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QUEING ANALISIS OF AIRCRAFT MOVEMENT AT THE APRON AREA (THE PARKING STAND) IN I GUSTI NGURAH RAI INTERNATIONAL (BALI)

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Keywords : Aircraft Movement, Apron, Queing

ABSTRACT
I Gusti Ngurah Rai International Airport (Bali) is one of the busiest airports in Indonesia which has the potential as a center of tourist destinations for foreign/international tourists. The potential for aircraft movements tend to increase from year to year. One of the facilities that continues to be monitored is the aprons where there are so many parking stands which are the parking lots for aircraft. The results of this study are the arrival of airplanes (λ) is 225.6 airplanes / day, or 9.44 airplanes / hour, or 6.35 minutes / airplanes. Then the Utilization (ρ) of the entire Parking Stand is 30%. The average queue length (L_q) for parking stands is 0 aircraft, and the average queuing time (W_q) is 0 minutes. Then the average number of aircraft in the parking stand system (L_s) is 18.9 aircraft and the average length of time for aircraft in the parking stand system (W_s) is 120 minutes.
Keywords: Ngurah Rai International Airport, Parking Stand, Performance

PRELIMINARY

Background of I Gusti Ngurah Rai International Airport (IGNRIA) as the one of the busiest airports in Indonesia has the potential as a center of international tourist destinations, this potential has a very important role in economic growth activities for the country in the tourism sector.

Tourist visits in the fourth quarter alone in 2019, the province of Bali was recorded at 1.62 million visits, these tourist visits were still dominated through airports which recorded 1.60 million visits. In terms of the country of origin, Australian tourists were the highest contributor, which was recorded at 20.72% or one-fifth of the total tourists heading to Bali province, followed by tourists from China who recorded at 15.28% and tourists from India who recorded at 6.39%. .

AMC (Apron Movement Controller) work unit under the auspices of PT. Angkasa Pura I (Persero) has the duty and obligation to prepare for the operation of safety facilities, the air side, the land side, and large airport

equipment as well as supporting facilities, and the implementation of services to regulate the movement of aircraft in the airport area. Data Aircraft Movements at the Apron Area of International Airport I Gusti Ngurah Rai Bali as follows:

Year**:** Aircraft movements
2017: 146,413
2018: 162,623
2019: 155,334
Source: PT. Angkasa Pura I Bali

Based on the above background, therefore the author is interested and become the background for the author to examine these problems by taking the title *"**ANALYSIS OF AIRCRAFT MOVEMENT AT THE** APRON AREA IN INTERNATIONAL AIRPORT I GUSTI NGURAH RAI **(**BALI**)**"*.

IDENTIFICATION OF PROBLEMS

Based on the description that has been explained in the background above, the writer can find several problems that can be concluded:

1. Are the number of aprons and parking stands available at I Gusti Ngurah Rai Airport (Bali) (IGNRIA) insufficient?
2. There are too large number of aircraft movements at IGNRIA.

The problem boundaries are made so that the topics discussed are not widened so that the writing will focus on the topics to be studied.
The limitation of the problem in this study, the researcher will only discuss and focus on the movement of aircraft in the air side apron area (Airside) of I Gusti Ngurah Rai International Airport, Bali.

THE AIM OF THESE RESEARCH

To calculate the performance of aircraft services at I Gusti Ngurah Rai International Airport (IGNRIA), as follows:

1. How arrival rate of aircraft (λ) (or we can say aircraft movements) is at I Gusti Ngurah Rai International Airport (IGNRIA)?
2. How average number of queues of aircraft (L_q) is at the apron area of IGNRIA?
3. How average queue time for aircraft (W_q) to be served is at the apron area at IGNRIA?
4. How is the Utilization (ρ) of The Apron Area atn IGNRIA?
5. How rate number of aircraft will be is at the apron system of IGNRIA?
6. How long time is the aircraft will be at the system apron of IGNRIA?

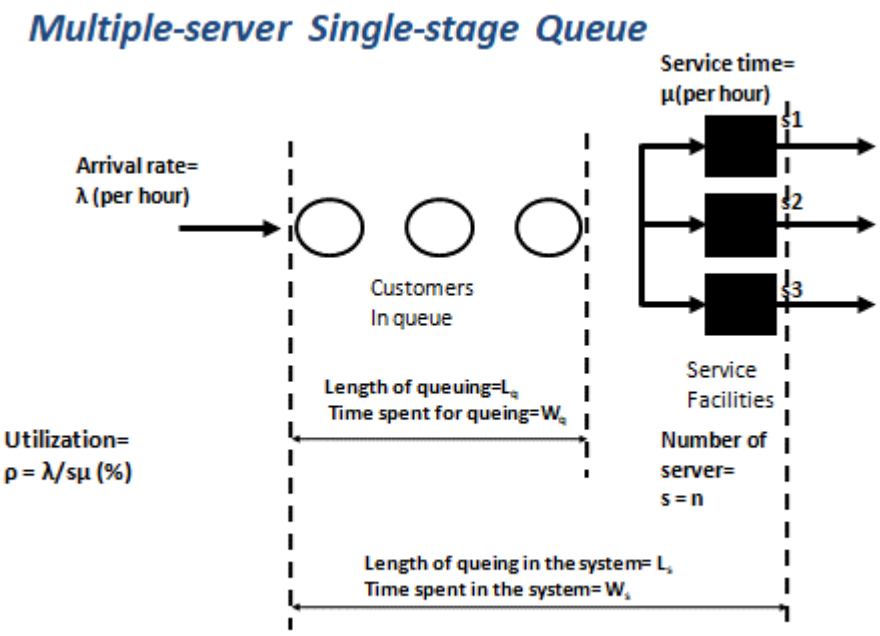
THEORETICAL BASIS

Apron is an airport area on land that has been determined to accommodate aircraft for the purpose of boarding and descending passengers, loading and unloading cargo, passengers, mail, refueling, airplane parking, or aircraft maintenance.

In the apron area, there is an area designated for aircraft parking purposes, this area is known as the aircraft parking lot or Aircraft Stand or Parking Stand. All activities in the apron area are supervised and controlled in Apron Management Services or AMC in providing services for activities and movements of aircraft and vehicles in the apron area.

Apron Management Service or apron service management is a service provided to regulate the movement of aircraft and vehicles in the apron area (ICAO, 2016).

Model of queuing method to be implemented



Analytical technique that will be used by the writer for the purpose of research is Queuing Theory (Operational Mathematics).

Queuing Theory:

- Managers using queuing models to be more efficient in providing customer services
- Models measure average waiting times and average length of waiting lines.

Historical roots, that Agner Kraup Erlang a Danish Engineer who work for the Copenhagen Telephone Exchange published the first paper on Queuing Theory in 1909. David G Kendall introduce an A/B/C queuing notation in 1953.

There are three queuing discipline in the queuing theory, namely FIFO, LIFO, and Processor Sharing. Here we use FIFO. Here we have four models of queuing:

- Single-Server Single-Stage Queue
- Multiple-Server Single-Stage Queue
- Single-Server Multiple-Stage-Queue
- Multiple-Server Multiple-Stage-Queue

What firstly we have to measure in the queuing theory?

- In the Queuing Theory we have to measure the customer arrival rate/ traffic (λ) (per unit of time).
- We have to measure time/ speed to serve customer (μ) (per unit of time).
- Also we have to know the total/ number/ channel of server.

There are four factors that are used to understand performance of the queuing system. The five configuration models that have to be calculated are:

a. Utilization Rate in Queuing System, Utilization rate in a service system

$\rho = \lambda/(s.\mu)$, s= total server/ channel in the system.

Utilization:	**Conclusion:**
0% – <33,3%	Under Utilized
33,3 % - <50%	Normally Utilized
50% - <66,6%	Fully Utilized
66,6% - 100%	Over Utilized

Source: UTPK/ JICT, Indonesia Port Corporation, and arranged by writter

b. Waiting Time for Queuing (W_q)

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

c. Length of Queuing (L_q)

L_q directly depends on waiting time in queuung (W_q) and arrival rate λ.

$$L_q = \frac{(\lambda/\mu)^2 \ (\lambda/S\mu)}{S!\,(1 - \lambda/S\mu)^2} P_0$$

P_0= Probability of zero customer in the system

d. Time Spent in The System (W_s)

W_s is time that is counted since customers entering the waiting line until the service process is finished.

$$W = W_q + \frac{1}{\mu}$$

e. Length of queuing in the system (L or L_s),

L or L_s or length of the queue in the system is the total amount of customers in the system, either those who are still in the waiting line or who are currently being serviced.

$$L = L_q + \frac{\lambda}{\mu}$$

RESEARCH RESULTS AND DISCUSSION

Data Findings, with the large number of existing aircraft it requires a large number of parking spaces. I Gusti Ngurah Rai Bali International Airport has 63 apron facilities, consisting of 47 north aprons and 16 south aprons.

Table, Spesification of Airport I Gusti Ngurah Rai

Uraian	Terminal						
	Runway	*Apron*	*Avio-bridge*	Internasional	Domestik	VIP	Kargo
	mxm	*Parking stand* (m²)	(unit)	Luas (m²) dan Kapasitas (*Pax*/tahun)			
DPS	3,000mx45m	North Apron Area: 82.899 m² Cap: 47 PS South Apron Area: 83.020 m² Cap: 16 PS	30	126.162 m² 16.000.000 mppa	67.884 m² 9.000.000 mppa	7,074 m²	189,669 m² 73,327 ton/thn

Resource: Laporan Tahunan Angkasa Pura I (2019)

Layout of Airport I Gusti Ngurah Rai (Bali)

Source: PT. Angkasa Pura I Denpasar Bali

Total movemnts of aircrafts in Airport I Gusti Ngurah Rai, October-December 2019

Month	International		Domestic		Total Movements Per Month
	Departure	Arrival	Departure	Arrival	
October	3168	3176	3591	3603	13538
November	3082	3087	3559	3567	13295
December	3228	3233	3746	3753	13960
TOTAL	9478	9496	10896	10923	40793

Source: PT Angkasa Pura I Bali (Persero) & Arranged by writer

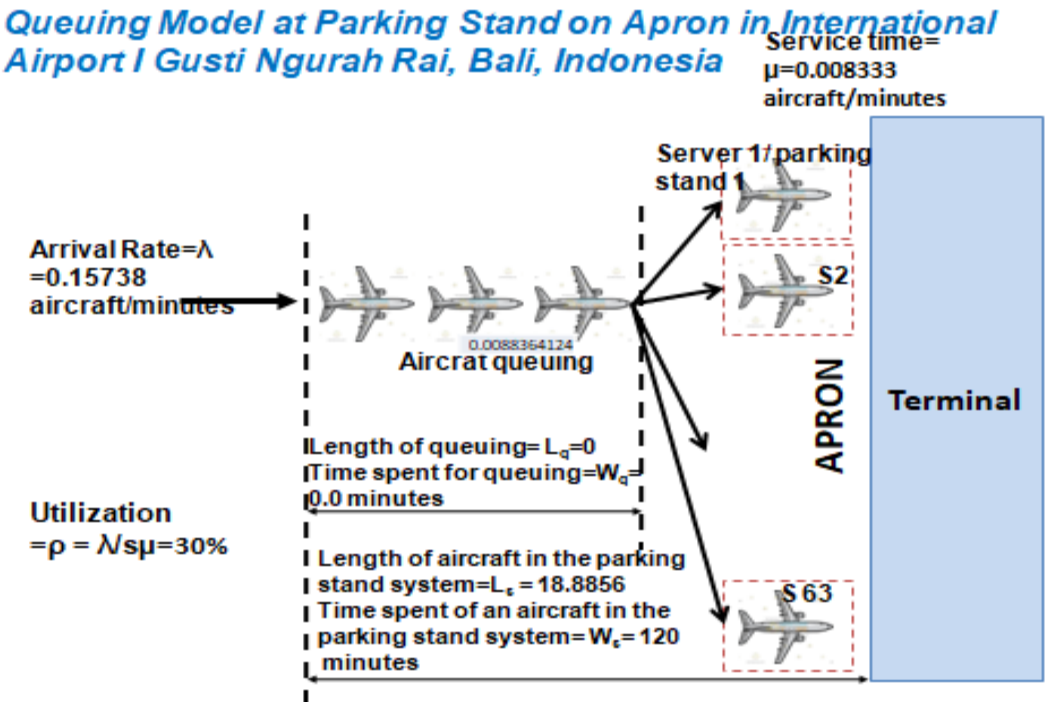
λ=	13538	movements/moth	6769	aircrafts/month	225.6333	aircrafts/day	9.401389	aircrafts/hour			
λ=	13295		6647.5		221.5833		9.232639	aircrafts/hour			
λ=	13960		6980		232.6667		9.694444	aircrafts/hour			
λ=							9.442824	aircrafts/hour	average	0.15738	aircrafts/minute
										6.354031	minutes/aicraft
μ=	63	aircrafts/2 hour	31.5	aircrafts/hour		λ/μ=	0.299772				
ρ=	30%										

Table calculation using Microsoft Excel

iting Line Approximation Spreadsheet		
Mean (average) Time Between Customer Arrivals (minutes) =		6.354031
Standard Deviation of the Time Between Customer Arrivals =		0
Mean (average) Service Time (minutes)=		120
Standard Deviation of the Service Time =		
Number of Servers =		63
Customer Arrival Rate (customers per minute)	λ =	0.15738
Service Rate (customers per minute)	μ =	0
Expected Server Utilization	ρ =	0.2998
Coefficient of Variation of Customer Arrival Time	C_a =	0.0000
Coefficient of Variation of Service Time	C_s =	0.0000
Expected Number of Customers Waiting in Line	L_q =	0.0000
Expected Number of Customers in the System	Ls =	18.8856
Expected Time Waiting to be Served	W_q =	0.0000
Expected Time Waiting to be Served	Ws =	120

For service level (μ) the writers focused on both the north and south apron areas. The service level (μ) is measured from the number of parking stands available in the north and south apron area at IGNRIA (I Gusti Ngurah Rai International Airport). Then the maximum time at the parking stand is 2 hours.
The number of parking stand = 47 + 16 = 63 Parking Stand (server)
The analysis was carried out using the queuing theory with the queuing model used was Single Channel and Multy Phase. This is because every 1 (one) parking stand is designated for 1 (one) aircraft. With this queuing system, researchers will analyze the movements of aircraft in the northern and southern apron area of IGNRIA.
The process of aircraft movement in the apron area includes taxi activities starting when the aircraft has landed on the runway and taxis to the apron area, aircraft movement activities in the apron area are said to be complete after the aircraft blocks off and taxis go to the runway.
The following is a calculation using the Single Channel Multy Phase queuing theory model in the apron area of I Gusti Ngurah Rai Bali airport:
Movement rate (λ) = 9.44 aircraft / hour
Number of server (s) = 63 Parking stands

Explanation of Calculation



CONCLUSION

Indicator	**Value**
The Utilization of the all parking stand = ρ	30%, under utilized
The Arrival rate of the aircrafts = λ	0.15 aircraft/minutes
The Length of the the aircrafts queuing = L_q	0 aicrafts
The Waiting time of the aircfats queuing = W_q	0 minutes
The Length of aircraft queuing at the system = L_s	18.86 aircrafts
The Waiting time of aircfats in the system (maximum) = W_s	120 minutes

The explanation of the conclusion:

1. The Utilization of The All Parking Stand at I Gusti Ngurah Rai International Airport (IGNRIA) = ρ = 30%, its mean under utilized or tend to be normally utilized. There are still more available parking stand to give services of the increasing arrival rate of aircrafts at IGNRIA (I Gusti Ngurah Rai International Airport).
2. The Arrival rate of the aircrafts (half of the aircraft movements) at IGNRIA = λ = 0.15 aircraft/minutes.
3. The Length of the aircrafts queuing for getting service at the parking stand at IGNRIA = L_q = 0 aircraft, or tend to be 0.
4. The Waiting time of the aircfats queuing for getting services at the parking stand at IGNRIA = W_q = 0, although there are some aircrafts at the parking stands, there are still available more parking stand to give services.
5. The Length/ the number of the aircraft queuing and getting services at the parking stand system at IGNRIA = L_s = 18.86 aircrafts.
6. The Waiting time/ spent of time of the aircfats in the parking stand system at IGNRIA = W_s = 120 minutes. (maximum).

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