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The Implementation of Single Channel Single Phase Queue Model at Gadog Clinic during the COVID-19 Pandemic

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Abstract

Queuing is a common thing and often happens in everyday life. Queuing is a phenomenon that usually occurs when service needs exceed the provided capacity. The number of people who need services simultaneously and the number of individuals who come exceeds the number of service facilities available, so consumers/patients who arrive cannot get service immediately and are in the queue. The study aims to analyze the implementation of the Single Channel-Single Phase model and the effectiveness of the service time at the Gadog Clinic during the Pandemic COVID-19. The Single Channel-Single Phase Queuing model or one queue one service is the simplest model. Single Channel means that there is only one path to enter the service system or there is one service facility while single phase means that there is only one service or a single set of operations carried out. After receiving the service, the individual exits the system. Based on observations for 30 days, it is known that the patient arrival rate is 575 people/week. The average patient arrival (λ) is 10 people per hour and the average patient service (μ) is 2 people per hour. The average usage rate of Gadog Clinic's counter service is 5 or 500%. Results above 100% indicate the patient arrival rate is very high exceed the number of server and patients are not served properly. This research was carried out during the COVID-19 pandemic so that it provided a phenomenon of patient arrivals that was much larger than usual and this is the novelty of this research.
Keywords: Queuing Model; Arrival Rate; Service Rate

Introduction

Every company in the business world will compete to improve service quality to win the hearts of its customers. Direct service to customers or operators is often encountered in life daily. In general, a company has operators or service facilities that are fewer in number compared to many existing customers. It usually causes a queue to form at the service facility. The queue is a waiting line for customers who require the services of one or more service facilities (1). This event can occur if the need for a service exceeds the available server, so the arriving consumers/patients cannot immediately get the service. Waiting in the language of applied mathematics can be identified with a queuing process. In everyday life, there are often many queues in certain places, both on a small and large scale that require optimal solutions. Queuing theory is a theory that concerns the mathematical study of queues or waiting lines. Facility users come at random, irregular times and cannot be served immediately, so they have to wait quite a long time which causes the increase in competition, which requires the business world to struggle to improve effective, efficient and flexible services to be able to innovate quickly and appropriate (2). Queuing time is too long and can cause consumers to be bored, and reluctant to return to visit in the future, on the other hand, otherwise, if there is no queue of workers in the service department (cashier), there are many unemployment causes implicit losses for the company.

The queuing system includes customers who arrive at a constant or variable rate to get services at a service facility. The queuing system includes customers who arrive at a constant or variable rate to get services at a service facility. Customers who come can enter the service facility, can be served directly. If the customer must wait, customers will be in queue until their turn. Customers will be served with speed constant or

variable service and eventually leaves the system. Queuing theory was discovered and developed by A. K. Erlang, an engineer from Denmark who worked for a telephone company in Copenhagen in 1909. Erlang conducted experiments on fluctuations in demand for telephone facilities related to automatic equipment, namely automatic telephone connection equipment. In busy times operators are so overwhelmed to serve callers quickly, so callers have to queue for their turn (3). According to Supranto (4), Erlang treated the calculation of the delay from an operator, then in 1917 the research was continued to calculate the busyness of several operators. After the second world war, the results of Erlang's research were expanded to include in queuing theory. the Queue is a waiting line from customers (units) who require services from one or more services (service facilities) (5). A queuing process is a process related to the arrival of a customer at a service facility, then waiting in a line (queue) if everything is busy, and finally leaving a certain facility suatu proses (6) (Bronson, R. 1991)

Queue system includes both queues and service facilities (7). Annisa Ikrimah (8) in her research on Single Channel-Single Phase queuing analysis at the Kaligung train ticket sales counter at Poncol Station concluded that the customer service process for selling Kaligung train tickets at Poncol Semarang Station was effective seen from the criteria for the average standard service time for the maximum capacity of the train. counter service period. Suggestions from this research is that further research needs to be done using a longer research time and also observations at a time that is not busy, so that more optimal results are obtained. The results of Dian kusuma negara research's (9) entitled analysis of the queuing model at the ticket counter (Case Study of PT. Central Proinaprima Tbk. Sidoarjo) using the Single Channel-Single Phase model which is a single model with one service counter concludes that based on the results of data analysis , the arrival rate (λ) is 0.09523 trucks per unit, and the delivery rate (μ) is 0.16296 trucks per unit, the probability of a truck queue occurring in the system $P_{\circ}$ = 0.00193, the average truck in the queue (Lq) is 0.79278, the average truck in the system (Ls) is 1.37605, the average waiting time in the queue (Wq) is 14,47714. Based on the results obtained, it can be seen that at PT. Central Proteinaprima Tbk. Sidoarjo there is no queue. This is because the time of data collection is done in only two weeks.

Gadog Clinic is one of the public clinic under the name of the Smile Indah Madani Foundation with Dr. Fenty Zulaikhah and was allowed to operate on March 12, 2019. Gadog Clinic is very strategically located on Jl. Cikopo Selatan RT. 05 RW. 03 Gadog Village, Megamendung District, Bogor Regency. The purpose of establishing the Gadog Clinic is to improve the quality of health services for the general public of Megamendung and the participants of BPJS Kesehatan and other Commercial ASKES.
In providing services to patients, Gadog Clinic operates every day from 07.00 – 20.00, with a team of doctors who are always ready to serve patients, and are assisted by nurses and administrative staff. Gadog Clinic also has a prolanis and home visit program that aims to monitor BPJS participants who have Diabetes Mellitus, Hypertension and Asthma.
Gadog Clinic has a vision that is to be the best clinic that provides quality, professional and patient-oriented services. To achieve this vision, Gadog Clinic has set a mission, namely providing excellent health services by utilizing medical information and technology, prioritizing trust and patient satisfaction by providing excellent and affordable health services, and carry out work in a professional, dynamic, innovative, highly dedicated and trusted team. Gadog Clinic has values that are a whole in carrying out health services. These values are: Honesty, Responsibility, Visionary, Discipline, Cooperation, and Fairness. Gadog Clinic's motto is Serving With Heart. Services consist of: General Patients, BPJS Health, Inhealth Insurance. This study aims to analyze the service system implemented at the Gadog clinic with a single channel single phase whether it has been able to provide optimal service or not during the COVID-19 pandemic.

Methodology
This research is a descriptive research, that explain the characteristics of a particular variable in a structured and specific manner (10). The data used in this study is primary data obtained directly from the object of research, namely the Gadog Clinic, which is located on Jalan Cikopo Selatan, RT. 005 RW. 003 Gadog Village, Megamendung District, Bogor Regency. This research was carried out during the COVID-19 pandemic for one month from September to October 2020. Data collection process is done through the process of observation, interviews, discussions and observations.

The model used to calculate the effectiveness of services at the Gadog clinic is a single channel single phase model. The selection of this model is in accordance with the service pattern currently taking place at the Gadog clinic. The Single Channel-Single Phase queuing model or one queue one service as shown in Figure 1 is the simplest queuing system. Single Channel means that there is only one path to enter the service system or there is one service facility. Single Phase means that only one service or a single set of operations is performed. After receiving the service, the individual exits the system. An example of a queuing system with a single channel single phase pattern is a doctor's general practice (11).

Figure 1 : *Single Channel-Single Phase*

The rules for selecting individuals who enter the queue to be served first or what are often referred to as queue discipline queues use the service discipline First-Come First-Served (FCFS) or First-In First-Out (FIFO) which means first come, served first (out), for example queuing to buy cinema tickets (12 - 13).

Single Line Queue Model (M/M/1):(GD/∞/∞)
Single Line Queue Model (M/M/1):(GD/∞/∞) means that the first M represents the arrival distribution. The second M shows the distribution of services, 1 shows the number of service facilities in the system or one channel, and GD shows the queue discipline. It is assumed that the arrival process and service delivery are independent (no relation in the calculation). This means that the average arrival will not change in a certain time and does not affect the number of units in the first queue on service decomposition (13). Some notations that will be used in the single channel single phase queuing model are:
λ = average arrival rate per unit time (unit/time)
μ = average level of service per unit time (unit/time)
Lq = average number of individuals in the queue (units)
Ls = the average number of individuals in the system (units)
Wq = average waiting time in queue (hours)
Ws = average waiting in the system (hours)
P = level of usability of service facilities (ratio)

The following are some formulas of the queuing system for the model (M / M / 1):(GD /∞/∞) :
First. The level of usability of service facilities (ρ)
For a system (M/M /1):(GD /∞/∞), The level of usability of service facilities is defined as $\rho = \lambda/\mu$, which is the quotient between the arrival rate and the service rate. The greater the price , the longer the queue and vice versa.
Second. Average Number of Customers in the System
The Average Number of Customers in the System can be formulated with $Ls = \lambda/(\mu - \lambda)$
Where:
λ= average number of arrivals per unit time
μ= average number served per unit time per line
Third. Average Number of Customers in Queue
The average number of customers in the queue can be formulated with $Lq = Ls - \frac{\lambda}{\mu} = \frac{\lambda}{\mu - \lambda} - \frac{\lambda}{\mu} = \frac{\lambda^2}{\mu(\mu - \lambda)}$
Where :
Ls = the average number of customers in the system
Fourth. Average Waiting Time in System (Ws) is the average time that a customer will spend in the system, then

Ws = Ls/λ where Ls is the average number of customers in the system. $Ws = \frac{\frac{\lambda}{\mu - \lambda}}{\lambda} = \frac{1}{\mu - \lambda}$

Fifth. Average Waiting Time in Queue (Wq)

Wq is the average time spent by a customer in the queue. $Wq = \frac{Lq}{\lambda} = \frac{1}{\lambda}\frac{\lambda^2}{\mu(\mu - \lambda)} = \frac{\lambda}{\mu}\left(\frac{1}{\mu - \lambda}\right) = \frac{\lambda}{\mu(\mu - \lambda)}$

Result

Gadog Clinic, Bogor Regency has daily service hours. The arrival rate of consumers or patients is random, i.e. the arrival of other consumers or patients does not depend on time or is not limited. In addition, the service discipline carried out is First-Come First-Served (FCFS) where consumers or patients who come first will get the first service at the counter.

Arrival Rate Analysis (λ)

The table 1 and graph 1 shows the arrival of patients who transact at the payment counter of the Gadog clinic in Ciawi, Bogor Regency during COVID-19 Pandemic. Observations were made for 30 working days with an average of 8 working hours per day. Based on the data in the table above, it can be seen that the number of patients at the Gadog Clinic is 575 people. The highest number of patients is on Sunday with 115 people and the least number of patients on Wednesday is 64 people. The average patient arrival (λ) per day is 82 patients. If in one day is 8 hours of work, then the average patient arrival is 10.25 people per hour. Based on observations made for 30 days, it can be seen that the average rate presented in the following table:

Table 1. Patient Arrival of Gadog Clinic

No	Day	Average Days of Patient Arrival (λ) (Per Days)
1	Monday	100
2	Tuesday	72
3	Wednesday	64
4	Thursday	72
5	Friday	68
6	Saturday	84
7	Sunday	115
	Quantity	575
	Average	82.14285714

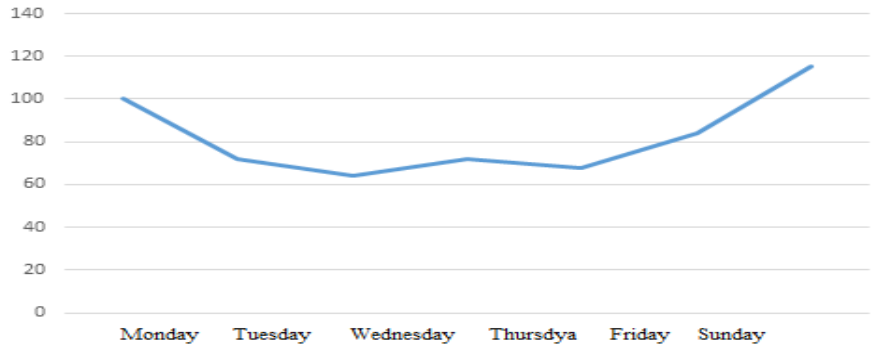

Figure 2. Patient Arrival of Gadog Clinic

The Analysis of Service Level (μ)
Service pattern is the time used to serve individuals in a system, namely how many customers are served every hour or how long each patient can be served. Based on observations made for 30 days, it can be seen that the average rate and level of service per day as presented in the following table:

Table 2. Patient Service Per Minute of Gadog Clinic

No	Day	Average Service Level (μ) (Minutes Per Person)
1	Monday	24
2	Tuesday	27
3	Wednesday	30
4	Thursday	27
5	Friday	28
6	Saturday	23
7	Sunday	21
	Quantity	180
	Average	25.71428571

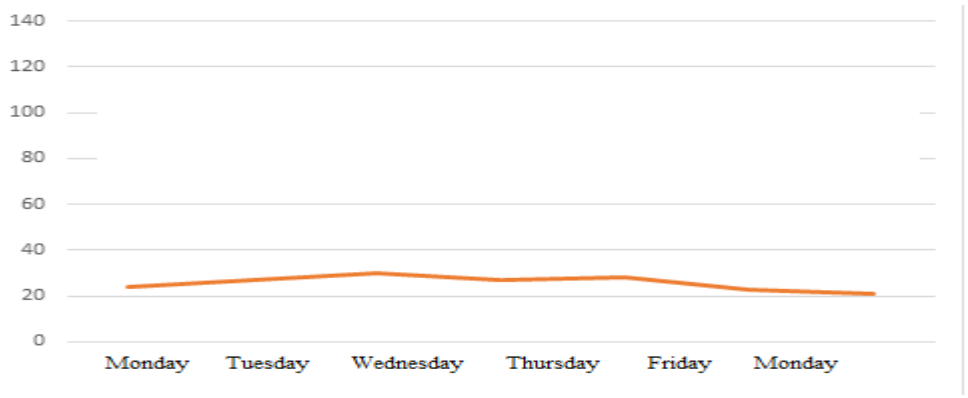

Figure 3. Patient Service Per Minute of Gadog Clinic

From table 1, it's known that From the data obtained during 30 days of observation, it is known that the number of patient arrivals during the 30 days of observation was 575 people/week.The average patient arrival (λ) on 30 days of observation is = 82/8=10 people per hour.
From table 2, it's known that the average patient care (μ) on 30 days of observation is = 25 minutes per person or 2 people per hour. Average patient care (μ) every 1 hour = 60/25 = 2.40 = 2 people per hour. Facility Usage Rate = λ /μ= 10/2=5
Average number of patients in queue (waiting before getting service)

$$Lq = \frac{\lambda^2}{\mu(\mu-\lambda)} = \frac{(10)^2}{2(2-10)} = \frac{100}{-16}$$ =-6 people.

A negative value indicates that the system is unable to accommodate patients, resulting in accumulation of patients.
Average number of patients in the system

$$s = \frac{\lambda}{\mu-\lambda} = \frac{10}{2-10} = \frac{10}{-8}$$ =-1.25 people.

The average number of patients in the system must be greater than the number in the queue because the number of patients in the system is the number of queues plus one person being served.

Average waiting time in queue

$$Wq = \frac{\lambda}{\mu(\mu-\lambda)} = \frac{10}{2(2-10)} = \frac{10}{-16}$$ =-0.625 hours = -37.5 minutes

Average waiting time in the system

$$Ws = \frac{1}{\mu-\lambda} = \frac{1}{2-10} = \frac{1}{-8}$$ = -0.125 hours = -7.5 minutes

The explanation of the results of the queuing analysis calculation using the Single Channel-Single Phase method at the Gadog Clinic is :

The average level of usability of service facilities (P) is 5 = 500%. A result below 100% means that the patient arrival rate is still low and there is still an opportunity to be unemployed for the clinic counter staff, while a result above 100% indicates a very high patient arrival rate so that there is a buildup and patients are not served properly. What happened at the Gadog clinic was the very high rate of patient arrivals so that there was a buildup so that patients were not served properly.

Average number of customers in Queue (Lq) is -6 people per hour, indicating an accumulation of patients in the queue. Average Number of Customers in the system (Ls) is -1.25 people per hour. These results indicate that the system is unable to accommodate patients, resulting in accumulation of patients.

Average waiting time in queue (Wq) is -37.5 minutes, means that the average time patients spend waiting in the queue is -37,5 minutes. Average Waiting Time in System (Ws) means that the average time a patient spends in the system is -7.5 minutes.

Conclusion

Based on the results of the analysis, it is known that the type of queue that existed during data collection in September 2020 - October 2020 at the Gadog Clinic was a single channel single phase model queue with one operator with 8 hours of work a day. After being analyzed according to the single-channel single-phase queue model, it can be seen that there is a very long queue caused by the arrival rate that exceeds the service level, causing an accumulation of patients in the queue. This situation will cause disappointment in patients caused by the long waiting period in the queuing system.

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