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Analysis non-poisson systems cases of queuing passenger aircraft at Ahmad Yani Airport

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Abstract
Aircraft are effective transportation compared to land and sea transportation. This causes the growth of demand flow of movement, both passengers and aircraft each time period is always increasing. However, The issues that arise are the issues that arise. Meanwhile, the problems that occur are capacity building. Based on the description above, one example of a queue system that is often encountered in daily life is the transportation service system, for example the plane queue at Ahmad Yani International Airport. Based on observations made while boarding the plane, it is not according to the schedule, which is normal because of the arrival of the plane that is not on time. This causes the airport parking lot to be full or busy and can prevent the arrival of the aircraft. Related to the application of the queue method can overcome the difficulties in standing aircraft parking facilities at Ahmad Yani Airport in Semarang.The results analysis model data of passenger plane queue system at Ahmad Yani International Airport (G / G / 8) : (GD / ∞ / ∞). The non-poisson model of time distribution interval arrivals the normal log and logistic distribution time, servers 8 with queue discipline use FIFO, unlimited service capacity, and unlimited transfer resources.

INTRODUCTION

Based on the projection of the 2013, National Development Planning Agency predicted that Indonesia's population in 2018 will reach 265 million people. Increasing human population in Indonesia resulted increasing need for transportation every year, this can also result in the growth of air transport passengers in Indonesia that has experienced a significant increase in recent years. The growth in the number of passengers from 2016 reached 16.65% and it is estimated that it will increase every year (Rachmansyah, 2017)he growth in demand for movement, both passengers and aircraft for each period of time must be followed by the availability of infrastructure that has the capacity. Sufficient to fulfill the movement. However, the problem that generally occurs is a condition which is the airport capacity cannot increase simultaneously with an increase the number of movements occured.

In addition, the number of airlines that go through the airport, both arrival and departure, does not match the schedule. And it causes the plane's boarding time to not match the existing schedule. This results in the use of the airport parking stand being full and can hinder the arrival of the next aircraft. This condition will result in queues and delays which will have implications for decreasing service levels or performance at airports (Rachmansyah, 2017). Queuing theory is one of the statistical methods that can be used to overcome these problem.

The purpose of using queuing theory is to design service facilities to overcome these problems. Service requests that fluctuate randomly and maintain a balance between service costs and costs required during queuing, so the application of this method is used to determine the queue model and determine performance measures on passenger aircraft on Ahmad Yani International Airport Semarang.

Literature Review

Ahmad Yani International Airport Semarang is an airport that serves domestic flights to many big cities in Indonesia and international flights to Kuala Lumpur and Singapore. In addition, it also provides Aeronautical Services, aircraft placement and storage services in the airport area. For this reason, PT Angkasa Pura I (Persero) Semarang Ahmad Yani Airport provides apron facilities consisting of 12 parking stands but in this study only observes passenger aircraft so that observations are only on parking stand 3 to parking stand 10, parking stands are used for increasing lowering of passengers in addition to providing refueling facilities, aircraft maintenance and operational support needs of airlines.

Queuing theory was discovered by AK Erlang for the first time.,a Danish engineer in 1910. He conducted experiments on fluctuations in the demand for telephone facilities in which operators were overwhelmed to serve the callers as quickly as possible, so that callers had to wait in line for a long time (Supranto, 2016). Queuing discipline is seen in customers who will be served based on the first come. Customers can come within the same time interval or it can be random, with different arrival times. This situation often occurs and is found. what is maxed out. Queue is a number of customers waiting to get service, the quequing process includes customer arrival, waiting in the queue if it can't be served, being served and finally leaving the facility after being served.

Queue System Factor:

1. Distribution of Arrivals
2. Distribution of Service Time
3. Service Facilities
4. Queuing discipline
5. Size In Queue
6. The Source of the Call

Standard notation designed By (Taha, 2015) in the form (p/ q / r): (s / t / u) which is known as Kendall notation.

- P : Arrival distribution.
- q : Distribution of service time (service time distribution).
- R : Number of service points (where c = 1, 2, 3,… ∞).
- S : Service discipline, for example FIFO, LIFO, SIRO, PS.
- T : The maximum number of subscribers allowed in the system.
- U : The source of the call

Steady state is a condition when the system properties do not change over time (constant). According to Taha (2015), for example λ is the average arrival of customers to the service place per unit of time, μ is the average customer who has been served per unit of time, and c is the number of service facilities (servers). The steady state condition is met if $\rho < 1$, where ρ is $\lambda / C\mu$. After the conditions are met, it will be able to measure system performance that is used to analyze the queue system operation.

According to (Taha, 2015) the Poisson process is assumed if the between arrival time and service time are exponentially distributed or the number of arrivals and the number of services are Poisson distributed, this is if it meets the following three assumptions:

a. Independent
   N (t) is independent of the number of events that occurred in the past. In this case, independent means that N (t) does not depend on past experiences or events.
b. Homogeneity in time
   Pn (t) only depends on the length or length of the time interval but does not depend on where the time interval differs. Pn (t) is the probability of occurrence during time t
c. Regularity
   In a small interval between time t and $t + \Delta t$, the probability that one event occurs is $\lambda \Delta t + o(\Delta t)$. So that it can be written P {there is an arrival between $t + \Delta t$} = $\lambda \Delta t + o(\Delta t)$, where λ is a constant that is independent of N (t), (Δt)

The Kolmogorov Smirnov test steps are as follows:

a. Determining Hypotheses
   H0: The distribution of the sample follows the distribution specified
   H1: The distribution of the sample does not follow a defined distribution
b. Determining the Level of Significance
   Here we will use α
c. Test Statistics
   $D = (\max (| S(x_i) - F_0(x_i) |, (| S(x_{i-1}) - F_0(x_i) |))$
   S(x):cumulative probability function calculated from the sample data
   F0 (x): cumulative probability function
d. Test Criteria
   Reject H0 if the D value ≥ the Dtabel value (1- α), or if the significance value <α value. Dtabel (α) is obtained from the Kolmogorov-Smirnov table.

According to (Stenio.R., 2017) log Logistic distribution is a continuous distribution function. Log-logistics distribution is often used to analyze data that is positively skewed. The two-parameter logistic distribution has the following PDF and CDF:

If x

$$f(x;\alpha,\beta) = \begin{cases} 0 & jika\ x < 0 \\ \dfrac{\alpha\left(\frac{x}{\beta}\right)^{\alpha-1}}{\beta\left(1+\left(\frac{x}{\beta}\right)^{\alpha}\right)^{2}}, & \text{If } 0 \le x\ \infty \end{cases}$$

According to Kundu & Manglick (2014), Suppose X is a random variable with normal distribution, then Y = ln (X) has a log norm distribution L (X ~ LN (μ, σ 2)) with parameters μ and σ2; σ2> 0, if and only if it has the density function of X defined as follows:

$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} e^{-\frac{1}{2\sigma^2}(\ln x - \mu)^2}\text{;for } x > 0$$

According to Taha (2015), the queuing model (G / G / c) :(GD / ∞ / ∞) is a queuing model with a general distributed arrival pattern and a general distribution service pattern with c. , c = 1, 2, 3, ...

The queue discipline used in this model is general, namely FIFO (First In First Out), the maximum capacity allowed in the system is infinite, and has infinite call sources. For the calculation of the number of customers estimated in queue (Lq) based on the performance measure in the model (M / M / c) :(GD / ∞ / ∞). The formula for finding performance measures in the model (G / G / c) :(GD / ∞ / ∞) is as follows:

$$L_{q/M/M/C} = \frac{r^c}{c!(c-\rho)^2} P_0$$

$$L_q = L_{q/M/M/C} \frac{\mu^2 v(t) + v(t')\lambda^2}{2}$$

$$L_s = L_q + \rho$$

$$W_q = \frac{Lq}{\lambda}$$

$$W_s = Wq + \frac{1}{\mu}$$

μ is the mean of the service time distribution

$$\left(\frac{\beta\left(\frac{\pi}{\alpha}\right)}{\sin\left(\frac{\pi}{\alpha}\right)}\right)$$

λ is the mean of the time distribution between arrivals is

$$e^{\mu+\frac{1}{2}\sigma^2}$$

v (t) is a variant of the service time distribution

$$\left(\beta^2\left(\frac{2b}{\sin 2b} - \frac{b^2}{\sin^2 b}\right)\right)^2$$

v (t ') is the variant of the time distribution between arrivals

$$\left(e^{2\mu+\sigma^2}\left(e^{\sigma^2} - 1\right)\right)$$

MATERIALS AND METHODS

This study uses primary data obtained from direct observation at the Ahmad Yani International Airport Semarang Apron Movement Control. Data sampling was conducted from January 13, 2020 to January 22, 2020. from 05.30 WIB to 20.30 WIB every day. The software used by Statistics software, namely, R Studio, Easyfit. The steps in the research are as follows;

1. Determine the place and research method Conduct research to obtain data on the arrival time of the aircraft (landing) and data when the aircraft is served.
2. The data obtained must meet the steady-state conditions (ρ = λ / Cμ <1).
3. Test the suitability of the exponential distribution for the time between arrivals and the time visitors are served using the Kolmogorov Smirnov test. if it does not meet, the data is generally distributed.
4. Determine the appropriate queuing model, in terms of arrival distribution, service distribution, number of services, queue discipline used, capacity and source of calls.
5. Determine general distribution with Easy fit software.
6. Determine a complete queue model that contains a predetermined general distribution.
7. Determine system performance, Ls, Lq, Ws, Wq.
8. Making results and discussing the optimal model.

RESULT AND DISCUSSION

The queuing system for aircraft at Ahmad Yani International Airport is generally for passenger aircraft using parking stand 3 to parking stand 10. Parking Stand as a waiter and passenger aircraft as customers. The plane that landed on the runway at Ahmad Yani International Airport was declared an arrival, after going from the runway to the predetermined parking stand. Then the service starts when the boarding plane is on the first call. The aircraft is finished serving when it blocks off or when the aircraft is pushed out of the parking stand. For more details, the aircraft queuing system is shown in Figure 1.

Table 1. Level of Use of Aircraft Service Facilities

	Λ	μ	$\boldsymbol{\rho} = \frac{\lambda}{c\,\mu}$
8	2.854714	2.770652	0,1287925

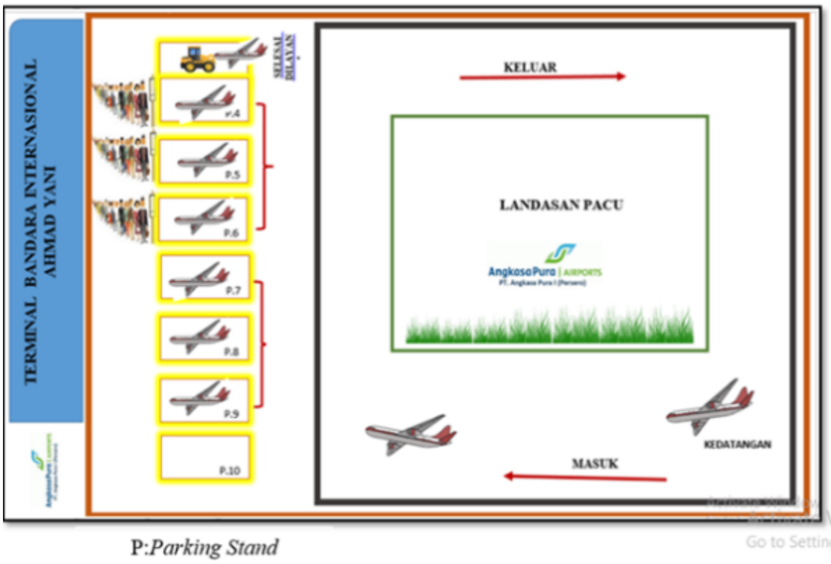

Fig 1. Queuing System for Ahmad Yani International Airport Passenger

The steady state condition satisfies if $\rho < 1$ means that the average number of aircraft arriving is smaller than the average number of aircraft served. The time interval used is 60 minutes. The average number of incoming aircraft (λ) in 60 minutes is 2.854714. The average service time of the aircraft served (μ) in 60 minutes is 2.770652 . The number of parking service stands used at Ahmad Yani International Airport is 8 for aircraft.

From Table 1, it can be seen that the level of use of the Ahmad Yani International Airport service facilities in Semarang is less than one, so it can be concluded that the steady state conditions are met. The distribution compatibility test using software R with the Kolmogrov Smirnov test to determine the time data between aircraft arrivals and service time.

Table 2. Output Distribution Test

Data	D_{count}	D_{table}	Decision
Arrivals Time Interval	0.16409	$\frac{1.36}{\sqrt{263}} = 0.083861$	H_0 rejected
Service Time Interval	0.3857	$\frac{1.36}{\sqrt{270}} = 0.082767$	H_0 rejected

Table 3. Performance Measures of the Queuing System

Data	D_{count}	D_{table}	Decision
Arrivals Time Interval	0.03965	$\frac{1.36}{\sqrt{263}} = 0.083861$	H_0 accepted
Service Time Interval	0.03311	$\frac{1.36}{\sqrt{270}} = 0.082767$	H_0 accepted

Table 4. Performance Measures of the Queuing System

c	λ	μ	L_q	L_s	W_q	W_s	P_0
8	21.927	2.814	7.695	6.721	0.662	0.306	0.0000710

A plane queue system model, Arrivals Time Interval is normal log distributed and service time interal is distributed Logistic log (Table 2). So at a significant level of 5%, the results obtained from the time data between aircraft arrivals and aircraft service times at Ahmad Yani International Airport do not have an exponential distribution or a general distribution.

Based on Table 3. A plane queue system model, time data between aircraft arrivals is normal log distributed and time data between. Based on Table 4. for aircraft at Ahmad Yani International Airport in 60 minute intervals, the following information can be obtained;

1. The number of parking service stands to serve airplane is eight
2. λ = 21,927 in 60 minutes, which means that the average arrival time of each plane arriving in the queue of aircraft at Ahmad Yani International Airport in Semarang is 2,736 minutes.
3. μ = 2,814, within 60 minutes. This means that the average service time per one aircraft served at Ahmad Yani International Airport is 21,322 minutes.
4. Ls = 7,695 in 60 minutes. This means that in 7,797 minutes there is 1 number of aircraft in the aircraft queue system.
5. Lq = 6,721, the average aircraft in 60 minutes means that in 8,927 minutes there is 1 number of planes queuing.
6. Ws = 0.360926 out of 60 minutes. This means that the time spent waiting in the system from queuing to finish being served is around 39,709 minutes.
7. Wq = 0.306 out of 60 minutes. This means that the time spent waiting in line for an airplane before getting service or before boarding is around 18,390 minutes.
8. P0 = 0.00007108, the queue has a chance of not being busy by 0.007% and the remaining 99.993% is the chance the queue system is busy.

CONCLUSION

From the research results it can be concluded that the aircraft queuing system model at Ahmad Yani International Airport Semarang is a non-poisson queue, namely LNORM / LLOGIST / 8) :(GD / ∞ / ∞) with the time distribution between aircraft arrival and normal log distribution and aircraft service time. Distributed logistics logistics with eight services, first-come-first-served (FIFO) service rules, unlimited service capacity, and unlimited call sources. From this distribution, it is obtained a measure of the performance in the average arrival time of each aircraft arriving in the queue of planes at Ahmad Yani International Airport, Semarang, which is every 2,736 minutes. And the average service time for each one aircraft served at Ahmad Yani International Airport is 21,322 minutes. And within 7,797 minutes there are 1 number of aircraft in the queuing system and within 8,927 minutes there is 1 number of plane qeuing. The time spent by an aircraft waiting in the queuing system to finish being served is approximately 39,709 minutes. The time spent for an airplane waiting in line before receiving service is approximately 18,390 minutes. The queue system has a 99.993% chance of being busy and the remaining 0.007% is the chance that the queue system is not busy.

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