Application of Simulation for Cinema Queue Policy in the COVID-19 Era

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ABSTRACT
In the COVID-19 era, in a situation where the number of COVID-19 sufferers has decreased, there was a policy that allowed opening a business with one condition being to maintain a distance from human queues, including cinema ticket queues. Simulation is a method for comparing policies by analyzing the results of their implementation. Costs can be reduced by implementing simulations because policy testing is done by executing the designed model without implementing it directly. Therefore, the purpose of this study analyzed cinema queues in the COVID-19 era by comparing the policies of the previously designed queuing system. To get an effective queuing policy, the analysis was carried out by comparing the queues of various policies by considering the distance between the queues. This study developed a queuing policy that reduced the number of queues. The results obtained can be used to recommend the cinema on how to design a queuing system to reduce queues while maintaining distance settings.

Keywords: *Simulation, COVID-19, Queue, Policy*

1. INTRODUCTION

In the COVID-19 era, there were rules for maintaining distance among people, this also applied to queues which require that there was a distance between people who were queuing. This caused limit the queue capacity at a facility where there was a queue. A change in queuing policy will affect other attributes such as the length of the queue and the number of people served. In order to optimize these changes, an analysis is needed to know the impact of changes in queuing policies. Simulation can handle this, because simulation is a technique that can run a model and find out the impact of a scenario. simulation may be necessary because experimenting with real-life systems is risky and costly [1] .Before running the simulation, a model design that resembles the real world must be made, and then proposed changes to get the optimal model. Previous research has proven that the application of simulation by changing the scenario reduced the number of queues and increase the number of outputs [2].

Research on simulation applications has been carried out by several previous researchers. Alban et al (2020) applied simulation related to ICU capacity during COVID-19 [3]. Meanwhile, there was also a study applying applications related to mass vaccination during COVID-19 [4]. Another study used discrete event simulations to evaluate shift plans during the COVID-19 period [5]. In addition, there was also the discrete event simulation model application at the university related to the COVID-19 testing [6]. There was also a study regarding queue analysis on the COVID-19 condition [7]. In addition, there were also some researches that discussed the problem of queuing with simulation [8][9][10][11][12][13]. Based on the above background then the purposes of this study were developing a queuing simulation model in conditions of queuing restrictions due to COVID-19 and making changes to the scenario (number of cashier) to see the impact of employees, queues and consumers.

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2. METHODS

In this study, a queuing system model was created, then adjustments were made to the proposal by limiting the queue. The analysis used in this study was an analysis with a discrete event system with the help of simulation software. The queuing system initially used a single queue and a single server for each cashier. Discrete event simulation was used in this study. In discrete-event simulations, system changes are represented only at points in time or the system is modeled as a series of events in time when the state change occurs [14].

A proposed model was developed that describes a queuing system at the cashier which consisted of several cashiers with queues that were limited due to distance and queue capacity. Queue restrictions based on distance and capacity set. The input data for the simulation consisted of time between arrival and service time. Before running the simulation, it is necessary to run setup. In the run setup, there are replication parameters settings such as replication length [15].In this study, the simulation was run for 2 hours and then compared for each scenario of adding cashiers

3. RESULTS AND DISCUSSION

The results of the initial queuing system modeling consisted of 3 components, namely arrival, server and exit from the queuing system. The queue was in front of each server (cashier) with a predetermined number of cashiers. Meanwhile, the entity flow began from visitors who entered to the cinema with the time between arrival at the component and then went to the cashier queue for buying tickets, visitors went to the quietest queue and will be served immediately if there was none line up. Then after being served by the server (cashier) according to the service time with the distribution expression 4 + 7.84 * BETA (1.19, 1.75). After being served, visitors exited the queue system. An overview of the initial design of the queuing system could be seen in Figure 1.

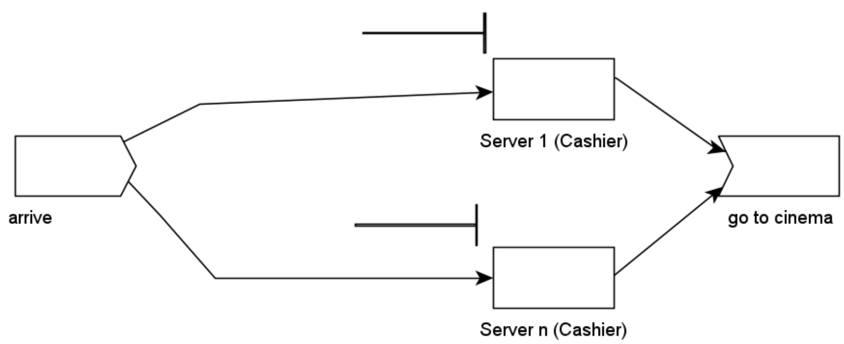

Figure 1. Initial design of the queuing system

The change in the design of the proposed model compared to the initial model was that there was a limit to the number of queues caused by the limitations of queuing distance and queuing capacity. The description of the proposed model (figure 2) consisted of several components, namely arrival, the decision to enter or not, server (cashier), and exit of a queuing system.

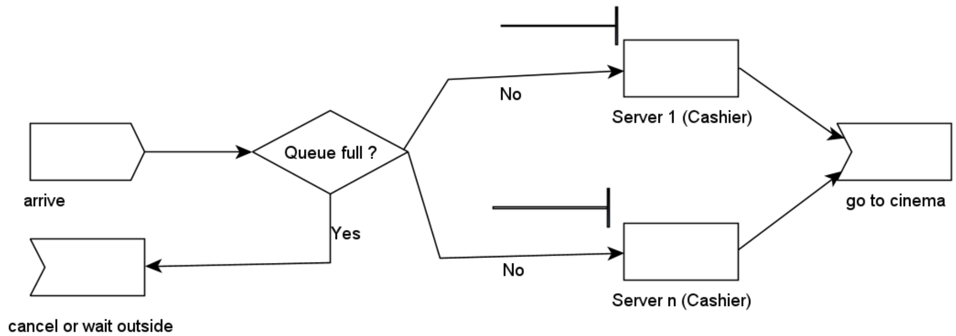

Figure 2. The proposed design of the queuing system

The proposed alternative scenario in this study was to change the number of cashiers and then analyzed the impact on the queue, cashier utility, and the number of people watching and waiting outside or canceling to watch due to queue restrictions. The output of the queuing system with the cashier is 1 (table 1), the number of waiting was 19 people. Meanwhile, the cashier's utilization was 1. This indicated that during 2 hours of work the cashier had no idle time at all with 18 people being served. While 49 people did not enter because the queue was full. From these results, it was necessary to add a cashier to get the optimal parameter size results.

Table 1. Results of simulation with 1 server

Description	Value
Number of waiting (Average) Total	19
Average of Waiting Time (minutes)	46.79
Utilization of cashier 1	1
Total Number Seized (Chasier 1)	18
Total Number of consumers go to movie	17
Total number of consumers waiting outside or cancel	49

The second scenario added cashiers to 2 people, the results could be seen in table 2. In the table could be seen that the number of people queuing has decreased from the 19 to 18 people. As for cashier utility, cashier 1 still had utility 1, while cashier 2 had 0.99 utility. It indicated that cashier 1 had no idle time, while for cashier 2 there was very little idle time. The changing occurred in waiting times, and people who did not enter the cinema were reduced, while the number of people who were served by cashiers increased.

Table 2. Results of simulation with 2 servers

Description	Value
Number of waiting (Average) Total	18
Average of Waiting Time (minutes)	32,72
utilization of cashier 1	1
utilization of cashier 2	0,99
Total Number Seized (Cashier 1)	18
Total Number Seized (Cashier 2)	17
Total Number of consumers go to movie	34
Total number of consumers waiting outside or cancel	21

The third scenario, the cashier increases by 3 people. From the results (table 3) it could be seen that the total waiting time was reduced to 12, while the waiting time was to 18.56. For the output of the utilization of one cashier was 1 while the other two cashiers were 0.98. Meanwhile, the total people served also increased to 50 people. From the results described above, the addition of a cashier changed the others.

Table 3. Results of simulation with 3 servers

Description	Value
Number of waiting (Average) Total	12
Average of Waiting Time (minutes)	18,56
utilization of cashier 1	1
utilization of cashier 2	0,9884
utilization of cashier 3	0,9756
Total Number Seized (Cashier 1)	17
Total Number Seized (Cashier 2)	18
Total Number Seized (Cashier 3)	18
Total Number of consumers go to movie	50
Total number of consumers waiting outside or cancel	0

In the fourth scenario, the number of cashiers increased by four. According to the results (table 4), the total waiting time was reduced to 4, while the waiting time was reduced to 6.49. For the utilization output, each cashier was less than 1 but greater than 0.95. Meanwhile, the total number of people served increased to 64.

Table 4. Results of simulation with 4 servers

Description	Value
Number of waiting (Average) Total	4
Average of Waiting Time (minutes)	6.49
utilization of cashier 1	0.9942
utilization of cashier 2	0.972
utilization of cashier 3	0.9621
utilization of cashier 4	0.9524
Total Number Seized (Cashier 1)	17
Total Number Seized (Cashier 2)	16
Total Number Seized (Cashier 3)	18
Total Number Seized (Cashier 4)	17
Total Number of consumers go to movie	64
Total number of consumers waiting outside or cancel	0

In the fifth Scenario, the number of cashiers were increased to 1 people. From the results (table 5) it can be seen that the total waiting time was reduced to 4, while the waiting time was reduced to 0.93. For the utilization of the output of all cashiers were between 0.83 and 0.96 Meanwhile, the total people served also increased to 75 people.

Table 5. Results of simulation with 5 servers

Description	Value
Number of waiting (Average) Total	1

Average of Waiting Time (minutes)	0.93
utilization of cashier 1	0.96
utilization of cashier 2	0.91
utilization of cashier 3	0.88
utilization of cashier 4	0.83
utilization of cashier 5	0.83
Total Number Seized (Cashier 1)	17
Total Number Seized (Cashier 2)	18
Total Number Seized (Cashier 3)	15
Total Number Seized (Cashier 4)	15
Total Number Seized (Cashier 5)	15
Total Number of consumers go to movie	75
Total number of consumers waiting outside or cancel	0

In the sixth scenario, the number of queues that did not change, it was 1, as well as the number served and those who could not watch, namely 75 people and 0 people. while the waiting time was 0.18 and the cashier utility was in the range of 0.43 and 0.92. If it was assumed that the idle time was 5%, then this scenario has succeeded in achieving this goal.

Table 6. Results of simulation with 6 servers

Description	**Value**
Number of waiting (Average) Total	1
Average of Waiting Time (minutes)	0.18
utilization of cashier 1	0.92
utilization of cashier 2	0.82
utilization of cashier 3	0.81
utilization of cashier 4	0.77
utilization of cashier 5	0.69
utilization of cashier 6	0.43
Total Number Seized (Cashier 1)	15
Total Number Seized (Cashier 2)	15
Total Number Seized (Cashier 3)	14
Total Number Seized (Cashier 4)	14
Total Number Seized (Cashier 5)	14
Total Number Seized (Cashier 6)	9
Total Number of consumers go to movie	75
Total number of consumers waiting outside or cancel	0

Based on the evaluation of six alternative simulation scenarios (Table 1-6), scenario 6 was determined to be the most desirable by including six cashiers. This study has limitations, including the need for several scenarios to determine which one is the best. The simulation technique is useful for testing policies with predetermined parameters. These optimal parameters can be obtained by optimization techniques. so that further research can use a combination of optimization and simulation methods.

4. CONCLUSION

In this study, a queuing system model was proposed by considering the queuing limitations caused by COVID-19. several scenarios of changes to the proposed design of the queuing system model (addition of cashiers) were tested using the simulation method and obtained different results for each scenario. From the simulation results of 6 scenarios, the best scenario was obtained by considering the queue, the customers served and the cashier's utility. As a result, the scenario by placing 6 cashiers was the best selection

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