Single Server Queuing Model for Ambulatory Patient At The Rsud Dr. M.M Dunda Limboto, Gorontalo

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Abstract: ***Introduction:*** Queuing is an event that is often encountered in everyday life. The purposes of conducting this research are to analyze the effectiveness of the queuing system that occurs during the service of ambulatory patient care and to examine whether the one-way queuing model (M/M/1) is still an affective model when serving ambulatory patient at the RSUD Dr. M.M Dunda Limboto, Gorontalo. The data used in this research is secondary data of ambulatory patients at the RSUD Dr. M.M Dunda Limboto, Gorontalo on February 2nd until 17th 2021 (during work days). ***Methods:*** An unobtrusive (non-reactive) analysis using the secondary data of ambulatory patients at RSUD Dr. M.M Dunda Limboto, Gorontalo. ***Results:*** The waiting time for ambulatory patient is 0.05 hour and the queue length formed is 3 patients, so there is no queue that significantly detrimental the patients at RSUD Dr. M.M Dunda Limboto, Gorontalo and the queuing system that applies at RSUD Dr. M.M Dunda Limboto, Gorontalo for ambulatory patients is an effective queuing system, where the server can serve all patients every day in a fairly short time using only one server. So, the M/M/1 system can still be used by RSUD Dr. M.M Dunda Limboto, Gorontalo.

Keywords: *Queue, M/M/1, Poisson, Ambulatory Patient*

INTRODUCTION

Queuing process is a process associated with the arrival of patients at a care facility then wait in a queue (if all servers are busy) and eventually left the facilities (Green, 2006; Gupta, 2013). The interesting things about queue are the arrival of the patient, whether the patient comes one by one or in groups and whether the balking or reneging allowed (Peter & Sivasamy, 2019; Pramudhita, 2017; Suardi et al., 2021). Queues with balking and reneging often appear in daily events due to the propensity of impatient patients with long queue (Kuaban et al., 2020). As a result, the patient either balk (i.e., decide not to join the queue) or renege (i.e., leave after joining the queue without getting served). If not mentioned specifically, the standard assumption is all of the patients arrive one by one and there is no balking and reneging (Goswami, 2014).

In probability distribution, there is exponential distribution (Lakshmi & Iyer, 2013). Consider the occurrence of an event governed by the exponential distribution as an arrival, then given that no arrival has occurred up to time t, the time until the next arrival is exponentially distributed with mean $1/\lambda$ (Ibe, 2013). As for model of stochastic process, there is Poisson processes. Poisson processes are widely used to model intervals (or occurrence of events) in a system. Poisson random variable have mean $E[X(t)]=\lambda t$. This mean indicates that λ is the expected number of arrivals per unit time in the Poisson process. Thus, the parameter λ is called the arrival rate for the process (Ibe, 2013).

The purposes of conducting this research are to analyze the effectiveness of the queuing system that occurs during the service of ambulatory patient care and to examine whether the one-way queuing model (M/M/1) is still an affective model when serving ambulatory patient at the RSUD Dr. M.M Dunda Limboto, Gorontalo. Because the it uses the M/M/1 queue, there are some measurements of the effectiveness characteristics that need to be considered, such as:

1. Unlimited population of patients
2. First Come First Serve
3. Poisson arrival rate (λ)
4. Exponential service time (μ)
5. All of the above, assuming $\lambda<\mu$

Literature Review

Queueing systems are classified according to (Pinsky & Karlin, 2011):

1. The input process, which is the probability distribution of the patient arrival (in time);
2. The service distribution, which is the probability distribution of the random time to serve a patient (or group of patient in case of batch service); and
3. The queue discipline, which is the number of servers and the order of patient service. The most common queue discipline is First Come First Served, where customers are served in the same order in which they arrive.
4. Queuing systems also vary, including (Pinsky and Karlin: 2011):
5. The M/M/1 queue, where arrivals follow a Poisson process, service times are exponentially distributed and there is a single server. The number $X(t)$ of patients in the system at time t forms a birth and death process.
6. The M/M/∞ queue, where there are Poisson arrivals and exponentially distributed service times. Any number of customers are processed simultaneously and independently. Often self-service situations may be described by this model.
7. The M/G/1 queue, where there are Poisson arrivals but arbitrarily distributed service times. The analysis proceeds with the help of an embedded Markov chain.

Methods

Research Design

This research is non-reactive research (unobtrusive). Unobtrusive is a measurement made when the sample (people under the research) are not aware of being part of a research. So, the measurements made in the study will not make the person feel disturbed. This happens because the information obtained from the sample is a past event and becomes secondary data. This happens because the measurements carried out do not interfere with the person, due to the information obtained comes from events that have passed and becomes secondary data (Kuntoro, 2009). Therefore, this research uses secondary data to analyze whether the one-way queuing model (M/M/1) is an affective model when serving ambulatory patient at the RSUD Dr. M.M Dunda Limboto, Gorontalo.

Source Of Data

The data used in this research is secondary data of ambulatory patients at the RSUD Dr. M.M Dunda Limboto, Gorontalo on February 2nd until 17th 2021 (during work days).

Data Analysis

The dominant task of queuing analysis is to find out the arrival rate and service time information as input. While the outputs are waiting items, waiting time, queuing items and queuing time. The required result in this research, specifically is the average value of the output. The methods of data analysis are (Kakiay, 2004):

- Calculate the average number in the system
- Calculate the average time of service (μ)
  - Determine the intensity of traffic queues (the probability of patient being waited) (ρ)
  - Determine the average number of patients in the system (L)
  - Determine the average number of patients is waiting to be served (L_q)
  - Determine the average time that spent by a patient in system (the time of the queue in minutes) (W)
  - Determine the average time that spent by a patient in the queue (the waiting time) (W_s)

Results And Discussion

The SAS System

average_patients_perday
104.38095
average_time_effective
3.6
average_arrival_rate
28.994709

average_service_rate_hour	average_service_rate_seconds
41.944444	1.4304636
56.666667	1.0588235
42.5	1.4117647
47.5	1.2631579
36.388889	1.648855
40	1.5
59.166667	1.0140845
36.944444	1.6240602
50.277778	1.1933702
46.944444	1.2781065
32.222222	1.862069
51.111111	1.173913
37.777778	1.5882353
29.444444	2.0377358

myuseconds	myuhour
1.4346171	41.823007

e	rho	L	Lq	Whour	Wsecond	Wqhour	Wqsecond
2	0.6932717	2.2602148	1.5669431	0.0779527	4.6771599	0.0540424	4.6771599

On the results obtained

1) The average number of ambulatory patients at the RSUD Dr. M.M Dunda Limboto, Gorontalo (in day) (X) is 104 (≈104,38) patients during work days.
2) The average time of effective service (t) for ambulatory patients at the RSUD Dr. M.M Dunda Limboto (during work days) is 3.6 hours a day.
3) The average of arrival rate (λ) for ambulatory patients at the RSUD Dr. M.M Dunda Limboto is 29 (≈28,99) patients/hour.
4) The average of service time (μ) for each ambulatory patients at the RSUD Dr. M.M Dunda Limboto is 42 (≈ 41,8) patients/hour or 2 (≈1,43) minutes/patient.
5) The intensity of traffic queues (the probability of a patient being waited) (ρ) is 0,70 (≈ 41,8), which 70% of the servers will be busy during their serving time.
6) The average number of patients in the system (L) is 3 (≈ 2.26) patients, which means there is 2 patients are in the queue and 1 patient is being served.
7) The average number of patients is waiting to be served (L_q) is 2 (≈1,57) patients.
8) The average time that spent by a patient in the system (the time of the queue in minutes) (W) is 5 (≈4,68) minutes, where 4.8 minutes is the time that the patient is in the queue and the time the patient is served.
9) The average time that spent by a patient in the queue (the waiting time) (W_s) is 0.05 hour

The results of the queuing analysis can be evaluated in several parts, including: (1) the head of RSUD Dr. M.M Dunda Limboto, Gorontalo must consider the busy time of the server (70%) and free time of the server (30%); (2) The waiting time for ambulatory patient is 0.05 hour and the queue length formed is 3 patients, so there is no queue that significantly detrimental the patients at RSUD Dr. M.M Dunda Limboto, Gorontalo; (3) The queuing system that applies at RSUD Dr. M.M Dunda Limboto, Gorontalo for ambulatory patients is an effective queuing system, where the server can serve all patients every day in a fairly short time using only one server.

CONCLUSION

The queuing system that applies for ambulatory patient registration at RSUD Dr. M.M Dunda Limboto, Gorontalo is still an effective system using only one server (M/M/1) and can still be used by RSUD Dr. M.M Dunda Limboto, Gorontalo, because it can serve all patients every day in a fairly short time.

ADVICE

If this result is not acceptable or the queue is still considered too long by the head of RSUD Dr. M.M Dunda Limboto, Gorontalo, it is necessary to add a second server or make other changes in the characteristics of the arrival of the queue as an effort to improve services to ambulatory patients at RSUD Dr. M.M Dunda Limboto, Gorontalo.

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