Analysis of Queuing Theory at McDonald's Galuh Mas Karawang Using the Single Channel-Single Phase Model

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Abstract
Queue is the density or the number of customer waiting. However, the density of customers will also lead to the loss of potential customers. In this study, the aim of this research is to determine the queuing discipline applied by Mc Donald’s Galuh Mas Karawang and the characteristics of the queues needed to wait for the queue. Based on these problems, this study used is single channel-single phase model, where there is only one path for its service. The results showed that the queuing discipline used is First In First Out (FIFO) and the characteristics of the queue include average of 3 people queuing in the system, average queuing in the queue is 2 people, waiting time in system is 5.53 minutes, time expected by customers to wait in the queue is 4.183 minutes, with a server busy rate is 75.60% and a server unemployment rate is 24.40%.

Keywords: queue, single channel-single phase, characteristics of the queue, queuing discipline, customer.

Abstrak
Antrean merupakan kepadaan atau banyaknya pelanggan yang menunggu namun kepadatan pelanggan pun akan menyebabkan hilangnya calon pelanggan. Dalam penelitian ini bertujuan untuk mengetahui disiplin antrean yang digunakan oleh Mc Donald’s Galuh Mas Karawang dan karakteristik antrean yang dibutuhkan untuk menunggu antrean. Berdasarkan permasalahan tersebut, maka penelitian ini menggunakan model single channel-single phase. Hal ini hanya terdapat jalur tunggal untuk pelayanannya. Hasil penelitian menunjukkan bahwa disiplin antrean yang digunakan adalah first in first out dan karakteristik antrean meliputi rata-rata yang mengantre dalam sistem sebanyak 3 orang, rata-rata waktu yang mengantre dalam antrean sebanyak 2 orang, waktu menunggu dalam sistem adalah 5,53 menit, waktu yang diharapkan oleh pelanggan untuk menunggu dalam antrean adalah 4,183 menit, dengan tingkat kesibukan server 75,60% dan tingkat pengangguran server 24,40%.

Kata Kunci: antrean, single channel-single phase, karakteristik antrean, disiplin antrean, pelanggan.

1. Introduction
In today’s era, fast food restaurants, also known as a fast food is in great demand by all groups, consumption among children and adults. Because, fast food is a very practical in consuming its food and also fast in its manufacture [1]. Generally, fast food restaurants can be found around cities where people are busy so they do not have time to cook and have a lifestyle that tends to want things to be fast and practical [2]. The emergence of these fast food restaurants for the first time, it attracted customers’ attention, where the service process carried out by the fast food restaurant was fast so that the customer arrival rate increased. However, as time went on, the number of customers increased, the problems began to arise. Hence, the slow customer service by fast food workers can cause other customers to be served longer [3].

Therefore, a high effort is needed to its increase, so was not beaten in competition among fast food restaurants and improves service [4]. The density or the number of customers waiting is called a queue [5]. It cannot be denied that waiting is time-consuming for busy-people who need a quick service [6]. The waiting condition is where a person is in a series of random operating activities at a service facility [7]. Long queues also can cause customers [8].

Based on the above queuing problems, Single Channel-Single Phase Model can be used as the queuing model in this study. Single channel is a single line that has service facilities and single phase is a single service station, then those that have been serviced can leave the queue system [9]. This single channel-single phase model can be found in fast food restaurants. Fast food restaurants serve customer
orders with a time of approximately 3 minutes, which usually provide burgers, fried chicken, French fries, and others [10]. One of the fast food restaurants is McDonald's.

In order to avoid long queues, an analysis of Mc Donald's Galuh Mas Karawang queuing system can be carried out using the queuing theory. This research was carried out in order to produce useful input which later the problem can be solved more optimally. Mc Donald's Galuh Mas Karawang itself provides facilities for ordering services, there is one line, so that when the customer has finished paying, they can immediately bring the order to the dining table. Thus, this study aims to determine the queuing discipline used by Donald's Galuh Mas Karawang and the characteristics of the queues needed to wait for the queue, so as to improve and increase customer satisfaction in terms of waiting for queues.

**Queuing Theory**

According to [11] in [12] queuing is a waiting line for people, components, and worksheets must wait first to get service. The basic purpose of the queuing model are to minimize the total cost and indirect costs because customers have to wait for service facilities.

**Queuing Discipline**

Queuing discipline is the sequence of queuing actors selected to be ready to be served. Generally, queuing discipline was divided into four rules [13]:

1. First In First Out (FIFO) is a rule whereby a customer who comes first is the first one to come out or the customer who comes first is served first.
2. Last In First Out (LIFO) is a rule that a customer who comes last can go out first or be served early.
3. Service In Random Order (SIRO) is a rule where a customer is served randomly, it does not matter who arrives early or is served first.
4. Priority Service (PS) is a queuing rule where a customer has the highest priority of service compared to the lowest priority. It didn't matter who arrived first.

**Previous Research**

The previous research was conducted by Alloysius Vendhi Prasmoro, Murwan Widiantoro, and Warniningsih, where the results of the research at the ABC gas station using queuing theory analysis is the calculation of multi-channel single-phase models. Shows that after analyzing with the addition of service line and also operator can be more optimal and in terms of service time from initially one service line into two service line. And then average service intensity which initially 98% to 34% for average customer in queue 46 person to 1 person. Average customer in the system 47 people to 2 people and for the average waiting time in the queue from 58.7 minutes to 0.38 minutes. Later for the average wait in the system 60 minutes to 1.6 minute. For that, with single-phase multi-channel or addition to two lines in terms of time, it becomes more optimal [14]. In addition, several studies have reported similar result by ref. [15, 16, 17, 18].

The difference between this study and previous research includes the service time used at the average value of service / 10 minutes not / customers who come. Another difference is the observations made over a period of 3 days for 100 minutes in the late afternoon. Then it has the results of the 1-sample Kolmogorov-Smirnov test with the number of customer arrivals with a Poisson distribution and the average service time is not normally distributed. Besides that, using the chi square test, the 1-sample Kolmogorov-Smirnov test with a Poisson and exponential distribution. Testing data analysis using SPSS for windows and manual calculations. There is a difference with previous research using POM-QM, WinQSB and Visual Basic software.

2. Material and Methods

**Preliminary Studies**

Preliminary studies consist of field studies. Field studies were carried out to collect data or observations in McDonald’s. Meanwhile, the literature study used to get any information related to queuing theory. These literature studies refer to books or journals that related to this method.

**Types of Research**

The type of data used is quantitative data. The data was collected from the number of customer arrivals and the average service time. Observations in this study were carried out in the late afternoon for 3 days for 100 minutes, at 17.30 - 19.10 WIB. Data collection is supposed to measure customer arrival time and service time is calculated in one time unit. This research was conducted at McDonald's Galuh Mas using the Single Channel-Single Phase queuing method.
Single Channel-Single Phase Queuing Method

In the single channel-single phase queuing method will calculate the customer arrival rate ($\lambda$), service level ($\mu$), the average queue in the system ($L_s$), the average customer queuing in the queue ($L_a$), the chance of the customer being in the queue ($P_n$), the time expected by the customer waiting in the queue ($W_a$), the busyness of the server, and the server unemployment rate.

Data Analysis

After collecting the data, the data will be analyzed. These are three steps to analysis data. The first step is the collection of related data to illustrate the queuing system applied by Donald's, then illustrated. The second step, data was analyzed using the Kolmogonorov Smirnov 1-Sample Test. The third step, the calculation of queuing characteristics using the Single Channel-Single Phase model.

3. Results and Discussion

Queuing System Illustration

McDonald's Galuh Mas Karawang has 2 service servers for ordering food or however, only one server most commonly used. The type of queuing system used by Mc Donald's Galuh Mas Karawang is the Single Channel-Single Phase model, where there is a single line to fulfill services. The following is an illustration of Mc Donald's Galuh Mas Karawang queuing system is presented in Fig. 1, so it can be easily understood.

![Figure 1. Illustration of queuing system](image)

Source: Research results (2020)

From data collection, data on the number of customer arrivals in Mc Donald's Galuh Mas Karawang queuing system with ten minute intervals from 21 to 23 November 2019 are presented in Table 1 and Table 2.

<table>
<thead>
<tr>
<th>Number of Observation</th>
<th>Date</th>
<th>Hours</th>
<th>Number of Arrivals (People)</th>
<th>Average Service Time (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>21/11/2019</td>
<td>17:30 – 17:40</td>
<td>8</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17:41 – 17:50</td>
<td>5</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17:51 – 18:00</td>
<td>4</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:01 – 18:10</td>
<td>5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:11 – 18:20</td>
<td>6</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:21 – 18:30</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:31 – 18:40</td>
<td>4</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:41 – 18:50</td>
<td>7</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:51 – 19:00</td>
<td>4</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19:01 – 19:10</td>
<td>6</td>
<td>1.4</td>
</tr>
<tr>
<td>2.</td>
<td>22/11/2019</td>
<td>17:30 – 17:40</td>
<td>4</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17:41 – 17:50</td>
<td>5</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17:51 – 18:00</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:01 – 18:10</td>
<td>7</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:11 – 18:20</td>
<td>6</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:21 – 18:30</td>
<td>8</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18:31 – 18:40</td>
<td>5</td>
<td>1.4</td>
</tr>
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<td>18:41 – 18:50</td>
<td>6</td>
<td>1.2</td>
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<td></td>
<td>18:51 – 19:00</td>
<td>8</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19:01 – 19:10</td>
<td>4</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Table 2. Summary of customer arrival data and business hours

<table>
<thead>
<tr>
<th>No</th>
<th>Days</th>
<th>Date</th>
<th>Arrival of Customer</th>
<th>Total Hours of Operation (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Saturday</td>
<td>21/11/2019</td>
<td>52</td>
<td>100</td>
</tr>
<tr>
<td>2.</td>
<td>Sunday</td>
<td>22/11/2019</td>
<td>56</td>
<td>100</td>
</tr>
<tr>
<td>3.</td>
<td>Monday</td>
<td>23/11/2019</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>168</td>
<td>300</td>
</tr>
</tbody>
</table>

Source: Research results (2020)

Data analysis of the number of arrivals was carried out using the 1-Sample Kolmogorov-Smirnov test with a Poisson distribution. With the hypothesis of the number of customer arrivals at McDonald’s Galuh Mas Karawang as follows:
1. H0: The number of customer arrivals has a Poisson distribution.
2. H1: The number of customer arrivals is not Poisson distributed.

Following are the results of the 1-Sample Kolmogorov-Smirnov test using SPSS for windows can be seen in Fig. 2.

Figure 2. Kolmogorov-Smirnov 1-Sample Test Results of the Number of Arrivals
Source: Research results (2020)

Based on Fig. 2, the test results using 1-Sample Kolmogorov-Smirnov showed that the positive deviation value is 0.114, the negative deviation is -0.124, and the Asymp value, Sig. is 0.746. With a significant level of 0.05, the number of arrivals is a Poisson distribution because 0.746 ≥ 0.05. Meanwhile, the average service time is tested with 1-Sample Kolmogorov-Smirnov which is normally distributed. With the hypothesis that McDonald’s Galuh Mas Karawang’s average customer service time is as follows:
1. H0: The number of customer arrivals is normally distributed.
2. H1: The number of customer arrivals is not normally distributed.

The following are the results of the Kolmogorov-Smirnov 1-Sample Test using SPSS for Windows can be seen in Fig. 3.
Based on Fig. 3, the results of the 1-sample Kolmogorov-Smirnov test showed that the positive deviation value was 0.169, the negative deviation value was -0.121 with the Asymp value. The Sig is 0.028. With a significant level of 0.05, this means that the customer service time of Mc Donald's Galuh Mas Karawang is not normally distributed, because 0.028 ≤ 0.05. The next step is the data that has been obtained, processed and calculated for data analysis. Where is the calculation of the queue characteristics as follows:

1. Average queue time in the system.
2. Average time queued in queue.
3. Average waiting time in the system.
4. Expected time to wait in queue.
5. Server busyness.

Based on Table 2, it is obtained customer data totaling (N) = 168 people with a total arrival time or working hours of 300 minutes.

\[
\lambda = \frac{\text{Average Number of Visits}}{\text{total hours worked}} = \frac{168}{300} = 0.56 \text{ minutes}
\]

\[
\mu = \frac{1}{t} = \frac{1}{1.35} = 0.7407 \text{ minutes}
\]

Thus, the customer arrival rate for 168 subscribers is 0.56 minutes and the service level is 0.7407 minutes. After that, with these data, the queue model of single channel-single phase can be calculated, which is as follows:

**Average Queue In The System**

The average queue in the system can use the following equation:

\[
L_s = \frac{\lambda}{\mu - \lambda}
\]

Where:
1. \(L_s\): Average queues in the system.
2. \(\lambda\): Arrival rate.
3. \(\mu\): Service level.

\[
L_s = \frac{0.56}{0.7407 - 0.56} = 3.099
\]

The \(L_s\) value is 3.099, thus the average number of customers in the queuing system is 3 people.
The Average Queued In The Queue
The average queued in the queue can use the following equation:
\[ L_a = \frac{\lambda^2}{\mu(\mu-\lambda)} \]

Where:
1. \( L_a \): Average queue in queue.
\[ L_a = \frac{(0.56)^2}{0.7407(0.7407-0.56)} = 2.34 \]
La value is 2.34, which means that the average customer queuing in the queue is 2 people.

Chances Of The Number Of Customers In The Queue
The probability of the number of customers in the queue can use the following equation:
\[ P_n = \left( \frac{\lambda}{\mu} \right)^n \left( 1 - \left( \frac{\lambda}{\mu} \right) \right) \]

Where:
1. \( P_n \): Chances of the number of customers in the queue.
\[ P_n = \left( \frac{0.56}{0.7407} \right)^2 \left( 1 - \left( \frac{0.56}{0.7407} \right) \right) \]
\[ P_n = (0.57159)(0.2439) \]
\[ P_n = 0.1394 \]
The \( P_n \) value above means that the probability of customers queuing is 0.1394 or 13.94%.

Average Waiting Time In The System
The average waiting time in the system can use the following equation:
\[ W_s = \frac{1}{\mu-\lambda} \]

Where:
1. \( W_s \): Average waiting time in the system.
\[ W_s = \frac{1}{0.7407-0.56} = 5.53 \text{ minutes} \]
The value of \( W_s \) above means that the average waiting time in the system is 5.53 minutes.

Average Time Expected By A Customer To Wait In A Queue
The average time a customer expects to wait in a queue can use the following equation:
\[ W_a = \frac{\lambda}{\mu(\mu-\lambda)} \]

Where:
1. \( W_a \): Average time a customer waits in a queue.
\[ W_a = \frac{0.56}{0.7407(0.7407-0.56)} = 4.183 \]
The \( W_a \) value above means that the time the customer expects to wait in the queue is 4.183 minutes.

The Level Of Server Activity
The level of server activity can use the following equation:
\[ K = \frac{\lambda}{\mu} \]

Where:
1. \( K \): The level of server activity.
\[ K = \frac{0.56}{0.7407} = 0.756 \]

From the value above, it can be seen that the server business is 75.60%.
Server Unemployment Rate

The server unemployment rate can be calculated using the following equation:
\[ W = 100\% - K \]

Where:
1. \( W \): Server unemployment rate.
2. \( K \): The level of server activity.

\[ W = 100\% - K = 100\% - 75.60\% = 24.40\% \]

Then it can be seen that the server unemployment rate is 24.40%.

Research Parameters

In order for the processing results to be in accordance with previous research, previous research was taken as a parameter of this study. The results of the calculations in this study refer to several research results as follows.

Research conducted by Asyor Itaar, Enny Ariyani, and Erlina P., based on the results of the study can be assumed that by using the 6 counters could obtain 99.64% server utilities, if using 7 counters, the server utility is 86.46%, while using 8 counters, the server utility is 69.26%. Based on the results of the 3 improvement proposals, the second most optimal proposal is chosen by adding 1 counter service facility. Then the suitable queuing model is the Multichannel-Single Phase queuing system [19].

Research conducted by Hendra Nurjaya Al-Kholis, Ellysa Nursanti and Thomas Prisumanu: Based on the results of several scenarios that have been designed and executed with the help of the ARENA 10.0 process analyzer software, scenario 2. In scenario 2 it assumes the addition of one service station facility. Then the suitable queuing model is Multi Channel- Single Phase (M / M / 2); (FCFS) where there are 2 service station facilities in busy conditions at 14.00-16.00, 18.00-22.00 and 16.00-18.00 hours on Saturdays and Sundays. Adding stations can reduce the queue to Queue Waiting Time ranging from 0-18 seconds, Queue Number Inqueue value is 1 person, Utilization value ranges from 0.37-0.68% and Work In Process value ranges from 1-5. So it can be said that scenario 2 reduces the number of queues 89% [20].

Research conducted by Dwi Setiawan: The result showed the service capacity is 1.13 (the service is worse then amount of costumers) [21]. Research conducted by Sri Hartini and Lesti Hartati: Results showed that determined the average total scoring of KFC restaurant (20.56, 14%), McD restaurant (18.29, 12%), Pizza Hut restaurant (16.67, 11%) and others [10].

Research conducted by Yashinta Mayangsari and Estik Hari Pratiwi: The result showed data processing by POM-QM for Windows, the result showed for each customer spent 2.64 minutes in each system, the queuning time to finish serviced, that is under SOP Bank Mandiri 4 minutes [12].

4. Conclusion

In conclusion, the type of queue applied by McDonald's Galuh Mas Karawang is Single Channel Single Phase with the service discipline is FIFO (First In First Out). From the results of the calculation of the characteristics of the queue using a single channel single phase: 1.) The average queue in the system consisting of three persons; 2.) The average queue in the queue consisting of two persons; 3.) The probability of customers queuing is 13.94%; 4.) The average waiting time in the system is 5.53 minutes; 5.) The waiting time for customers in the queue is 4.183 minutes, with a server busy rate of 75.60%; and 6.) Server unemployment rate of 24.40%. This shows that McDonald's Galuh Mas Karawang can be said to be good. But if it’s further improved in terms of service and preparing orders, it will be much better and waiting time and customers queuing will be reduced.

5. Acknowledgment

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6. References


