% on average. This paper suggests XYZ Bank to apply scenario 2 that can improve the utilization by 23.72%.

Keywords: simulation, tellers, utilization

I. INTRODUCTION

According to Law and Kelton (1991), simulation is one of the techniques of operations research and management science that is most used widely. Simulation is used in complex systems which the models can not be evaluated analytically. The goal of simulation is to estimate the performance measures of the evaluated system using computers (Taha, 2007). This paper provides the simulation of tellers to estimate and then improve its performance measure which is the utilization. The simulation that is built in this paper adopts the methodology of Law and Kelton (1991).

There are four tellers that are available in the XYZ Bank. The conceptual model of XYZ Bank is given in Figure 1. Customers arrive at the bank and they queue to get the service. The customers are served based on FCFS (first come first served) rule

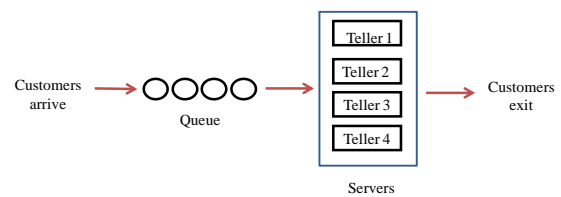and the availability of the tellers. After the customers are served by the tellers, they leave the bank.

Figure 1. The conceptual model of XYZ Bank

II. METHODOLOGY

As it was mentioned previously, this paper adopts the methodology of Law and Kelton (1991) to build the simulation. The flow chart to build the simulation can be seen in Figure 2.
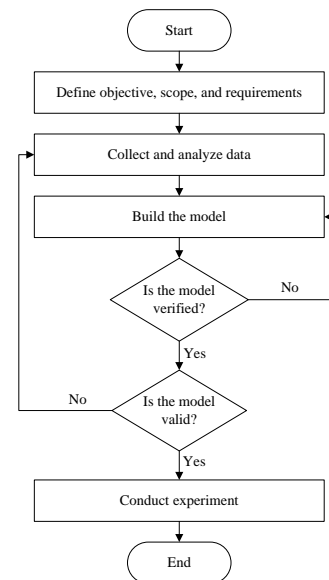

**Figure 2. The flow chart of the simulation**

III. SIMULATION MODEL

III. 1 Data

Based on Figure 1, it can be known data needed to build the simulation. They are interarrival time of the customers, service time of Teller 1, Teller 2, Teller 3, and Teller 4. The distribution of all the data is given in Table 1.

**Table 1. The distribution of the data used**

Data	Activity Time	Activity Resource	Next Location
Interarrival time	E(2.04) min	None	Teller 1
			Teller 2
			Teller 3
			Teller 4
Service time of Teller 1	L(1.05, 0.843) min	Teller 1	Exit
Service time of Teller 2	E(6.99) min	Teller 2	Exit
Service time of Teller 3	L(1.49, 0.603) min	Teller 3	Exit
Service time of Teller 4	L(1.21, 0.8) min	Teller 4	Exit

In Figure 3, the result of goodness of fit test for interarrival time of the customers is given.
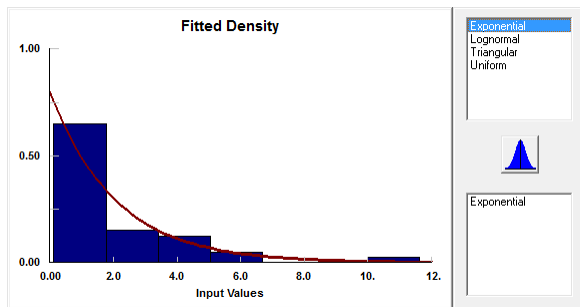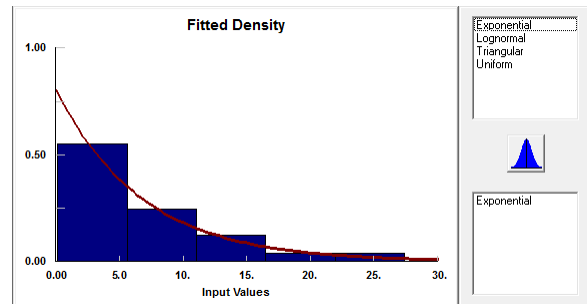

Figure 3. The result of goodness of fit test for interarrival time

The result of goodness of fit test for service time of Teller 1 is given in Figure 4.
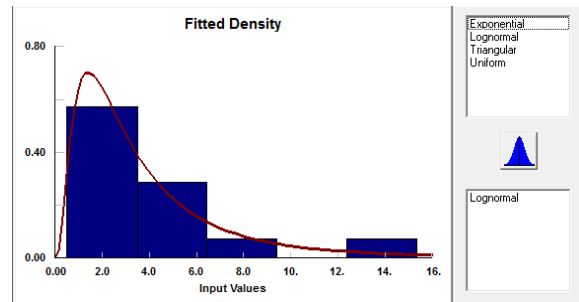
Figure 4. The result of goodness of fit test for service time of Teller 1

The result of goodness of fit test for service time of Teller 2 is given in Figure 5.

Figure 5. The result of goodness of fit test for service time of Teller 2

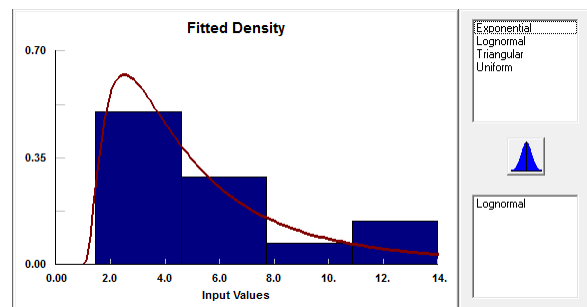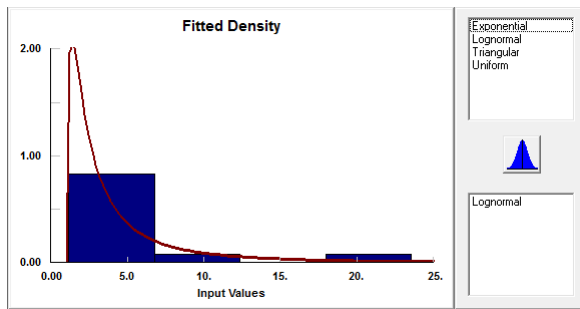The result of goodness of fit test for service time of Teller 3 is given in Figure 6.

Figure 6. The result of goodness of fit test for service time of Teller 3

The result of goodness of fit test for service time of Teller 4 is given in Figure 7.

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Figure 7. The result of goodness of fit test for service time of Teller 4

III.2 Verification and Validation

Verification is performed to assess whether the model (computer model) operates correctly (Altiok and Melamed, 2007). After performing verification for simulation model in this paper, it concludes that the simulation model is verified.

The accuracy of the simulation model to represent the real system is known as validation (Law and Kelton, 1991). Hypothesis testing is used to validate the simulation model. The result of the simulation model in the terms of number of customers exiting is given in Table 2.

Table 2. Simulation output

Replication	Number of customers exiting
1	239
2	225
3	234
4	245
5	220
6	237
7	225
8	247
9	213
10	267
Mean	235.2
Standard deviation	14.82
Variance	219.76

Meanwhile, from collected data, the number of customers exiting for ten days of observation is given in Table 3.

Table 3. Data of real system

Day	Number of customers exiting
1	239
2	248
3	223
4	259
5	243
6	241
7	236
8	238
9	228
10	240
Mean	239.5
Standard deviation	9.42
Variance	88.65

Hypothesis testing used is confidence interval on the difference in means where $\sigma_1^2 \neq \sigma_2^2$ (Montgomery and Runger, 2003). The hypothesis is given as follow.

$$H_0 : \mu_1 - \mu_2 = 0 \qquad \ldots[1]$$

$$H_1 : \mu_1 - \mu_2 \neq 0 \qquad \ldots[2]$$

Confidence interval on the difference in means is as follow.

$$(\bar{x}_1 - \bar{x}_2) - t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \leq \mu_1 - \mu_2 \leq (\bar{x}_1 - \bar{x}_2) + t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

$$\ldots[3]$$

Degree of freedom (v) is given as follow.

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$$v = \frac{\left[\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right]^2}{\frac{\left[\frac{s_1^2}{n_1}\right]^2}{n_1-1} + \frac{\left[\frac{s_2^2}{n_2}\right]^2}{n_2-1}} \qquad \dots[4]$$

For $\alpha = 5\%$, the conclusion is do not reject H_0 and states that the model is valid.

III.3 Number of replications

The method used to determine the number of replications needed (n) is relative error method that is given as follow.

$$n = \left[\frac{(z_{\alpha/2})s}{(\frac{re}{1+re})\bar{x}}\right]^2 \qquad \dots[5]$$

For the evaluated system, the data are given in Table 2. For $\alpha = 5\%$ and $re = 5\%$, the number of replications needed is 7 replications.

IV. DESIGN OF EXPERIMENTS

Result of the initial simulation in the terms of the utilization can be seen in Table 4. As it was mentioned before, this paper tries to estimate and then improve the utilization of the tellers.

Table 4. The utilization of the tellers from initial simulation

Teller	Utilization (%)
Teller 1	34.67
Teller 2	47.34
Teller 3	10.71
Teller 4	3.78
Average	24.13

There are two scenarios developed to improve the utilization. Scenario 1 is removing Teller 4 and the result of scenario 1 is given in Table 5.

Table 5. The utilization of the tellers from scenario 1

Teller	Utilization (%)
Teller 1	36.08
Teller 2	47.64
Teller 3	13.07
Average	32.26

Scenario 2 is removing Teller 3. The result of scenario 2 can be seen in Table 6.

Table 6. The utilization of the tellers from scenario 2

Teller	Utilization (%)
Teller 1	42.93
Teller 2	52.75
Average	47.84

V. ANALYSIS OF COMPARING SYSTEM

Number of customers exiting for initial, scenario 1, and scenario 2 is given in Table 7.

Table 7. Number of customers exiting for intial, scenario 1, and scenario 2

Replication	Initial	Scenario 1	Scenario 2
1	239	243	251
2	225	227	240
3	234	234	219
4	245	246	260
5	220	229	207
6	237	224	224
7	225	223	245

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Replication	Initial	Scenario 1	Scenario 2
Total	1625	1626	1646
Mean	232.143	232.286	235.143

Since there are 3 populations and single experiment, the hypothesis testing used is one-way Analysis of Variance or one-way ANOVA (Walpole et al., 2007).

The hypothesis is given as follow.

$$H_0 : \tau_1 = \tau_2 = \tau_3 = 0 \qquad \dots [6]$$

$$H_1 : \tau_i \neq 0 \text{ for at least one } i \qquad \dots [7]$$

For $\alpha = 5\%$, the conclusion is do not reject H_0 and states that one population is not significantly different than the others.

VI. CONCLUSIONS

This paper estimates and improves the utilization of tellers at XYZ Bank using simulation. As it can be seen in Figure 8, initial utilization of XYZ Bank is 24.13% on average. Two scenario are conducted to improve the utilization. Scenario 1 improves the utilization by 32.26% on average and scenario 2 improves the utilization by 47.84% on average.
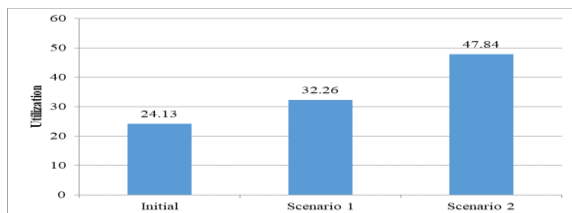
Figure 8. Improvement of the utilization

This paper suggests XYZ Bank to apply scenario 2 that can improve the utilization from 24.13% to 47.84%. There is an improvement by 23.72%. The number of tellers also decreases from 4 tellers to 2 tellers which means the cost also decreases.

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