Milk Tea Shop Simulation Model

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Abstract

Begun in 1940s, the birth of Milk Tea has been traced back in Taiwan. The creation of this Milk Tea has become a revolutionary invention during Post-war Taiwan, the idea of consuming food and beverage at the same time started the Bubble Tea Phenomenon globally. With the growing industry, Milk Tea shop owners grew exponentially introducing competition and realizing the need to have an edge to stand-out. By employing Excel spreadsheets which are frequently used for a range of modeling activities and offer an interface that is familiar to most users. This study introduces a discrete-event simulation system that uses a spreadsheet as an input/output device. The system can introduce the discrete simulation's underlying concepts to the entrepreneurs in a business context. When Milk Tea Shop owners have a firm understanding of these ideas, they are better prepared to build models utilizing specialized simulation tools that employ Monte Carlo Simulation, Normal Distribution, T-test etc. that will help improve and optimize their efficiency and profitability. The system might introduce the technique to a new group of end users in a different industry setting. To demonstrate how the system can be applied in an entrepreneurial environment, a case study of a Milk Tea Shop system is shown.

Keywords: Monte Carlo, Discrete Simulation, Milk Tea Shop, Normal Distribution, T-test, Excel Spreadsheets

I. INTRODUCTION

With the growing popularity of Milk Tea in the Philippines the country came second among Southeast Asia's countries with the most bubble tea consumers in 2019. In a month, Filipinos consume an average of five cups of milk tea. Milk tea is consumed 3 to 5 times per week by an average teen and young adult. [1]

In these times, in proportion with the growth of the Milk Tea Shops' popularity is the emergence of new brands like CoCo, Cha Time, Macao Imperial, Dakasi, and many more. [2] Considering the number of different known brands, a newly created shop will have a hard time managing their sales. To provide a solution to maximize efficiency and optimize the process flow of a milk tea shop using a discrete simulation to simulate the process of the activities undergoing in the shop and considering factors that may cause delays.

The study is organized as follows. Section II discusses methods for simulation. Section III contains the results of simulation runs. Section IV contains the discussion and conclusion of the paper.

II. METHODS

A. Excel

Computer spreadsheets are widely used for a variety of modelling tasks and provide an interface that is well understood by most users. There is evidence that organizations are not using simulation to its full potential as a tool for decision-making. According to the survey, institutions need to teach their students in simulation methods more frequently. Simulation is seen as a tool for "experts" in the industry, and end users rarely use it. Spreadsheets are a popular tool that both students and end users can use. In this study, a discrete-event simulation system on this platform is described. Using a spreadsheet to conduct discrete-event simulation has two benefits. By using Excel spreadsheets for a discrete-event simulation, time is advanced in discrete pieces from event to event, omitting any lag time. Consequently, the simulation must keep track of when future events will take place and trigger them in the proper order.

B. Discrete Simulation

Discrete event simulation (DES) is a method used to model real world systems that can be decomposed into a set of logically separate processes that autonomously progress through time. Each event occurs on a specific process and is assigned a logical time (a timestamp). The result of this event can be an outcome passed to one or more other processes. The content of the outcome may result in the generation of new events to be processed at some specified future logical time. The underlying statistical paradigm that supports DES is based on queuing theory. The approach has been used historically to evaluate telephone scheduling of and more recently computer network job allocation. A useful queuing model both (a)

represents a real-life system with sufficient accuracy and (b) is analytically tractable.

C. Normal Distribution

The normal distribution, also known as the Gaussian distribution, is a type of probability distribution that is symmetric around the mean. This means that it demonstrates that data that are closer to the mean are more likely to occur than data that are further away from the mean. When represented graphically, the normal distribution takes the form of a bell curve. [3]We used Normal Distribution to find the probability of observations in a distribution falling above or below a given value. We also used it to find the probability that a sample mean significantly differs from a known population mean.

D. Uniform Distribution

The term "uniform distribution" refers to a certain kind of probability distribution in which the odds of each possible result are the same. The probability of drawing a heart, club, diamond, or spade from a standard deck of playing cards is the same. As a result, the distributions within a standard deck of cards are uniform. When you flip a coin, you have the same chance of getting heads as you have of getting tails. This means that a coin also has a distribution that is uniform. [4] It was used in the Dine in and out situations because the situations are identical.

E. Monte Carlo

Monte Carlo simulations are used to represent the likelihood of various outcomes in a process that cannot be easily anticipated owing to the intervention of random variables. These simulations are used to model the probability of different outcomes in a process. It is a method that is used to understand the influence that risk and uncertainty have on the models that are used for prediction and forecasting. [5] It was used to determine and estimate the possible outcomes of the Milk Tea Shop Simulation and to show that there is no significant difference between the data gathered from the real world and simulation.

III. FLOWCHART

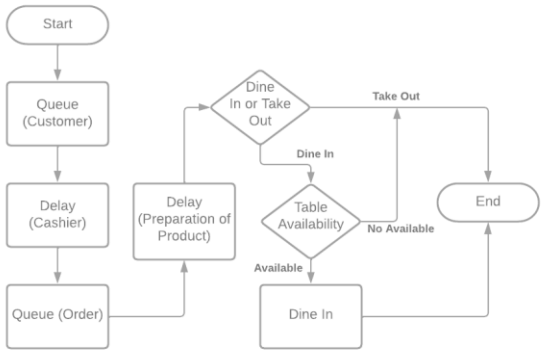

Figure 1. Process Flowchart

IV. RESULTS

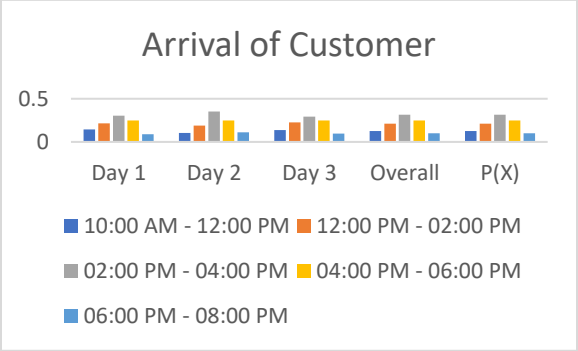

Fig.1: Probability of customer at given range of time

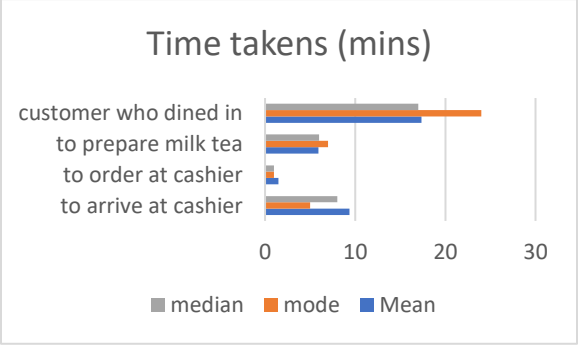

Fig.2: Time Taken

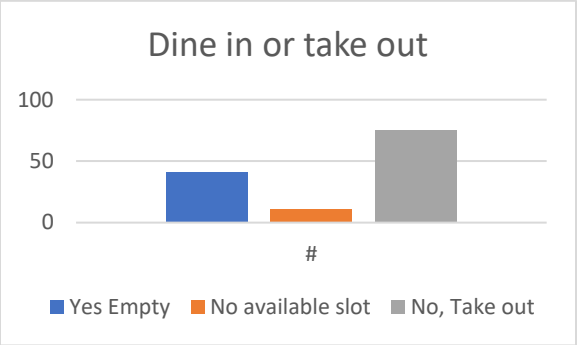

Fig.3.: Number of Customer Dine In/Take out

Unpaired *t* test results

P value and statistical significance:
The two-tailed P value equals 0.9262
By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:
The mean of Simulation Data minus Historical Data equals -0.0200
95% confidence interval of this difference: From -0.4442 to 0.4042

Intermediate values used in calculations:
t = 0.0926
df = 1552
standard error of difference = 0.216

Review your data:

Group	Simulation Data	Historical Data
Mean	1.9100	1.9300
SD	4.1400	1.0300
SEM	0.1206	0.0532
N	1179	375

Fig.4: Customer Arrival at Cashier

Unpaired *t* test results

P value and statistical significance:
The two-tailed P value equals 0.5041
By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:
The mean of Simulation Data minus Historical Data equals 0.0200
95% confidence interval of this difference: From -0.0388 to 0.0788

Intermediate values used in calculations:
t = 0.6682
df = 1552
standard error of difference = 0.030

Review your data:

Group	Simulation Data	Historical Data
Mean	1.5100	1.4900
SD	0.5000	0.5200
SEM	0.0146	0.0269
N	1179	375

Fig.5: Duration of customer ordering at cashier (mins)

Unpaired *t* test results

P value and statistical significance:
The two-tailed P value equals 0.8110
By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:
The mean of Simulation Data minus Historical Data equals 0.0200
95% confidence interval of this difference: From -0.1443 to 0.1843

Intermediate values used in calculations:
t = 0.2392
df = 1552
standard error of difference = 0.084

Review your data:

Group	Simulation Data	Historical Data
Mean	5.9800	5.9600
SD	1.4200	1.3800
SEM	0.0414	0.0713
N	1179	375

Fig.6: Milk Tea Preparation (mins)

Unpaired *t* test results

P value and statistical significance:
The two-tailed P value equals 0.4445
By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:
The mean of Simulation Data minus Historical Data equals -0.7400
95% confidence interval of this difference: From -2.6407 to 1.1607

Intermediate values used in calculations:
t = 0.7655
df = 385
standard error of difference = 0.967

Review your data:

Group	Simulation Data	Historical Data
Mean	16.8600	17.6000
SD	8.8800	9.6100
SEM	0.5662	0.8093
N	246	141

Fig.7: Customer Dine-In Duration (mins)

The simulation results of the Milk Tea shop simulation are displayed on the *Fig.1-3.* The validation results are present on the Fig.4-7. The statistical figures are then calculated on the spreadsheet automatically and the graphs updated simultaneously. In *Fig.1-3*, The mean, the STD, and the variance for each recorded variable are displayed using the bar graph type. A helpful indicator of the results' variability is the length of each graph tick. The findings are summarized below*:*

The overall variables are Customer Arrival at Cashier (mins), Duration of customer ordering at cashier (mins), Preparing milk tea (mins), Duration of how long customer dined in respectively.

The mean overall findings are 8.60, 1.49, 5.96, 17.60. While the STD findings are 4.11, 0.52, 1.38, 9.61. Lastly, the Variance findings are 16.89, 0.27, 1.91, 92.39.

By using Monte Carlo, we've rerun the simulation to gather data in order to perform validation. We used T-test in order to compare the means of the results we've got, and the data gathered from the Monte

Carlo Simulation rerun, the T-test results showed that we have achieved a 95% confidence interval in each variable from Simulation data and Historical Data as shown from *Fig.4-7*.

V. DISCUSSION AND CONCLUSION

In this paper, we have successfully recreated a satisfactory simulation of a Milk Tea shop using Normal and Uniform Distribution validated by Monte Carlo and T-test to ensure the mirroring of the simulation to the real-life data of the gathered information. This was accomplished by using Normal and Uniform Distribution to generate the data for the simulation, while also using Monte Carlo and T-test to determine whether the simulation was satisfactory. We constructed the simulation using the help of Excel and its legacy tools, and we used a T-test calculator to compute the results of the T-test. Based on the data that was collected, the simulation was successful. It was able to recreate the atmosphere of a milk tea store, which allowed for a good assessment of an ongoing company and allowed for a proper tally or assessment of what the sales statistics would look like. Even if there is an issue with queuing since it does not check any seats that are filled, we determined that it was not essential because it does not add to the sales as we were checking the dine in and out of a milk tea store. Consequently, we did not consider it necessary. We think that we have developed a simulation that, with the assistance of subsequent researchers, may be improved, adapted, and utilized in a variety of different ways over the course of time.

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