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# IMPLEMENTATION OF THE QUEUE SYSTEM MODEL [M/M/1]:[GD/∞/∞] IN THE DOCTOR QUEUE SERVICE PROCESS AT JETAK HEALTH CENTER, TUBAN DISTRICT

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***Abstrak*–One of the development efforts in the health sector is the availability of quality health services. Patient satisfaction is an indicator of success in providing health services to the community. UPTD. Jetak Health Center is a health unit in Montong District, Tuban Regency, which is located on Jalan KH. Chusnan Ali No. 163 Jetak Village, Montong District, Tuban Regency. Queuing Theory is the Mathematical study of queues or waiting lines. Queuing system at UPTD. Jetak Community Health Center follows the Single Channel-Single Phase or [M/M/1]:[GD/∞/∞] queuing system model with exponentially distributed services. Single Channel-Single Phase Model or [M/M/1]:[GD/∞/∞] on UPTD. Jetak Community Health Center is optimal because the waiting time for patients in the queue ($Wq$) is approximately 8.8 minutes, meanwhile the UPTD. Jetak Community Health Center applies a maximum waiting time for outpatients of 15 minutes**

**Keywords: Queue, Queuing Theory, Model [M/M/1]:[GD/∞/∞].**

## I. INTRODUCTION

One of the development efforts in the health sector is the availability of quality health services. Patient satisfaction is an indicator of success in providing health services to the community. Health service satisfaction is achieved if what the patient gets exceeds his expectations [1]–[3]. The availability of quality health services for the community is something that must receive attention from the government as one of the efforts in development in the health sector [4]. Jetak Community Health Center is a health unit in Montong District, Tuban Regency [5], which is located on Jalan KH. Chusnan Ali No. 163 Jetak Village, Montong District, Tuban Regency. Jetak Community Health Center is not the only health unit in Montong District, but there are other health units in Montong District. UPTD work area. Jetak Health Center covers 7 villages spread across Montong District with a total population of around 32,067 people.

Puskesmas is a basic health service facility that organizes health service efforts, health improvement (promotive), disease prevention (rehabilitative) which are carried out in a comprehensive, integrated and sustainable manner [6]. This concept of unified health efforts is a guideline for all health service facilities in Indonesia, including Community Health Centers. The position of the community health center is as the spearhead in the health service system and the community health center is the first health institution that deals directly with patients [7]. Therefore. Good service will produce benefits for both the health center and the patients. Apart from that, community health centers can form a positive image in the eyes of the community, so that they can increase people's trust and loyalty to seek treatment there. However, as time goes by, the puskesmas experiences an increase in patients, which will result in long queues of unserved patients.

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Unavoidable queues are a problem that often occurs in various Community Health Centers [8], [9].

Queuing Theory is the Mathematical study of queues or waiting lines. Queues are a natural phenomenon that occurs when the demand for a service at certain times exceeds the service capacity [10]–[12]. In general, busy time can be described as a queuing process that begins when a customer arrives, then waits, and ends when the customer leaves the system. During busy periods there is always at least one customer in the system, so queues will occur and human behavior cannot be separated from this queuing problem [13].

The uncertainty factor (randomize) also greatly influences the service system. One way that can be used to observe systems that contain uncertainty factors is to use a simulation model. Simulation models try to represent the actual system by simulation it is possible to observe how this system behaves. The more a simulation system is able to imitate a real system, the better the model is [14]. In general, in Mathematics, there are four classifications of basic queue structure models that occur in all queuing systems, namely: one channel, one stage (Single Channel Single Phase), many channels, one stage (Multi Channel Single Phase), one channel, many stages (Single Channel Multi Phase), and many channels many stages (Multi Channel Multi Phase). The occurrence of queues mainly depends on the nature of arrivals and the service process [15].

Kevin Girsang [16] analyzed the performance of the M/M/1 queuing system with the Preemptive-Resume priority discipline and also calculated the performance of the M/M/1 queuing system with the Non-Preemptive priority discipline. The results of the two analyzes were then compared. For type 1 system utilization values ($\rho 1$) = 0.6, 0.7, and 0.8 and type 2 system utilization ($\rho 2$) = 0.2, 0.3, 0.4, the values of $LS$ and $WS$ are close to the results. the. The results of Puji Robiati's analysis at the Ungaran Community Health Center, Semarang Regency, follow a compound series queuing system model with 3 stations. Detailed queue models include [M/M/1]:[GD/∞/∞] at the Registration Counter, model [M/M/7]:[GD/∞/∞] at the Doctor's Office, and [M/M/1 ]:[GD/∞/∞] at the Pharmacy Counter. The results of the effectiveness of the patient service process are as follows $Lq$ = 5; $Wq$ = 321.7384; $Ls$ = 8; $Ws$ = 738.4533. Based on the results of data analysis, a steady state is obtained because $\rho < 1$ so that currently the number of officers at the Registration Counter and Pharmacy Counter at the Ungaran Community Health Center, Semarang Regency is ideal and has reached the optimal level of 1 officer, so there is no need to add more counter officers.

The Single Channel-Single Phase model queuing system [17], [18] or [M/M/1]:[GD/∞/∞] is a model of a queuing system whose arrival pattern has a Poisson distribution and service pattern has an exponential distribution with one waiter. , the facility capacity is unlimited and the service discipline is FIFO (First In First Out) [19]. This queuing system is suitable to be implemented at the Jetak Community Health Center, where there is only one server and is in accordance with existing conditions. The queuing system for patient services at the Jetak Community Health Center begins with arriving patients who can immediately take a queue number in front of the Registration Counter and form a queue then wait until their queue number is called to register. After the registration counter it is then divided into several short queues according to the number of polys. This continuation queue is a queue for examinations at the Doctor's Room according to the registered clinic and ends at the queue for taking medicine. Before the service at the Registration Counter is complete, patients are not allowed to enter the next queue. A problem that often arises at the Jetak Community Health Center is that some patients feel that their time is being wasted because of long queues and taking too long to get their turn for service.

Therefore, systematic research is carried out to analyze queues, which in the end can be reduced or even prevented so that patients are satisfied with the services provided and the Community Health Center itself can provide optimal services. Optimal service in the world of health is very important, because it concerns the good and bad reputation of the Community Health Center, as well as the health problems of the patients themselves [20]. Therefore, a decision is needed about the ideal number of service providers to improve the quality of Puskesmas services. This problem can be solved by looking for the variables needed in the calculation process so that later a solution can be obtained which can at least reduce the length or queue time. This research was conducted to analyze the queuing system model at the Jetak Community Health Center so that it can be used as input for decision making for the Community Health Center so that it can provide comfortable services for patients but also not be detrimental to the Community Health Center.

## II. RESULT AND DISCUSSION

### A. *Data*

The data used is data on the number of patient visits at the Jetak health center in Tuban district during 12 working days and 164 patients were obtained and the total length of service was 1186 minutes. The following is the distribution of data shown in table 1*Gambar dan Tabel*

**Table 1:** ourly patient arrival rate for 12 days

| O'clock | Day | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| 08.00-08.59 | 3 | 12 | 3 | 9 | 4 | 9 | 10 | 4 | 7 | 9 | 5 | 10 | 85 |
| 09.00-09.59 | 2 | 8 | 2 | 0 | 7 | 9 | 7 | 4 | 3 | 6 | 7 | 7 | 62 |
| 10.00-10.59 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 0 | 3 | 1 | 4 | 4 | 17 |
| Total | 5 | 20 | 8 | 9 | 11 | 19 | 18 | 8 | 13 | 16 | 16 | 21 | 164 |

**Table 2:** Hourly patient service rate for 12 days

| O'clock | Day | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| 08.00-08.59 | 3 | 10 | 3 | 8 | 4 | 8 | 6 | 4 | 6 | 8 | 5 | 8 | 73 |
| 09.00-09.59 | 2 | 9 | 2 | 1 | 7 | 10 | 10 | 4 | 3 | 7 | 7 | 6 | 68 |
| 10.00-10.59 | 0 | 1 | 3 | 0 | 0 | 1 | 2 | 0 | 4 | 1 | 4 | 7 | 23 |
| Total | 5 | 20 | 8 | 9 | 11 | 19 | 18 | 8 | 13 | 16 | 16 | 21 | 164 |

**Table 3:** Hourly patient service time for 12 days

| Day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time(Minute) | 12 | 223 | 65 | 65 | 38 | 104 | 253 | 17 | 71 | 119 | 68 | 151 |
| Number of Patients per day | 5 | 20 | 8 | 9 | 11 | 19 | 18 | 8 | 13 | 16 | 16 | 21 |

### B. *Discussion*

#### 3.2.1 Steady State Measurement

The steady state measure of patient service system performance can be obtained by equation (1). The average hourly patient arrival rate was obtained

$$= 4{,}55 \approx 5 \textit{Patients come hourly}$$

Meanwhile, the average patient service time for 164 patients with a total service time of 1186 minutes was obtained

$$\textit{Average service} = 7{,}2317 \textit{ minute}$$

So the average service time is 7.14 minutes, the average hourly service rate is obtained$\mu = 8{,}2968 \approx 8\, patient\ per\ hour$

Next is the level of intensity of service facilities$(\rho)$ obtained

$$\rho = \frac{\lambda}{s.\mu} = 0{,}5491$$

Because $\rho = 0{,}5491 < 1$, it is in steady state

3.2.2 Distribution Fit Test

Distribution goodness-of-fit tests are useful for evaluating to what extent a model is able to approximate the real situation it describes. The goodness-of-fit test in this research uses Kolmogorov-Smirnov to test whether the available sample data is related to the hypothesis that the population from which the sample originates follows a predetermined distribution.

a. Poisson Distribution Goodness Test

Data on patient arrivals at the Jetak health center in Tuban district for 12 working days was then tested for goodness-of-fit using the Poisson distribution. The results of the Poisson distribution test using SPSS with the Kolmogorov-Smirnov test, the data is shown in Figure 1.

**One-Sample Kolmogorov-Smirnov Test**

| | | hari 1 | hari2 | hari 3 | hari4 | hari 5 | hari6 | hari 7 | hari 9 | hari 8 | hari 10 | hari 11 | hari 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Poisson Parameter[a,b] | Mean | 1,67 | 6,67 | 2,67 | 3,00 | 3,67 | 6,33 | 6,0 | 4,33 | 2,67 | 5,33 | 5,33 | 7,00 |
| Most Extreme Differences | Absolute | ,170 | ,332 | ,279 | ,617 | ,308 | ,478 | ,316 | ,295 | ,388 | ,303 | ,221 | ,164 |
| | Positive | ,144 | ,332 | ,279 | ,617 | ,308 | ,320 | ,316 | ,295 | ,264 | ,303 | ,170 | ,160 |
| | Negative | -,17 | -,315 | -,25 | -,330 | -,25 | -,478 | -,27 | -,19 | -,39 | -,24 | -,22 | -,16 |
| Kolmogorov-Smirnov Z | | ,295 | ,575 | ,483 | 1,07 | ,533 | ,827 | ,547 | ,512 | ,672 | ,524 | ,383 | ,284 |
| Asymp. Sig. (2-tailed) | | 1,00 | ,895 | ,974 | ,204 | ,939 | ,500 | ,926 | ,956 | ,757 | ,946 | ,999 | 1,00 |

a. Test distribution is Poisson.

b. Calculated from data.

**Figure 1:** Results of the Kolmogorow-Smirnov Test Output Poisson Distribution on patient arrival data at the Jetak Community Health Center, Tuban Regency

Figure 1 shows that if the significance value is greater than the specified real level then the test distribution hypothesis is accepted, conversely if the significance value is smaller than the real level then the distribution hypothesis is rejected. The decision result, namely $H_0$ dwas accepted with significance values, namely 1.00, 0.895, 0.974, 0.204, 0.939, 0.500, 0.926, 0.956, 0.757, 0.946, 0.999, 1.00 $> \alpha = 0.05$ with these results illustrating that the patient arrival data has a Poisson distribution.

b. Exponential Distribution Fit Test

Data on patient arrivals at the Jetak health center in Tuban district for 12 working days was then tested for goodness-of-fit using the exponential distribution. The results of the goodness-of-fit test are shown in Figure 2. Figure 2 shows that the significance value is greater than the set real level, then the test distribution hypothesis is accepted, conversely, if the significance value is smaller than the real level, the distribution hypothesis is rejected. The decision result, namely $H_0$ d, is accepted with a significance value, namely are 0.153, 0.702, 0.374, 0.154 0.175, 0.769, 0.952, 0.098, 0.442, 0.730, 0.374 0.273 > α = 0.05 with these results illustrating that the patient service data is exponentially distributed

**One-Sample Kolmogorov-Smirnov Test**

| | | hari1 | hari2 | hari3 | hari4 | hari5 | hari6 | hari7 | hari8 | hari9 | hari1 0 | hari11 | har12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | | 3[c] | 3 | 3 | 3[c] | 3[c] | 3 | 3 | 3[c] | 3 | 3 | 3 | 3 |
| Exponential parameter.[a,b] | Mean | 2,500 | 6,667 | 2,667 | 4,500 | 5,500 | 6,333 | 6,000 | 4,000 | 4,333 | 5,333 | 5,333 | 7,000 |
| Most Extreme Differences | Absolute | ,801 | ,407 | ,528 | ,801 | ,780 | ,384 | ,299 | ,868 | ,500 | ,398 | ,528 | ,576 |
| | Positive | ,801 | ,223 | ,325 | ,801 | ,780 | ,206 | ,189 | ,868 | ,250 | ,223 | ,269 | ,319 |

## III. KESIMPULAN

Based on the results of the analysis and discussion, the following conclusions can be drawn. Queuing system at UPTD. Jetak Community Health Center follows the Single Channel-Single Phase or [M/M/1]:[GD/∞/∞] queuing system model with exponentially distributed services. The time a patient spends in the queue is 8.8 minutes, so it is declared a queuing system at UPTD. Jetak Health Center is optimal. The average number of patients in the system is 1.2177 patients per hour..

Figure 2: Kolmogorow-Smirnov Test Output Results Exponential distribution of patient service data at the Jetak Community Health Center, Tuban Regency

**Queuing System Performance**

Queuing system performance at UPTD. Jetak Community Health Center uses the Single Channel-Single Phase model or [M/M/1]:[GD/∞/∞] with performance measures including $L_s, L_q, W_q,$ dan $W_s$, namely:

1. Average number of patients in the system$(L_s)$
   $L_s = \frac{\lambda}{\mu-\lambda} = 1{,}2177\ patient\ per\ hour$
2. Average number of patients in the queue$\left(L_q\right)$
   $$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = 0{,}6686\ pasien\ per\ jam$$
3. Average time spent by patients in the system $(W_s)$
   $$W_s = \frac{1}{\mu-\lambda} = 0{,}2673\ patients\ per\ hour$$
4. Average time spent by patients in queue $\left(W_q\right)$
   $$W_q = \frac{\lambda}{\mu(\mu-\lambda)} = 0{,}1468\ per\ hour$$
5. Percentage probability of no patient in the system $(P_0)$
   $$P_0 = 1 - \frac{\lambda}{\mu} = 45{,}15\ \%$$

**Analysis of the Optimal Level of Queuing System Performance**

Based on the results of calculating patient services at the Jetak Community Health Center using the Single Channel-Single Phase model or [M/M/1]:[GD/∞/∞] with unlimited services and only one server, the minimum waiting time required for patients in the system is obtained $(W_s)$ is 0.2673 hours or approximately 16 minutes, for patient waiting time in queue $(W_q)$ which is 0.1468 hours or approximately 8.8 minutes. The average number of patients in the system $(L_s)$ is 1.2177 patients per hour, the average number of patients in the queue $(L_q)$ is 0.6686 patients per hour, and the percentage probability of no patients in the system (P_0 ) is 45.15 %.

From this data it can be stated that the queuing system is with a Single Channel-Single Phase model or [M/M/1]:[GD/∞/∞] in the UPTD. The Jetak Community Health Center is optimal because the patient waiting time in the queue (W_q) is approximately 8.8 minutes. As a reference, the calculation results are said to be optimal by comparing the maximum service time applied at the

Community Health Center, which is 15 minutes

## 4. Conclusion

Based on the results of the analysis and discussion, the following conclusions can be drawn. Queuing system at UPTD. Jetak Community Health Center follows the Single Channel-Single Phase or [M/M/1]:[GD/∞/∞] queuing system model with exponentially distributed services. The time a patient spends in the queue is 8.8 minutes, so it is declared a queuing system at UPTD. Jetak Health Center is optimal. The average number of patients in the system is 1.2177 patients per hour.

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