A Discrete Event Simulation Model of Wonder Wings Restaurant

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***Abstract* — Developing a simulation model is a great advantage in any business systems to have an efficient and organized flow of service. It also helps them decide on what to improve on their current system. In this study, the researchers created a discrete-event simulation model of Wonder Wings restaurant that helps the business to estimate the total number of possible customers to come and their waiting time in the queue. Knowing this data, the owner can assess the system carefully for further improvements to the business.**

Keywords—Discrete-event, simulation and modeling, Simio Simulation Software, restaurant

I. INTRODUCTION

Modern advancements give us lots of advantage in dealing with our everyday system. One important aid that technology gives to any industry is the idea of simulation modelling. Simulation modelling, according to [1], is a well-established technique that duplicates the "features, appearance, and characteristics" of a real business or management system through an iconic or symbolic model. Simulation modelling is referred to as computer simulation when these models are created and executed using computers.

Computer simulation can be further defined by describing its underlying model as discrete event, continuous event, or combined event. A discrete event computer simulation uses "blocks of time during which no changes to the system state occur" to simulate variables within the model. This type of computer simulation uses the arrival of entities or the completion of an event as a cue to adjust the computer simulation time clock. Each movement in time takes place instantaneously, or "in discrete steps" [2].

An example of a discrete event computer simulation is to observe the behavior of a model of the customer flow in a quick service restaurant. Events such as the arrival of a customer, the completion of cooking a food, and the exiting of a customer from the restaurant all allow for the adjustment of the time clock and the manipulation of variables that are affected by each event.

In line with this, the researchers create a discrete event simulation model for Wonder Wings restaurant. The simulation time is set to start at 8:00 am until 10:00 pm that reflects the operation hours of Wonder Wings. The simulation starts at customer arrival, waiting in queue (if there is), taking orders, serving, eating, and customer exit. The simulation model is specifically discussed and illustrated throughout this paper.

II. METHODS

A. Queueing Theory

Queuing theory is the mathematics of waiting lines. It is extremely useful in predicting and evaluating system performance. Queuing theory has been used for operations research. Traditional queuing theory problems refer to customers visiting a store, analogous to requests arriving at a device. Solution of queue models are two approaches, namely mathematical and simulation, which are available for solving queuing models [3].

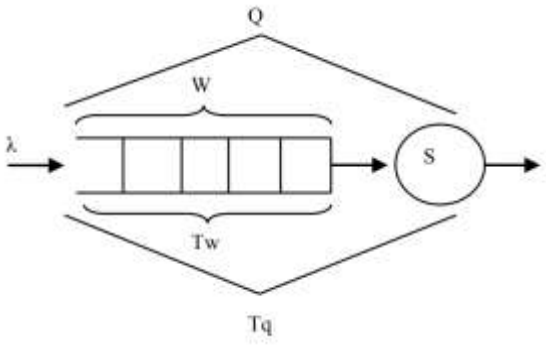

Figure 1. Queueing Model

The symbols and interesting values in figure1 as below:

- Arrival rate (λ) — the average rate at which customers arrive.
- Service time (s) — the average time required to service one customer.
- Number waiting (W) — the average number of customers waiting.
- Number in the system (Q) — the average total number of customers in the system.

• Time in the system (Tq) the average time each customer is in the system, both waiting and being serviced.
• Time waiting (Tw) the average time each customer waits in the queue. Tq = Tw + s

Arrival Rate: The arrival rate, λ, is the average rate new customers arrive measured in arrivals per time period. Common units are access/second. The inter-arrival time, a, is the average time between customer arrivals. It is measured in time per customer.

B. Statistical Treatment of Data

Statistical tests are mathematical tools for analyzing quantitative data generated in a research study. The multitude of statistical tests makes a researcher difficult to remember which statistical test to use in which condition [6].

In this study, the researchers used the paired sample t-test to statistically test the data gathered. The Paired Samples t Test compares the means of two measurements taken from the same individual, object, or related units. The purpose of the test is to determine whether there is statistical evidence that the mean difference between paired observations is significantly different from zero. The Paired Samples *t* Test is a parametric test [7].

[7] shows that the test statistic for the Paired Samples t Test, denoted t, follows the same formula as the one sample t test.

$$t = \frac{\bar{x}_{\text{diff}} - 0}{s_{\bar{x}}}$$

where

$$s_{\bar{x}} = \frac{s_{\text{diff}}}{\sqrt{n}}$$

where

$\bar{x}_{diff}$ = Sample mean of the differences
n = Sample size
s_{diff} = Sample standard deviation of the differences
$s_{\bar{x}}$ = Estimated standard error of the mean

C. Simulation Model Flowchart

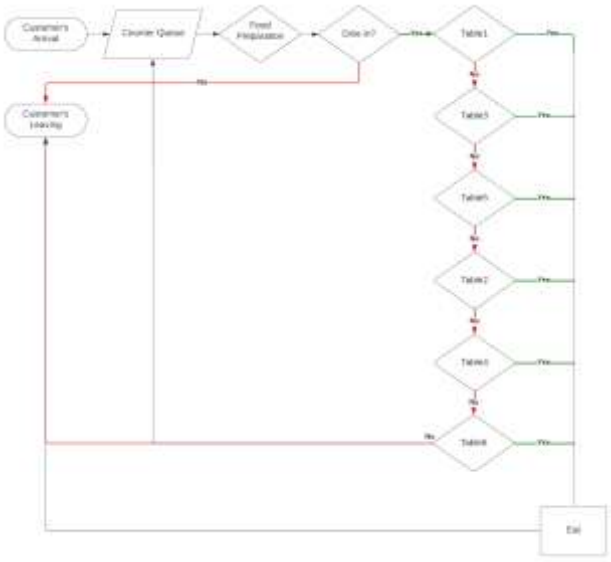

Figure 2. Simulation Model Flowchart

The flowchart shows the flow of the simulation model. It starts with the customer's arrival going to the waiting queue at the counter and waits for the food to be prepared. Next is the decision to dine in or take-out. If the customer chose to take out the food, it will leave the restaurant. Otherwise, the customer proceeds in choosing table, if the first table is occupied, then go to another table until it eats and then leave.

D. Simulation Model using Simio Simulation Software

Figure 3. Simulation Model using Simio Simulation Software

Simulation is a useful or powerful tool for analyzing complex systems and used in order to study real-life systems which do not currently exist [4]. Good for representing complex systems, the utility of the technology for finding the "answer". Easy to learn and are applicable to a wide range of problems. Figure 3 shows the actual simulation model created by the researchers using Simio Simulation Software.

E. Simulation Results

Figure 4. Status plot of number of customer and time in the system

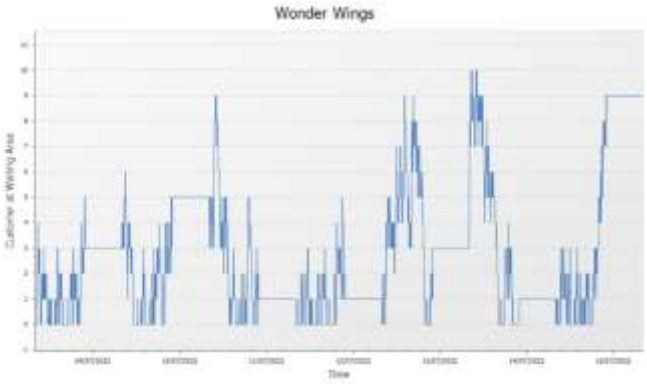

Figure 5. Status plot of number of customer in queue and time in the system

Figure 4 shows that the maximum number of customer entered the system are 13 peaking at nearly closing time 9:00 pm to 10:00 pm and lowest number of customer at 7:00 pm to 8:00 pm.

Figure 5 shows that the maximum numbers of customer in the queue are 10 with graphical movement same as with the number of customer in the system since the waiting queue is at the counter.

	NO. OF CUSTOMERS	
Date	Actual Data	Simulated Data
7/8/2022	98	93
7/9/2022	99	97
7/10/2022	95	91
7/11/2022	84	90
7/12/2022	94	89
7/13/2022	92	92
7/14/2022	89	90

Figure 6. Data Results of the Simulation

Figure 6 shows the summary report of the results of simulating Wonder Wings Restaurant Model together with the actual data gathered by the researchers from the restaurant from July 8 to 14 this year. The most number of customers that the restaurants have in the actual data is 99 while on the simulated is 97 on the same date. On the other hand, the lowest number of customers that the restaurants have in the actual data is 89 while on the simulated is 90 on the same date and in 11th of July.

F. Statistical Test Results

The following figures show the results of analyzing the data of Wonder Wings restaurant both actual and simulated. It is analyzed using IBM SPSS Statistics Software with paired saple t-test as the statistical test.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Actual_Data	91.71	7	2.690	1.017
	Simulation_Results	93.00	7	5.228	1.976

Figure 7. Paired samples statistics

The figure above shows the Paired sample statistics of both actual and simulated data of Wonder Wings restaurant with 7 days records each. Actual data has a mean of 91.71 and standard deviation of 2.690 and standard error mean of 1.017. While the simulated data has a 93.00 mean with standard deviation of 5.228 and standard error mean of 1.976.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Actual_Data & Simulation_Results	7	.664	.104

Figure 8. Paired samples correlations

Figure 8 shows the paired samples correlations of comparing actual data and simulation results which is .664 and a significance of .104. This means that the data are significantly positively correlated.

Figure 9. Paired samples test

Figure 9 shows the paired samples test of the actual data and simulation results which are the differences of their mean, standard deviation, and standard error mean. It also shows the lower and upper confidence interval of the difference. The test statistic (denoted t) for the paired T test is -.853 and the degrees of freedom for this test is 6. Lastly, The p-value corresponding to the given test statistic t with degrees of freedom df is .426.

III. CONCLUSION

Developing a simulation model is a great advantage in any business systems to have an efficient and organized flow of service. It also helps them decide on what to improve on their current system. In this study, the researchers created a discrete-event simulation model of Wonder Wings restaurant. Based from the result of 7-day simulation, the mean is exactly 93 compared to the actual data which has a mean of 91.71. This means that the system proposed in this study caters more customers in simulating a week of restaurant's operation.

IV. RECOMMENDATION

The researchers recommend a user-friendly system that analyzes the data into more understandable manner for business' everyday use. They also suggest using different simulation tool for another reference.

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