Comparing the Queueing System of Max's Restaurant with Full Capacity and the Half Capacity: a Model-based Evaluation

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Abstract

Because of the ongoing pandemic, some restaurants are restricted to having limited customers. There are times that they can only accommodate the 50% of the actual capacity of the restaurant which is a huge loss of profit. This study will simulate using Arena Simulation and compare both limited capacity with the full capacity of Max's restaurant and to determine the similarities of the rate of the customers.

Keywords: Restaurant Queueing System, Modeling and Simulation, Arena Simulation, Discrete Event Simulation

I. Introduction

The restaurant industry is one of the most profitable lines of business in the world, and it continues to thrive in the face of any global economic challenge [29]. There are several factors to run a successful restaurant business and one of the important keys to consider is queuing. Queuing is a major issue that can reduce the effectiveness of service delivery, particularly in restaurants. Waiting for service in the restaurant industry has become an everyday occurrence, causing needle delays and lowering effective service delivery. As a result, restaurant management will do everything in their power to avoid loss of customers due to the queue/long waiting line.

The primary goal of most restaurant industries is profit, which may not be achieved due to the continually waiting times of customers. Waiting costs consumers time and inconvenience. The time cost refers to the amount of time consumers spend on this exchange, while the hassle cost refers to the consumers' efforts as well as the negative emotions and perceptions they experience during this exchange [35]. Aside from monetary costs, the time and hassle costs should be considered. When the accumulated waiting time continues to raise the consumers' time costs and hassle costs, the perceived costs will outweigh the satisfaction or benefit, giving consumers more initiative to cancel [36].

Customer satisfaction is well-established in the service literature and is arguably the most significant factor in determining a restaurant's success [37]. Better revenue can be obtained through customer satisfaction, which will definitely aid the business in achieving more promising long-term profitability [32]. Service quality is one of the factors that lean towards customer satisfaction. Service delivery to customers begins with the process of entering the restaurant until leaving the restaurant which describes the customer's journey, which is generally outlined in a service blueprint[19]. Providing an emphasis on service quality and offering customers with exceptional quality service is the first step in convincing customers to use the service repeatedly. Thus, customers' satisfaction based on the improvement in service delivery is a major contributing factor which determines the success of any organization. A poor process design, on the other hand, will make it difficult for employees to carry out their roles and functions. As a result, the risk of service delivery failure increases. A service failure will have a negative impact on customer satisfaction and, as a result, the company's ability to gain profit will become lesser [7].

Food restaurant business is highly competitive and requires well-executed service and production facilities in order to effectively manage peak demand, as most sales occur during peak periods. Customers' satisfaction, which is the most important factor in achieving business objectives, is generally improved by providing high-quality service. In an effort to minimize customers' dissatisfaction with a service, the queue and waiting times experienced by customers must be given utmost importance by the restaurant management [25].

Queuing usually occurs in restaurants mostly at the time of lunch and dinner and is a major factor which plays a significant role in customers' belief about the quality of service delivery. Queuing has become one of the daily activities of human beings. To improve any system, it is necessary to study and understand its mode of operation and experiment its possible future problems as a means of providing solutions.

In order to test a system, it needs various methods and analysis in order to establish a well facilitated system, though some projects may cost a fortune, thus a digital representation would most likely be favorable to reduce costs, such is the work of a simulation. Simulation is the virtual representation of a real-world model in a computer using programming techniques in order to run the model virtually and gain an understanding of how it works as well as identify various problems present in the existing system and be able to modify them virtually without disrupting the actual system. Over the years, researchers have incorporated simulation studies into various real-world systems to demonstrate their functionality and determine if there is room for improvement. Because simulation can be performed on a variety of software packages, there are no operational costs and no downtime in the actual system [27]. Any system simulation begins with the creation of a model that represents the system's key characteristics and behavior. The modeled system can then be simulated by experimenting in order to provide a solution to the modeled system's impending problems. Simulation is essential for comprehending various scenarios in modeled systems. It can also be used to examine the operation of a system, whether existing or proposed, which is typically done under various configurations of interest and proposed real-time periods.

Thus, in this paper, Arena Simulation will be the premise in building a model that is appropriate for queuing systems. The Arena Simulation has different modules for representing processes and objects [10], such as the "create module" for input creation. The "assign module" is also helpful for parameter definition and the "process module" for specific input aggregation. The "station module" highlights parameter flow, while the "route module" is used for sequencing. The "decision module" to specify desired model conditions, as well as the "resources module" to display simulation outcomes, and finally the "dispose module" to release simulation resources.

Research Problem

In this study, the researchers opt to identify the closeness of generation of values between the actual and simulated values of 100% indoor capacity and 50% capacity. As well to identify the difference between the two groups if the Max's restaurant is having an appropriate number of customers during 50% capacity.

The following will be the structure of the paper as follows: Section II comprises the review of related works of authors in understanding queuing systems and its crucial constituents such as factors, models, and distributions; Section III will be discussing processes of building a model; The implementation of the model and simulation will be thoroughly discussed in Section IV; lastly, Section V includes the results and recommendations for future research.

II. REVIEW OF RELATED LITERATURE AND STUDIES

This section presents various related literature and studies that are important to further understand queuing systems.

Dining Restaurant in the Philippines

In the food service industry, customers are not criticizing the quality of the product but also the excellence of food service to the customers. Therefore, the importance of having a dining service experience was strongly considered by consumers in terms of intellectual and motivational attributes [35]. When the Coronavirus becomes a pandemic in the Philippines, the sales rate decreases because there are no operations in any establishment. Certain restaurants began to operate while still recovering from the loss and debts caused by the lockdown [31].

The continuous growth of the number of people who support the food industry and efficiently serving customers is a major challenge. Waiting lines in quick service restaurants are expected to enhance manpower planning, facility expansion, review of service time and reduce customer waiting time in their order and increase the customers satisfaction. Customers nowadays demand not only the quality of food but also promptness in services. One of the important factors of being efficient and having good quality services in the restaurants was to deliver the orders to the customers instantly. Therefore, customers do not stand in the waiting line for a long period of time just to claim their order unless it is really more important than to spend time waiting [29].

There are several parameters that determine a good restaurant. Quality of the food, cleanliness, and floor layout are just some. Another parameter that is important most especially when the restaurant is gaining popularity and has many customers is customer's waiting time. This is very crucial as some customers are very impatient [37].

In order to accommodate customers, there are few things that can be done like rearranging the floor layout, price increase, and spatial expansion. But there are also some that are not controlled like the customer's patience and its ability to wait. Customer's patience can also reflect on how in-demand the restaurant is. Having a line outside of the restaurant is an indication that the food and service is promising. Thus, managers must make some changes in order to accommodate the customers without leading them to dissatisfaction [17].

Providing solutions to long queues is always a hassle and is usually accompanied with quite expensive investments that sometimes do not even have a big impact on longer terms [17].

The waiting time of each individual customer varies and is always subjective and based on personal experiences [20].

Customer's waiting time is divided into three categories: satisfactory, unsatisfactory, and very unsatisfactory. On average, the satisfactory waiting time of the customers is

8.67 minutes, 13.23 minutes for the unsatisfactory, and 17.77 minutes and more for very unsatisfactory waiting time [17].

Not only the customer's patience is needed to take into account, but also their time limitations. For example, during lunchtime where it is peak hour, customers may only have a few minutes to line up. Although there are some that are willing to wait, they just cannot afford to wait longer since they have limited time for lunch [17].

Poisson Distribution will also be used in this simulation as it has a “memoryless” waiting time process. The next customer will not depend on the past customer, meaning the current customer can come after 10 minutes and the next one can come after a 10 seconds interval [19].

Data Distribution

Data distribution shows that all possible values of the data is a function or a list. It is also important how each value occurs. The data distribution will be arranged accordingly from smallest to largest, graphs and charts presents the value easily and the frequency appears [25]. Distributions is a scattering of data that can be considered in any population. It is important to analyze the statistical methods to determine the type of distribution in the population [13].

The advantages of distribution data in a sample space is to estimate the probability in a certain observation. Probability distribution in text or experiment is a method that calculates the probability that the possible different outcomes occur. It is used to define the types of random variables that depend on the decision of these models. Random variables use mode, mean, probability, range and other types of statistical methods [13].

Both are probability distributions, the Poisson distribution represents the frequency that something occurs during a specific time. It means when an event happens, it counts how many times it occurs [10]. The exponential distribution is a continuous distribution that is widely used when estimating the event of time to occur. For example, it is frequently used in physics to measure a radioactive decay, it is also used in engineering to measure the length of time of receiving a defective part on an assembly line, and it is also used in finance to measure a portfolio of financial assets [18].

Service time distribution

The major factors in contribution was to influence the success of the different organizations to increase the customer satisfaction to enhance the service delivery. Customer satisfaction was the major priority of the business organization to have a better business rate whether it is meant for the product or for a service [29]. One of the service patterns is the distribution of the independent service time of the inter arrival time that importantly can be consistent, exponential, hyper exponential, hypo exponential or general [27].The service time arrival is exponentially distributed and it consists of only two servers at the restaurant system. Therefore, the poisson and exponential distribution has data obtained that are tested to show if it fits [29].

Input analyzer

In this paper, input analyzer is used to determine the data analysis of the customer arrival patterns and the service patterns. It is a powerful and variable tool in the arena software environment because it is effective to use it to define the quality fit of the distribution function when inputting the data. Distribution function was to be used to fit the specific data file that allows users to compare whether it is distribution functions or display the effects of the changes in the parameters for the same distribution. Besides, it can generate the sets of the random data who determine using the software distribution fitting features. The input analyzer is used to examine the service time and the inter-arrival times of the customers entering the restaurant for five working days in order to determine the probability distribution of the acquired data. Users could easily enter collected raw data into the Input Analyzer and obtain the probability distribution that such data follows. In other words, it can be used to determine the probability distribution that best represents a data set [1].

Arrival distribution takes the place of the customer's arrival in your queuing system. Most queuing systems, at a given period of observation time, in Max's Restaurant the whole day is 12 hours and the customers commonly arrive randomly [30]. The arrival of one customer is independent from the arrival of the next customers [23]. During the 12 hours of observations and 10 replications of the simulation for the clear data, the researchers categorized the period of observation at 4 minutes up to 7 minutes randomly. Then set an observation line far behind the ordinary waiting line to count the number of customers arriving within the different period of observations.

Poisson distribution deals with the number of occurrences in a fixed period of time. Most common types of arrival distribution of customers in a queuing system are random and that follow Poisson Process or sometimes called Markovian[23]. The Poisson Distribution is a probability distribution that is used to show how many times an event is likely to occur over a specified period [31]. In Max’s Restaurant the researchers are aiming to simulate the queue of arrival of customers that is why the poisson distribution is used.

The inter arrival time is the time between each arrival into the system and the next. The arrival rate is calculated from the following equation: arrival rate = 1/inter arrival time [29]. The time difference between arrival of one customer and then the next customer is often mentioned as Interarrival time. It is a time elapse between the arrival of the object or person and one following it in the queue system. The concept is based on the values used in the queuing theory. Different models are used in queuing theory in order to determine the different views. It is calculated after the first customer and then average interarrival time is determined to get the mean which is represented by lambda [32].

In this simulation, the interarrival time during the 12 hours period of observations was illustrated by 10 minutes up to 20 minutes duration randomly. The exponential distribution deals with the time between occurrences of successive events as time flows by continuously and it is usually used to model the time until something happens in the process. The exponential and Poisson distributions arise frequently in the study of queuing, and of process quality [33].

In this paper, exponential distribution is used because the interarrival of queuing is exponentially distributed and it lacks memory property because it does not need to remember when the clock started [21]. The use of exponential distribution in the simulation is required to simulate the Max's Restaurant customer interarrival time for the good model.

Discrete Event Simulation (DES) is widely used in the service industry as well as in manufacturing (batch and process). The system corresponds to a set of entities being processed and expanding over time based on available resources and phenomena under study via an ordered queue of events [28].

In this paper, the researchers will apply simulation methods to help them visualize and understand the situation in order to reduce the waiting time of a particular queuing scenario, thus a simulation model will be the projected output to discern and solve the existing problem. A simulation's ability to address stochastic systems and the ability to deal with uncertainty is frequently regarded as the best choice for tackling these types of problems. Furthermore, simulation can be used to test alternative scenarios that would incur significant cost cuts if tested and proven effective [33].

Arena Simulation is one among the global market leaders in discrete event simulation (DES) software. Arena simulation is a software that can be used which specializes in simulation such as discrete-event simulation that can visualize real-world systems by using this kind of computer simulation application [23]. It is a graphical interface that employs the SIMAN programming language. SIMAN is a low-level simulation language that provides the fundamental elements for DES, such as event list management, random number generation, and data collection for statistical purposes [28]. The elements present in Arena Simulation are basic language structures which are important to build up a simulation model, these are entities, resources, queues, variables, and attributes [28].

The following are the basic definitions of the elements to be found in a simulation process. Entities in simulation are objects that are processed through systems such as products, customers, and documents. Entities can have unique characteristics such as cost, size, priority, quality or condition which can be grouped as a uniquely identified cluster. Resources on the other hand, is an object or piece of equipment used in the course of an activity. To complete a job, resources provide support facilities, equipment, and labor. Furthermore, an attribute is the properties or characteristics defined to identify an entity. Moreover, Activities can be defined as processes or tasks carried out by entities in a system over a specific time period. Additionally, an event in simulation is an instantaneous activity that can change the system's status (variable state). Endogenous events are activities or events that occur within the system, such as the completion of a customer service. Exogenous events are activities or events that occur outside of the system (environment) and have an impact on the system, such as a customer entering the bank. Lastly, a queue or delay is the duration of an activity or event that has an uncertain indeterminate period that is unknown until the activity or event of an entity is over [23].

Based on the previously discussed research, it can be concluded that simulation modeling can be used to solve problems in a queuing system and produce good results. The simulation modeling of a queuing system using Arena has been used to provide a clear picture of the actual real-life scenario of restaurant operations and to improve their services. The use of simulation models in Arena allows restaurants to be modeled based on their current scenarios, and users can then modify their restaurant based on trial and error to remove bottlenecks, increase the number of service counters, improve layout design, and other factors to improve the performance of their restaurants' services [36].

III. METHODOLOGY

This section will further discuss the methods that are crucial to create an appropriate DES model based on the data that will be collected. Moreover, to achieve the research objectives, modeling and simulation of services is required to evaluate the current system. The data collected will be later analyzed using the tool present in the Arena simulation to define the data distribution type for data inputs in the simulation model.

Data collection

The researchers conducted a face-to-face survey in consultation with the area manager of Max's Restaurant for data collection to be used to determine the data distribution prior in developing the model. The Data collected was from a given day in November 2021 and May 2022. The restaurant's opening time starts from 9:00 a.m and will close after 9:00 p.m. Input Analyzer took place from Arena to determine the proper data distribution for the given data of Max's restaurant. Furthermore, some assumptions were defined in order to focus on the specific processes only to be made from the model.

Data Distribution

The data collected from the Max's Restaurant will be used for analysis, but in order to have a proper experimentation towards the study, a degree of randomness must be applied. In Arena Simulation, there are multiple tools that can be used based on their respective functions, and one of them is Input Analyzer which are focused mainly on identifying the distribution inputted from it.

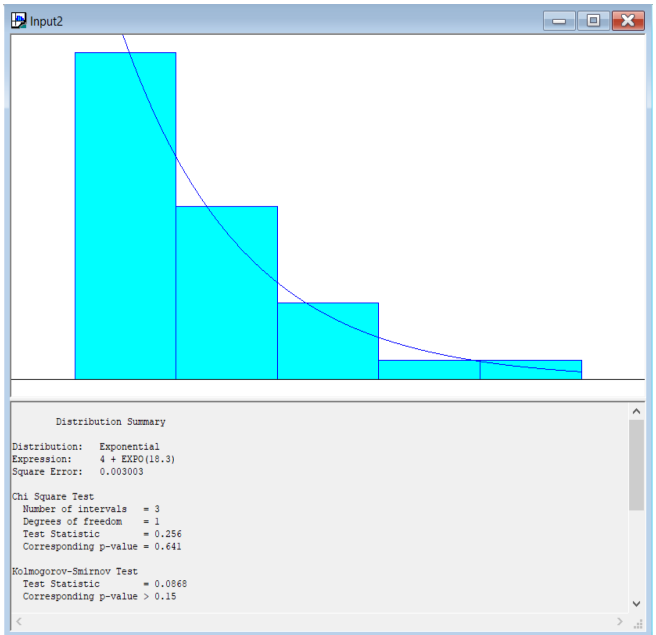

Fig. 1. Exponential Distribution for Interarrival time of Customers

Figure 1 shows the histogram of the exponential distribution that is based on the collected interarrival time of customers. It resulted with a Square Error of 0.003003 and corresponding p-value of 0.641 which is acceptable as it is greater than 0.1 [37] and the Kolmogorov-Smirnov (K-S) test has shown a corresponding p-value greater than 0.15 (p-value > 0.15) which implies a good fit since the lower the K-S, the better the fit [26]. Therefore, the researchers concluded that the interarrival time will be implementing the exponential distribution with the expression for the given data.

Assumptions and Limitations

It is not always possible to include all of the potential outcomes that could occur in reality when conducting a simulation study. As a result, the following assumptions were considered during this system analysis:

- There is no customer in the system at the start of a working day.
- Some Customers may not enter the restaurant, thus excluding statistical results when the customers decided to just check and leave.
- When entering the restaurant, the customers may either go and occupy the available seat or wait for a table in the waiting area.
- There are 12 available tables, wherein each table can occupy 4 pax. One person is a representative of a group of 4 people as visualization.
- The Customers will go to the waiting area if all tables are occupied.
- When customers are queued in the waiting area, they may either wait an average of 5 to 25 minutes for table occupancy or leave the system.
- When customers have occupied the table, they cannot exit to the system until they are serviced and payed for food
- The queue to order is First In First Out (FIFO).
- Service times are inconsistent and range between 10 to 15 minutes due to the kitchen's order fulfillment and food preparation policies.
- Customers do not leave at the same time after eating. It may take an average of 45 minutes to 75 minutes for a customer to finish eating and pay for its order.
- After the customer paid for the order, the customer may either go for takeout or leave the system.

Model Development

This section will further discuss the key methods in developing a Discrete Event Simulation model for Max's restaurant using Arena simulation which are based on the data collected from a survey. As shown in Figure 1 at the beginning of the queuing simulation, customers are going around to the restaurants to order and eat foods. Some of the customers are looking at the menu for the food that they want to order. The waiter will assist the customer at their designated seats to give the menu and take their orders. However, if the customer does not want the menu they will leave the restaurant. On the other hand, if all twelve seats are occupied the customers will wait at the waiting area until one occupied seat will finish and the customers will have an option to take out an order or to leave.

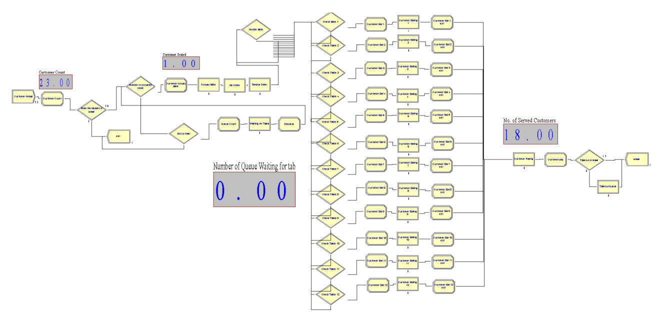

Fig. 2. Arena Simulation Model of Max's Restaurant

Full Capacity	
inter-arrival(minutes)	Customers per arrival
6.96	1
29.51	1
20.63	1
6.18	1
40.56	2
7.37	1
7.72	1
16.30	1
7.30	1
8.96	1
39.20	1
79.05	1
20.31	1
64.78	1
15.29	1
21.32	1

Fig. 3. Inter-arrival and entities per arrival Raw data

We used the raw data that we collected and processed it on an input analyzer to examine the arrival time of the customers entering the Max's Restaurant for November 2021 and May 2022 and acquire the probability distribution that best represents the formula of the data set as shown below in Figure 4 and 5. The data represents the data to be used for generating the distribution for inter-arrival and entities per arrival shown in Figure 4 and 5.

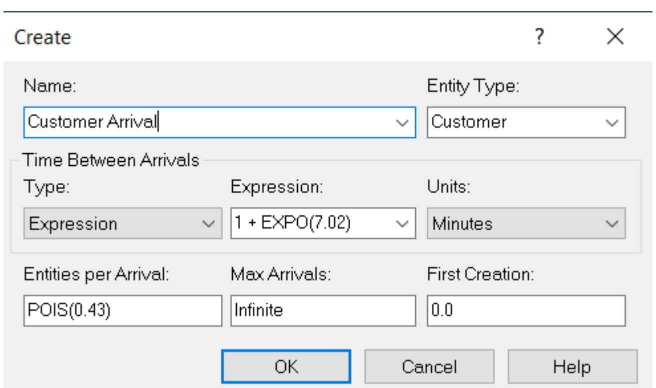

Fig. 4. Customer Arrival Before Pandemic

As shown in Figure 4, Customer's arrival during 100% indoor capacity includes the following properties: formula of expression has 1 + EXPO (7.02), poisson distribution formula of entities per arrival has POIS(0.43), and also set the max arrivals to infinite to see through the process of generating the number of customers per arrival.

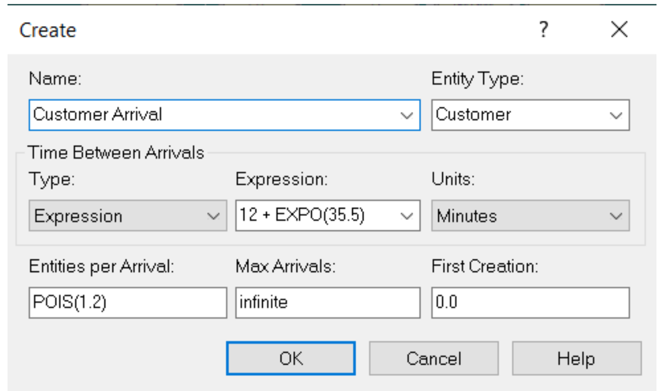

Fig. 5. Customer Arrival During Pandemic

As shown in Figure 5, Customer's arrival before During 50% indoor capacity includes the following properties: formula of expression has 1 + EXPO (14.8), poisson distribution formula of entities per arrival has POIS(0.43), and also set the max arrivals to infinite to see through the process of generating the number of customers per arrival.

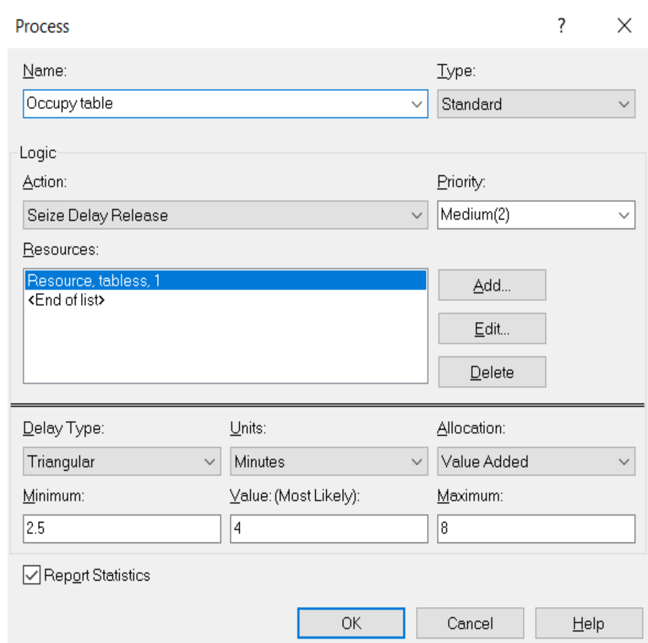

Fig. 6. Occupy Table

Occupy table includes the following properties: deciding on a table within 2.5 to 8 minutes, most likely the value of it is around 4 minutes, the action of occupy table properties is seize delay release, its delay type is triangular, and the resource is 1 table. The properties of the occupy table are shown on Figure 6.

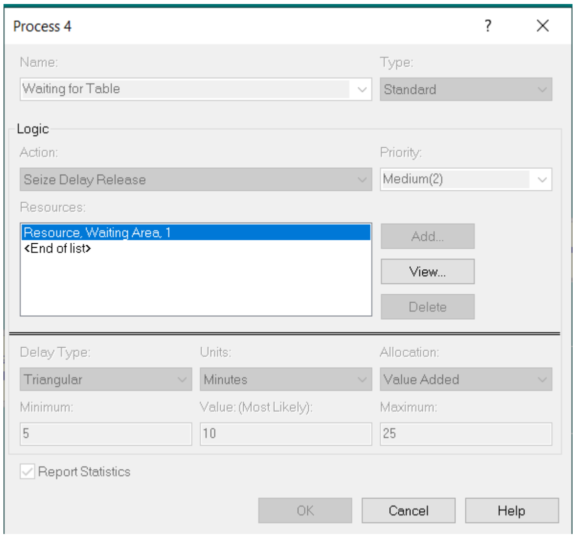

Fig. 7. Waiting Table

Waiting table includes the following properties: number of waiting time in minutes that is around 5 to 25 minutes, most likely the value of it is 10 minutes to wait until the seats are vacant, the action of waiting table properties is seize delay release, its delay type is triangular, and the resource is 1 waiting area. The properties of the waiting table are shown on Figure 7.

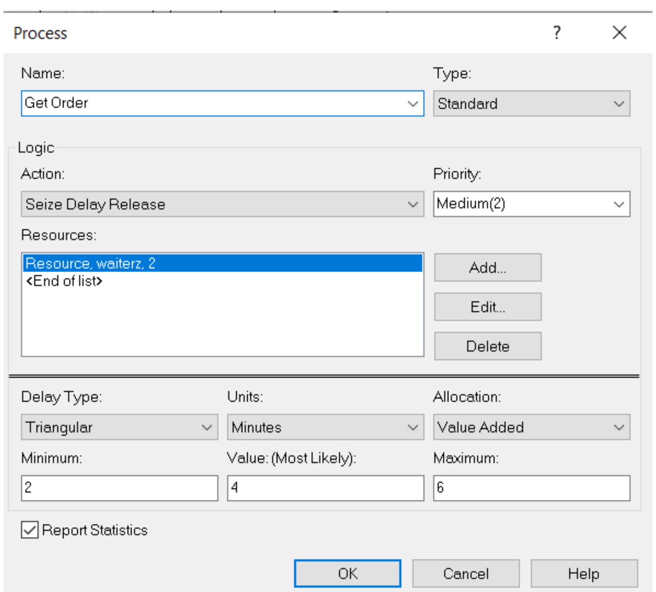

Fig. 8. Get Order

Get order includes the following properties: number of getting the order by the waiters in minutes that is around 2 to 6 minutes, most likely the value of it is 4 minutes to get the order, the action of get order properties is seize delay release, its delay type is triangular, and the resources are 2 waiters . The properties of the get order are shown on Figure 8.

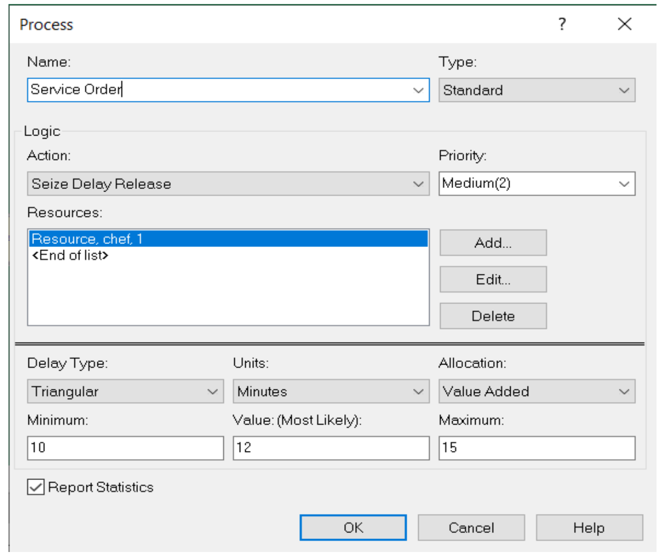

Fig. 9. Service Order

Service Order includes the following properties: number of service time in minutes that is around 10 to 15 minutes, most likely the value of it is 12 minutes to prepare the food, the action of service order properties is seize delay release, its delay type is triangular, and the resource is 1 chef. The properties of the get order are shown on Figure 9.

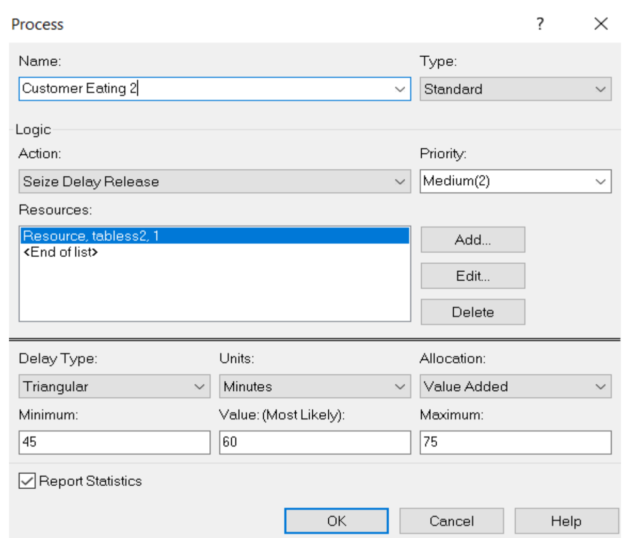

Fig. 10. Customer Eating

Customer eating includes the following properties: number of eating time in minutes that is around 45 to 75 minutes, most likely the value of it is 60 minutes to eat at the Max's Restaurant, the action of customer eating properties is seize delay release, its delay type is triangular, and the resource is 1 table. The properties of the customer eating are shown on Figure 10.

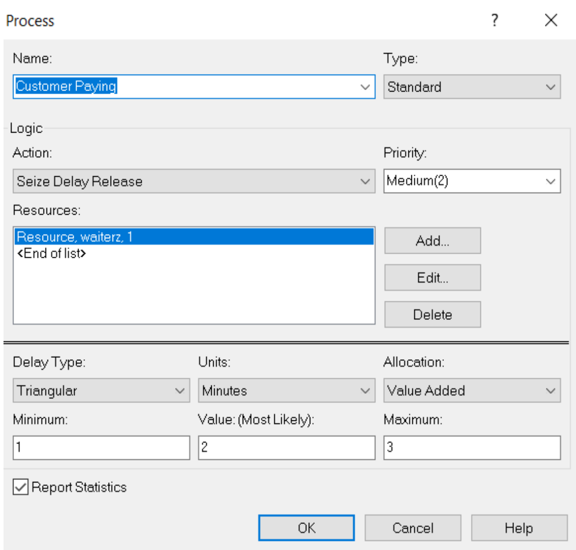

Fig. 11. Customer Paying

Customer paying includes the following properties: number of paying time in minutes that takes around 1 minutes to 3 minutes, most likely the value of it is 2 minutes to transact at the cashier Max's Restaurant, the action of customer paying properties is seize delay release, its delay type is triangular, and the resource is 1 chef.. The properties of the customer paying are shown on Figure 11.

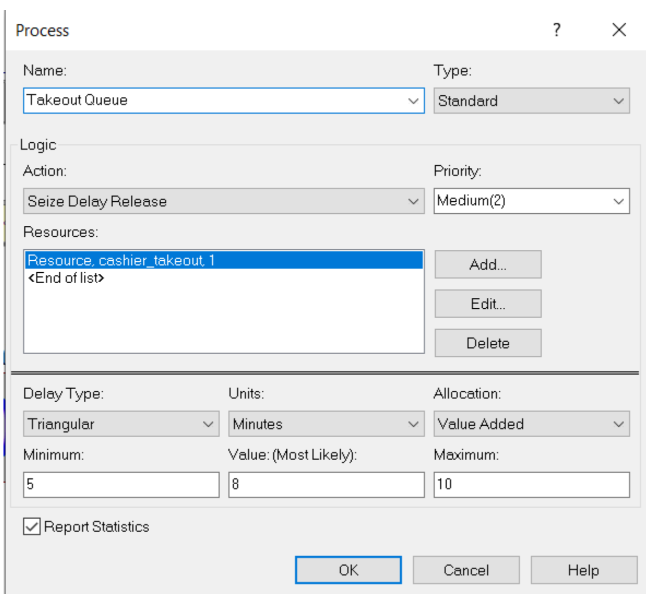

Fig. 12. Takeout

Takeout includes the following properties: number of takeout time in minutes that takes around 5 minutes to 10 minutes, most likely the value of it is 8 minutes to takeout a order at the Max's Restaurant, the action of customer paying properties is seize delay release, and its delay type is triangular, and the resource is 1 cashier.. The properties of the customer paying are shown on Figure 12.

Finally, the queueing simulation was modeled so that the customers' duration upon arriving and departure of Max's Restaurant can compare the queueing simulation of 100% and 50% Capacity during the pandemic.

IV. RESULTS AND DISCUSSION

This section presents the results and discussions about the simulation on queuing system using the data collected in Max's Restaurant using Arena simulation. After configuring the model's data input parameters, the researchers will simulate the model to verify and validate it. Once the validity of the model has been established, the researchers can conduct various experiments to observe the changes in the system and provide suggestions for improvement.

Verification and Validation

Before it can be used for analysis, the designed simulation model is verified and validated. Verification is used to ensure that the developed model accurately represents a real-world system. In contrast, validation is described as the procedure of attaining an acceptable level of confidence that the inferences drawn are relevant and applicable in the real-world system being expressed. To ensure that the developed simulation model is accurate and resembles the real-world system, model verification and validation must be performed [34]. Thus, the accuracy of the simulation output compared with the actual output is evaluated in this study. This simulation runs with 10 replications. As a result, the simulation result has an average of 32 groups of customers which in comparison for the actual output of 32 groups of customers. Moreover, there is 17 groups of customers and 15 simulated

$$Model\,Validation \;=\; \left|\frac{Simulation\ Output - Actual\ output}{Actual\ Output}\right| \times\ 100$$

TABLE I
Data of Group of Customers in Max's Restaurant and Simulated Number of Customer Group

	Actual	Simulated	Model Validation	Accuracy
100%	32	32	0%	100%
50%	17	15	11.76%	88.24%

As shown in table 1 and based on the Model validation formula [11], the output for the total average of number out has gained a result of 0% error for validation which in comparison gained an accuracy of 100% for the 100% indoor capacity model and on the other hand is validated with an error of 11.76% and accuracy reaching 88.24%. By this, it confirms that the model is valid as it has an acceptable range of ±10% [11] viable for further testing. Furthermore, to validate the models between the two groups which are Full capacity and half capacity, t-test formula will be used if there exists a significant difference between the models. The formula below will be used to further test the models presented.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{S_1^2}{n_1}\right) + \left(\frac{S_2^2}{n_2}\right)}}$$

	Full Capacity	Simulated
n	10	10
Mean	95.5	93.7
Variance	46.27777778	118.0111111
	DF	18
	Numerator	1.8
	Denominator	
	S_1^2/n_1	4.627777778
	S_2^2/n_2	11.80111111
	Sum	16.42888889
	Square Root	4.053256578
	t-statistic	0.444087357
	Critical Value	2.10092204
	Null Hypothesis	accept
	Conclusion	there is no significant difference

Fig. 13. T-test of Actual and Simulated Number Out under 100% capacity

Figure 13 shows the t-test to validate the closeness in the number of generations of customers in the restaurant. Since the t-statistic is lower than the critical value, the researchers conclude that there is no significant difference between actual and simulated number of customers, hence, the two models in the number of customers during 100% indoor capacity are close to each other.

	Half Capacity	Simulated
n	10	10
Mean	51.1	46.0
Variance	33.21111111	36
	DF	18
	Numerator	5.1
	Denominator	
	S_1^2/n_1	3.321111111
	S_2^2/n_2	3.6
	Sum	6.921111111
	Square Root	2.63080047
	t-statistic	1.938573472
	Critical Value	2.10092204
	Null Hypothesis	accept
	Conclusion	there is no significant difference

Fig. 14. T-test of Actual and Simulated Number Out under 50% capacity

Figure 14 shows the t-test to validate the closeness in the number of generations of customers in the restaurant. Since the t-statistic is lower than the critical value, the researchers conclude that there is no significant difference between actual and simulated number of groups of customers, hence, the two models in the number of customers during 50% indoor capacity are close to each other.

Experimental Design and Analysis of Results

The simulation was set to compare the situation of the queueing in Max's Restaurant with a full capacity during the pre-pandemic period and half-capacity that happens when the COVID alert level rises. The simulation is also done with 10 replications for more accurate readings.

Each simulation is set on May 29, 2022 from 9:00 am to 9:00 pm. The full-capacity simulation has 12 tables with a maximum of 4 persons each, 2 waiters, and 1 cashier. While the 50% capacity will include 6 tables, 2 waiters, and 1 cashier.

There are seven variables that are considered in the simulation: Waiting for Table, Occupy Table, Get Order, Service Order, Eating Time, Paying, and ordering Take Out if they wish.

The First Simulation (full capacity)

There are 94 customers on average for the first simulation who went inside the restaurant. 5 customers got bored or had no space in the waiting area and left without eating in the restaurant. The average number of groups served is 32 groups.

The average waiting time of the customers for a table is 1 minute. While the customers spent 1 minutes and 42 seconds occupying their tables and preparing before they got their orders taken.

While getting their orders takes around 30 seconds and 11 minutes 7 seconds for their dish to be served.

The customers' eating time on average is around 1 hour and 27 minutes, 26 seconds in waiting in line to pay and 23 seconds when taking out.

On average, a single group of customers spent 1 hour 41 minutes inside the restaurant and 14 minutes waiting in all the queues.

The Second Simulation (half capacity)

For the sake of the experiment, the tables on the second simulation will be cut into half, wherein reality, the 6 tables will remain but the limit of people each table will lessen with a maximum of 2 persons.

For the second run, there were 47 customers who went inside the restaurant and 1 of them left. 15 groups are served that day.

Due to the small number of customers, the customers did not wait for a table. While the customers spent 59 seconds occupying their tables and preparing before they got their orders taken.

While getting their orders takes around 22 seconds for their dish to be served.

The customers have an average eating time of 1 hour 27 minutes and a waiting time of 8 seconds in the line to pay.

On average, a single group of customers spent 1 hour 30 minutes inside the restaurant and 3 minutes and 44 seconds waiting in each queue.

V. CONCLUSION

To find out whether there is a huge impact on the rate of the customers in accordance with the restrictions, and if opening a restaurant with just half the usual capacity is worth it, the results are compared.

There are 32 groups served on the first simulation based on 100% indoor capacity which resulted in a total average of customers that has been served to 94 persons. On the other hand, the average number of served customers in the second simulation based on 50% capacity has resulted in 15 groups that have an average number of people of 46.

$$\text{Difference} = 1 - \left|\frac{94-46}{94}\right| \times 100$$

Difference = 48.94%

There is a difference of 48.94% of the total customers served from the full capacity simulation to the half-capacity which shows a significant difference between the number of customers serviced from Max's Restaurant during the implementation of 50% capacity compared to the service output before from the usual full capacity.

	100% Capacity	50% Capacity
n	10	10
Mean	94	46
Variance	118.0111111	36
	DF	18
	Numerator	47.7
	Denominator	
	S_1^2/n_1	11.80111111
	S_2^2/n_2	3.6
	Sum	15.40111111
	Square Root	3.92442494
	t-statistic	12.15464704
	Critical Value	2.10092204
	Null Hypothesis	reject
	Conclusion	there is a significant difference

Fig. 15. T-test between 100% capacity and 50% capacity of number of people serviced

Figure 15 shows the t-test to identify the difference between the number of people during 100% capacity and 50% capacity. Since the t-statistic is higher than the critical value, the researchers conclude that there is a significant difference between the number of customers in 100% and 50% capacity, hence, the number of customers during 50% indoor capacity have a relatively lower number of customers compared to 100% indoor capacity, which can be implied that they have majorly been impacted on the number of customers serviced during 50% indoor capacity.

With all the results, the final recommendation of this study if ever that the 50% capacity restriction will be implemented once again is to wait for the situation to subside since there is a huge significance in the number of customers in both situations. Considering that the management needs to pay for the staff, buy ingredients, and pay for utilities, with all of these sums up, it might not be able to compete with the low numbers of customers.

On the other hand, the waiting time of the customers when the restriction is implemented is almost half of the waiting time when the restriction is lifted. The customers wait a little more during the full capacity considering there are more customers arriving.

Acknowledgment

The researchers thank God for pushing them to the limits and helping them advance through the hardships. His daily guidance helped them through the hardest of trials and problems they have come across. Without him, everything would not have been possible. May they be blessed by his presence for more trials in the future.

The researchers would also like to thank our supervisor, Sir. Jan Eilbert Lee for his guidance, patience, and support. Without his guidance, the researchers would not be able to complete and comply with the papers and programs used to create the target output for research.

Finally, the researchers are also thankful to their parents for providing the technology, time, budget, and support throughout the semester while working on our research. The researchers would also like to thank their classmates for giving the moral and academic support needed to complete this paper. Without them, the tasks at hand would not have been possible in the slightest.

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