

## Queuing at Theme Park Using Arena Simulation Software

Noor Syahidah Azim Mohd Zainurin<sup>1</sup>, Muhamad Ghazali Kamardan<sup>1\*</sup>

<sup>1</sup>Department of Mathematics and Statistics, Faculty of Applied Sciences and Technology,  
Universiti Tun Hussein Onn Malaysia, Pagoh, Johor, MALAYSIA

\*Corresponding Author Designation

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**Abstract:** Waiting in lines generally are everywhere and become a norm in one's daily lives. This can be occurring anywhere such as at cinema, food court, healthcare where people usually queue for their turns to be served [8]. Besides, it also occurs at the theme park where visitors need to queue for the ride. Lines are typically the worst annoyance concerning the weather on that time which makes the waiting time is feeling like they waited longer than they actually did [1]. The purpose of this study is to simulate queuing situation and to analyze the queuing and facilities performance at the theme park using the simulation result. In this research, three variables will be analyzed such as average number waiting, average waiting time, and Instantaneous Utilization against the maximum arrivals of the visitors. The results from a simulation tool Arena shows a Roller Coaster (RC) have a very long queue due to the average number waiting = 22.86 and long waiting time of visitor = 197.09 minutes, meanwhile the number waiting for Bumper Car (BC) is 0.015 which is likely none and waiting time also short = 0.6 minutes.

**Keywords:** Arena Simulation Software, Theme Park Queuing Problem, Queuing

### 1. Introduction

Queuing system is defined as the mathematical study of congestion and delays of waiting in line. There are several components in queuing theory which is arrival, service, number of servers, number of system places, and the number of customers [9]. Queues happen when services and resources are limited or overcapacity. In this research, it is mainly focused on the queuing happen at the theme park.

Theme parks consist of massive entertainment facilities which have been well known in terms of their complicated designed facilities, interesting, demonstrated culture and enjoyable atmosphere, including thrill rides, interesting shows, arcade games and food [2]. Many people have been to theme park for its interesting and enjoyable facilities. The main purpose of the theme park is to provide the best service and best experience for the visitors who came. However, a long waiting line for a ride will

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\*Corresponding author: [mghazali@uthm.edu.my](mailto:mghazali@uthm.edu.my)

eventually affect their satisfaction and experience throughout the trip. A long waiting time and a long line of number of people waiting are considered the problem that may occur at the theme park. Hence, the visitor's satisfaction will not be achieved due to the waiting time spent on a queue line and the services provided [7].

Theme parks can be enjoyed by adults, teenagers, and children for their various kind of attractive rides. In a theme park, the visitors are on-site and flexible for the duration of their visit which they will certainly change their schedule and adapt in order to avoid queues [6]. Thus, this research aimed to simulate the queuing situation at the theme park using Arena software and analyze the queuing at the theme park using the simulation result [5]. With the use of the simulation application, a real-life situation is designed to illustrate the queuing line at the theme park. Besides, to whether solved analytically and provide the analyst for designing and evaluating the performance of queuing systems [3], also to imitate the real-life situation and observe the process of the queuing at theme park [4]. Arena software improved the visibility into the effect of a system or process change, it provided toolbar and menu access for common simulation activities such as animating model, running the model and viewing the results. This research is conducted with the purpose of analyzing the waiting time of visitor, number of waiting visitor and the instantaneous utilization. The data will be artificial until the simulation result is provided.

## 2. Methodology

### 2.1 Create pop-up box

To run the simulation, the required information needs to be filled-in completely in the Create pop-up box and double-click the Create button in order to open the Create pop-up box as in Figure 1. There are several field that need to be filled in the pop-up box.

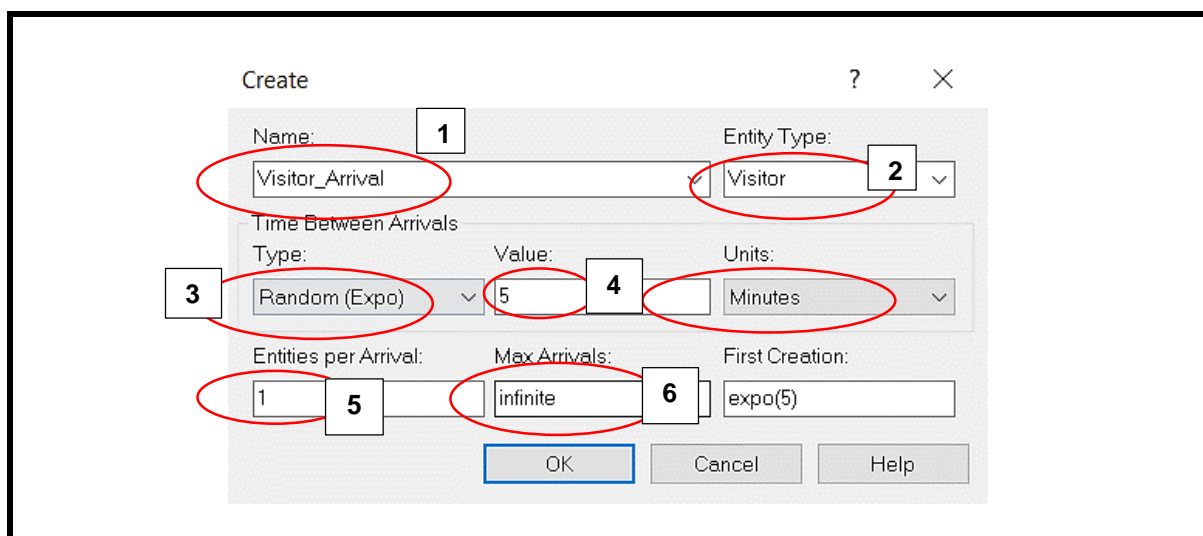


Figure 1: Create pop-up box

- 1) **Name field:**  
In this field, simply put any name to refer to visitor. For this research, it will be named as 'Visitor\_Arrival'. The entity must buy the ticket first at the ticket counter to be able to pass through the entrance.
- 2) **Entity type:**  
In this field, there are two options to select, 'Entity' and 'Visitor'. Entity is general arrival that enter the queue. Meanwhile, the second option appear since 'Visitor' will be stated in the entity field. If 'Visitor' is chosen, it means that the system only allowed the visitors to enter the queuing system. Hence, 'Visitor' will be selected in this field.

- 3) **Type field:**  
There are four type that can be choose between random (expo), schedule, constant and expression. In this field, we choose random (expo) as it will generate the arrivals of visitors in random arrivals according to Poisson Distribution.
- 4) **Value and Units field:**  
This field need us to field the time value to run the simulation. Then for units, there are three options such as hour, minute and second. In this study, we set random (expo) with the inter-arrival time between visitor is 5 minutes.
- 5) **Entities per Arrival field:**  
Entities per arrival specifies how many visitors that arrive at each arrival. In this research, entities per arrival will be set as 1 to make it easier while analysis the result.
- 6) **Max Arrivals field:**  
Max arrivals is the number of customers that will enter the system. We can set how many customers that we want to enter the system. In this research, the Max arrivals is infinite since there are no limitation for the visitor to enter from the opening of theme park until its closed, in this research we set the opening time at 9AM and close at 9PM.

## 2.2 Decide pop-up box

To model the situation that an arriving visitor may decide to ride a different theme park ride, a condition within Decide module need to be used.

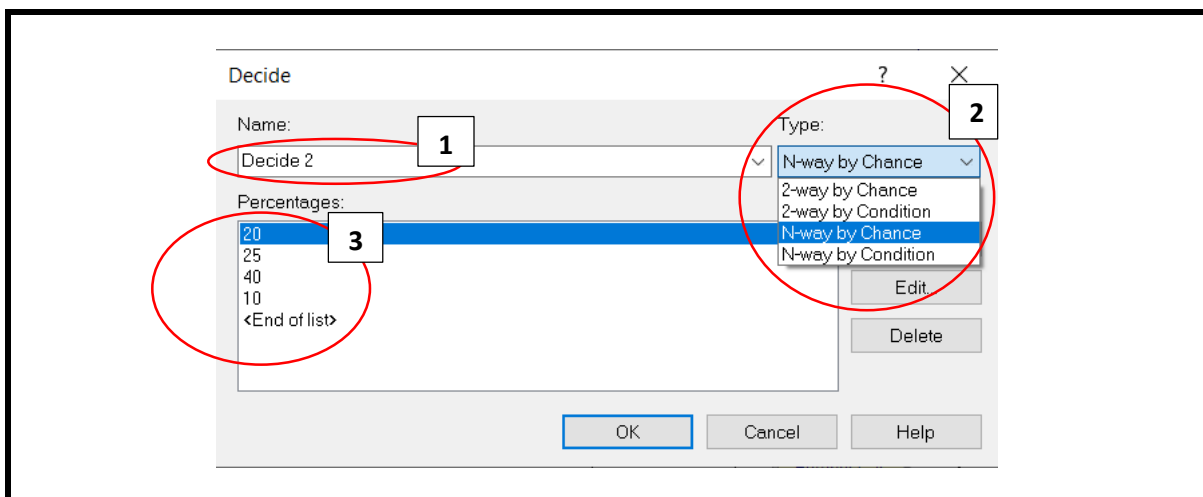


Figure 2: Decide pop-up box

- 1) **Name field:**  
In this field, simply put any name referring to the sequence in the canvas. Hence, simply let it as 'Decide 2' as it is in the second process where the visitor will choose different rides.
- 2) **Type field:**  
There are four options in this "Type" field which consists of 2-way by Chance, 2-way by Condition, N-way by Chance, and N-way by Condition. In this research, the N-way by Chance will be used since there are five probabilities of decision for the arrival visitors get served by any of five theme park rides.
- 3) **Percentages field:**  
The probability of arrival of any server is considered by the percentage, five servers of theme park ride; the probability are considered as 20%, 25%, 40%, 10% and 5% for each of them simultaneously.

### 2.3 Process pop-up box

Next, it is necessary to complete and put the required information into the Process pop-up box. In order to open the Process pop-up box, it needs to double click at the Process button, thus the Process pop-up box will appear as shown in Figure 3 and Figure 4. There are several fields that need to be filled-in in the Process pop-up box.

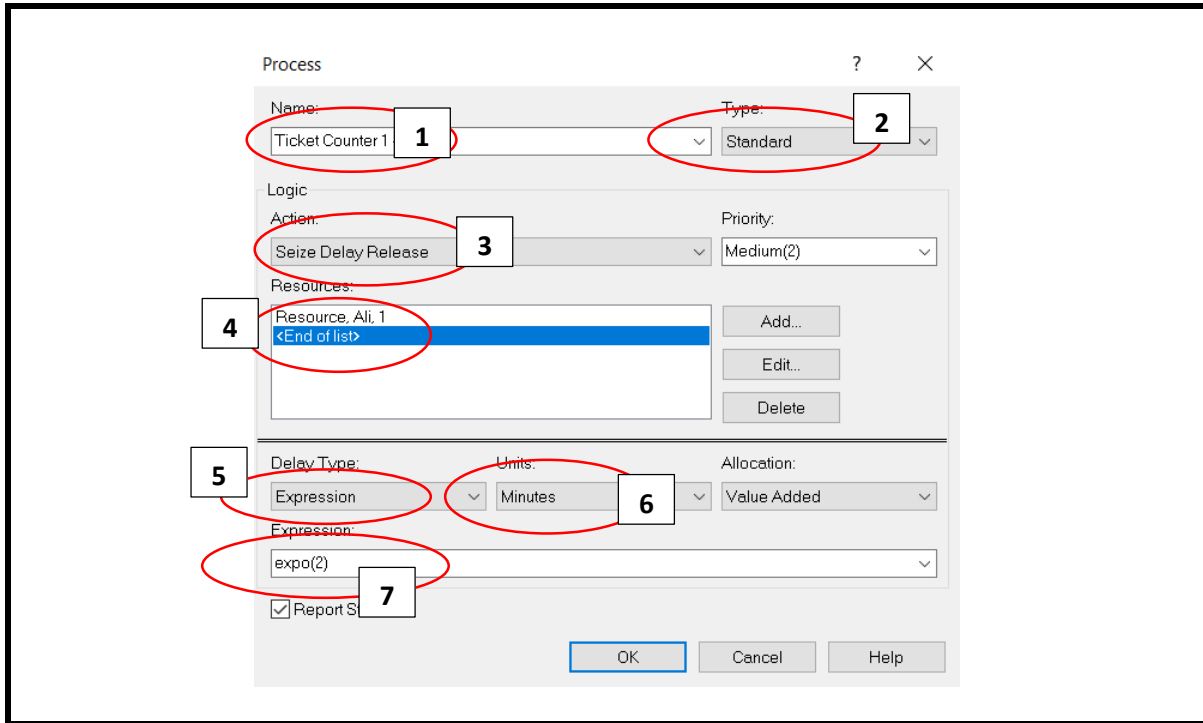


Figure 3: Process pop-up box for ticket counter

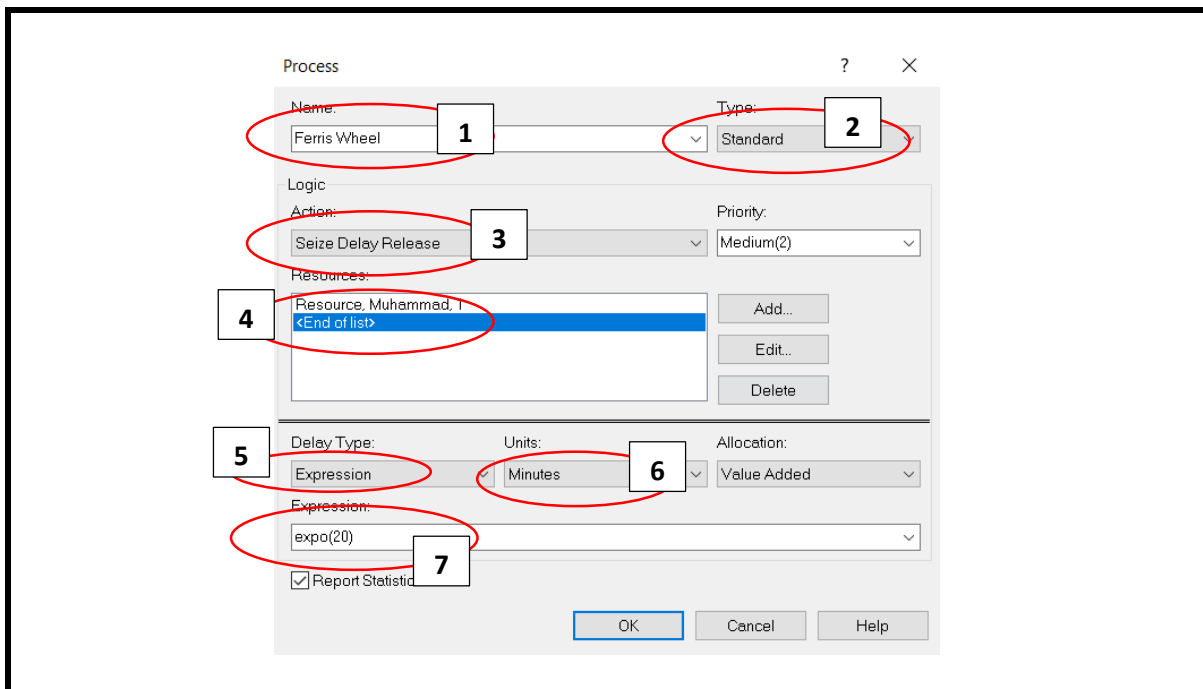


Figure 4: Process pop-up box for theme park rides

- 1) **Name field:**  
In this field, simply put any name to refer to the process in the simulation. In this research, it will be named as Ticket Counter 1, Ticket Counter 2, Ferris Wheel, Flying Chair, Roller Coaster, Bumper Car and Merry Go Round.
- 2) **Type field:**  
There are two option from type field, Submodel and Standard. In this research, Standard has been chosen as the standard queuing will be used in the system to run this simulation.
- 3) **Action field:**  
There are four options that can be selected in this field and Seize Delay Release will be chosen. Consider that visitor will go to the ticket counter in order to enter the theme park, delay as the visitor will wait for the worker to process and prepare their ticket at the ticket counter then release once the visitor finished with their services.
- 4) **Resources field:**  
This field will appear if Seize Delay Release option is chosen in the action field. Instead, except for Resource name field, keep the other details the same as it pop-up. Resource field will be named as Ticket Counter worker and Theme Park ride worker since they are the one that provides the visitors with the services. The name will be varying for the Resource name at each server.
- 5) **Delay type field:**  
There are five options: Triangular, Constant, Normal, Uniform and Expression. This indicates that the delay, which represents the service time. In this research, it will be randomly distributed according to an exponential distribution with a mean of 2 minutes for Ticket Counter 1 and Ticket Counter 2, meanwhile for the theme park rides, a mean of 20 minutes for Ferris Wheel, 15 minutes for Flying Chair, 30 minutes for Roller Coaster, 10 minutes for Bumper Car and 8 minutes for Merry Go Round.
- 6) **Units field:**  
This field indicate the time units that will be used in the simulation. Let this field as Minutes to obtain the result in minutes.
- 7) **Expression field:**  
This field is consequence from Delay type field. Then, "OK" button will be clicked to save the information to proceed with the next step.

### 3. Results and Discussion

After running the simulation for some time, the Arena Simulation software will execute the summary results of the simulation. From this simulation, we focused our study on three variables, which are Average Number Waiting  $L_q$ , Average Waiting Time  $W_q$  and Instantaneous Utilization  $(\frac{c}{c})$  used to analyze the performance of the theme park facilities [8]. These variables are taken from the result executed in the Arena Simulation software.

#### 3.1 Result of Average Number of Visitor Waiting ( $L_q$ )

**Table 1: Result of Number Waiting ( $L_q$ )**

Server	Service rate, $t$	Average Number of Waiting Visitor	Maximum Number of Waiting Visitor
Ticket Counter 1 (TC1)	2	0.0470	2
Ticket Counter 2 (TC2)	2	0.0356	3
Ferris Wheel (FW)	15	4.7358	10
Flying Chair (FC)	20	8.0240	18
Roller Coaster (RC)	30	22.8636	49
Bumper Car (BC)	10	0.0150	1

Merry Go Round (MGR)	8	0.0528	2
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From Table 1, it shows the average number of waiting,  $L_q$  of visitor at TC1, TC2, FW, FC, RC, BC, and MGR. TC1 and TC2 have 2 persons and 3 persons respectively as the maximum number of waiting visitor. However, both of the ticket counters have none as an average due to their service rate of 2 minutes per entities.

Furthermore, Table 1 also shows RC has the highest average number of Waiting Visitor among the other rides, 22.8636 and 49 persons as the maximum number of waiting visitor at a time. Even though the service rate of RC is 30 minutes, but due to the higher percentage of favourable theme park ride in Decide module, it caused a massive arrival and long queue at this RC ride.

### 3.2 Average Waiting Time of Visitor ( $W_q$ )

**Table 2: Result of Average Waiting Time, ( $W_q$ )**

Server	Service rate, $t$	Average Waiting Time of Visitor (minutes)	Maximum Waiting Time of Visitor (minutes)
Ticket Counter 1 (TC1)	2	0.4836	9.5322
Ticket Counter 2 (TC2)	2	0.3661	5.9578
Ferris Wheel (FW)	15	72.9143	147.40
Flying Chair (FC)	20	140.55	236.29
Roller Coaster (RC)	30	197.09	313.34
Bumper Car (BC)	10	0.5998	3.4539
Merry Go Round (MGR)	8	2.5357	22.1479

From Table 2, it shows the average waiting time,  $W_q$  of visitor at TC1, TC2, FW, FC, RC, BC, and MGR. We can see that a visitor will not have to wait for a long time when they buy the ticket as  $W_q$  of TC1 and TC2 are 0.4836 and 0.3661, respectively for each visitor. Besides, the maximum waiting time of visitor at both of the ticket counters are 9.5322 minutes and 5.9578 minutes which is acceptable for the visitor to wait in the queue for that long in order to buy the entry ticket. Table 2 also shows RC has the highest  $W_q$  among the other rides, 197.09 minutes which approximately to 3 hours and 17 minutes for the visitor. RC also hold accountable of the visitor at maximum waiting time of 313.34 minutes  $\approx$  5 hours and 13 minutes. This caused a long waiting time for the visitor in a line, it will somehow affect the visitor's satisfaction towards the theme park service management especially on RC ride.

### 3.3 Instantaneous Facility ( $\frac{\bar{c}}{c}$ )

**Table 3: Result of Instantaneous Utilization,  $\frac{\bar{c}}{c}$  and Percentage of  $\frac{\bar{c}}{c}$**

Server	Service rate, $t$	Instantaneous Utilization, $\frac{\bar{c}}{c}$	Percentage of $\frac{\bar{c}}{c}$
Ticket Counter 1 (TC1)	2	0.2083	20.83%
Ticket Counter 2 (TC2)	2	0.2184	21.84%
Ferris Wheel (FW)	15	0.9765	97.65%
Flying Chair (FC)	20	0.9319	93.19%
Roller Coaster (RC)	30	0.9948	99.48%

Bumper Car (BC)	10	0.1938	19.38%
Merry Go Round (MGR)	8	0.1729	17.29%

Table 3 shows the result of Instantaneous Utilization for the ticket counters and theme park rides. Instantaneous utilization is the amount of production facility output relative to its capacity, in simple word, the productivity of the service. The result is usually converted in percentage (%). moreover, instantaneous utilization is useful to measures the performance and to verify the production facilities that have been consumed.

The performance of FW, FC, RC are fully utilized as percentage of  $\frac{\bar{c}}{c}$  are 97.65%, 93.19% and 99.48% respectively, which are above average of percentage facility utilization. We accept this value due to more than half 50% of the theme park facility is being utilized and the working employer will have remaining % to rest. This result shows that there are several busy servers during the theme park operation hour for a day.

#### 4. Conclusion

In conclusion, Arena Simulation Software is a software that used to simulate the queuing situation. We able to analyse the queuing system at the theme park by using suitable queuing analysis tools which is Arena Output Result. We can see crowded situation at RC, FW, and FC due to popularity factor and long service time of the rides. Hence, the server is busy and fully utilized. Meanwhile, BC and MGR are not crowded, which means the ride are not so popular among the visitors. Last but not least, the queuing system at the theme park can reduced the visitor's waiting time by the most efficient queuing system which is adding a similar ride at the theme park to reduce long queue, and improvement on the queueing situation in RC, FW and FC rides will be studied. Thus, it is considered that the visitors will not wait for a longer time to get serve by the server in their favourable rides.

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