The Effectiveness of Aviation Fuel Receiving Operation Through Bridger During Hajj Flight Period

Moch. Raihan Ghaffar[1, *], Andian Ari Istiningrum[1]

[1] *Dept. of Oil and Gas Logistics Politeknik Energi dan Mineral AKAMIGAS, Cepu, Indonesia*
**Corresponding author. Email: moch.raihanghaffar@gmail.com*

ABSTRACT
The aims of this research are to: (1) forecast the demand of aviation fuel during Hajj Flight, (2) forecast the number of bridgers that will be needed during Hajj Flight, and (3) evaluate the effectiveness of aviation fuel receiving operation through bridger. To reach these aims, the research was conducted in Depot X. The research is a qualitative research. The data regarding aviation fuel sales was collected through documentation; whereas the data regarding the number of bridgers needed and the effectiveness of aviation fuel receiving operation through bridger were collected through observation and interview. The results show: (1) The demand of aviation fuel will increase at 28.95% during the departure period and at 17.55% during the arrival period for the next five years, (2) the number of bridgers is forecasted to increase to three units during the departure period and four units during the arrival period for the next five years, and (3) the effectiveness of aviation fuel receiving operation through bridger during Hajj Flight period reaches 94%.
Keywords: *aviation fuel, receiving operation, bridger, demand, aircraft refueling depot*

1. INTRODUCTION

The demand of air transportation has been increased significantly these days. According to the data shown by the Directorate General of Civil Aviation, the number of passengers increases by 49% and 47% at the arrival and the departure terminal in one of airport located in Java [1]. This increase may affect the amount of aviation fuel that should be provided by the Aircraft Refueling Depot.

The aircraft refueling depot is the place to store aviation fuel that is supplied from other depots, terminals, refineries, or imported from other countries, such as Singapore. The aircraft refueling depot is the important facility in an airport to support aviation fuel refueling process to aircrafts. The primary functions of aircraft refueling depot are to: (1) receive, store and fill the aviation fuel to aircrafts in accordance with the specifications that have been already set by the Directorate General of Oil and Gas, (2) anticipate the increase demand of aviation fuel in the future, (3) deliver proper quality and quantity of aviation fuel safely to the airliners, (4) provide information needed to support and to monitor the operation of aviation fuel refueling process, (5) measure, monitor, and analyze the effectiveness of receiving, storage, and refueling processes and implement continuous improvement process as the way to improve its effectiveness, (6) develop the efficiency of aviation fuel transportation operation, reduce losses, responsible for proper quantity, quality, time, and supply of aviation fuel to the airliners, and enhance the service and reputation to the airliners by providing quality and quantity assurances and health, safety, and environment assurances [2].

Aviation fuel functions as the fuel producing power and a force of thrust so it enables a plane to fly. It also functions as absorbent heat, patron of the wings of an airplane from friction with air, cooling machine components, and lubricant to grease fuel pump and other machine components. The quality of aviation fuel must be maintained strictly. Its quality control must be conducted when it is processed in refineries, it is in the custody transfer and it is delivered to the airplane. The aviation fuel specifications must meet the standard set by the Directorate General of Oil and Gas Number 33633.K/10/DJM.T/2011 [3].

The 'X' Aircraft Refueling Depot (Depot X) is one of aircraft refueling depot in Central Java. It has responsibilities to maintain the supply of aviation fuel, the effectiveness of storage operation, and to deliver aviation fuel safely to the airliners in the proper quantity and quality. Depot X has an important responsibility to provide excellent service in distributing the aviation fuel to the airplanes during Hajj Flight period in Airport X. Based on the information that was provided by the Operation Head of Depot X, the need of aviation fuel during Hajj Flight period increases 250% as compared to normal days. This results in the increase of aviation fuel supply to meet airliners' demand during Hajj Flight period. Depot X supplies its aviation fuel from fuel terminal (Terminal Y). The distance between Depot X and Terminal Y is 77 km. Aviation fuel is transported from Terminal Y to Depot x through bridger 24 KL. Terminal Y has five bridgers, however these bridgers supply aviation fuel not only to Depot X but also to another depot. As a consequence, Depot X has to rent additional bridgers to maintain the supply of aviation fuel using during Hajj Flight period.

Bridger is the vehicle used to transport aviation fuel to aircraft refueling depot. A bridger has a tank and loading and unloading equipment. The bridger is designed to maintain easily and to replace the loading and unloading equipment in an efficient way. The design of bridger must emphasizes on high level of safety and reliability aspects. The construction of bridger consists of: (1) loading system, (2) tank and tank equipment, (3) fitting and piping, (4) bottom loader, and (5) safety tools [4].

The increase of aviation fuel demand during Hajj Flight period has a consequence for the Depot X to be able to anticipate the demand by operating its supply process effectively. Based on those problems, this research was conducted with the purposes to: (1) forecast the demand of aviation fuel during Hajj Flight Period for the next five years, (2) forecast the number of bridgers that will be needed to transport aviation fuel during Hajj Flight Period for the next five years, and (3) evaluate the effectiveness of aviation fuel receiving operation during current Hajj Flight period.

2. LITERATURE REVIEW

Aviation fuel in aircraft refueling depot was received from refineries and transit terminals. The fuel can be brought using tanker, bridger, RTW, iso tank, pipeline, or drums. Before the receiving operation is conducted, it is necessary to check that there is ullage in the storage tank and to implement visual check to assure that quality of aviation fuel meets the requirements. When PDG at the receiving filtering facility is increasing faster than usual or it is found a lot of water or impurities during sampling, a single membrane colorimetric filter test must be carried out at the filtering facility as a form of quality check of the aviation fuel received. If the results of the colorimetric membrane filter test are more than four are dry, the results can be used as a reason for investigations, but it cannot be used as a reason to reject the aviation fuel. Therefore, it is necessary to do the next step. This step is double colorimetric membrane test at the filtering facility. If there are two dry differences between the first and second membranes, a gravimetric membrane test must be carried out. When the test shows that a gravimetric is more than 1.0 mg/liter, it needs further discussion with the supplier [5]

Bridger is a vehicle used to transport aviation fuel from transit terminal or refinery to depot. Bridger must meet the requirements as follows: (1) the tank is made of aluminum or steel with epoxy coated inside, (2) each compartment must be equipped with drain cock, (3) the outlet of each compartment is equipped with a bottom valve, (4) there is a manhole with a lid for inspection, and (5) special bottom loading and discharge point for aviation fuel. [5]

The aviation fuel receiving operation consists of three steps, including: (1) before discharge operation, (2) discharge operation, and (3) after discharge operation. Detailed information for each step is shown in the table I, II, III, and IV [6].

TABLE I. EQUIPMENT USED IN THE RECEIVING OPERATION

No	Equipment	Yes	No
1	Maat Glass/Beaker Glass		
2	Thermohydrometer		
3	Syringe & Chemical Water Deterctor		
4	Aluminium Buckets		
5	Conductivity Unit Meter		
6	Seal		
7	Majun		

TABLE II. BEFORE DISCHARGE OPERATION PROCEDURE

No	Procedure	Yes	No
1	Check that the bridger parks in the appropriate and safe position, the engine is turned off, the hand brake and anchoring wheels are operated.		
2	Check the accuracy of Aviation Fuel Delivery Release Note and Loading Order.		
3	Check and observe seal condition, manhole must be in the full position; seal code is in accordance with loading order. If the seal is broken/ not in accordance with loading order, investigate the sources.		
4	Conduct settling for the minimum time of 10 minutes that is calculated from bridger has stopped at the discharge point.		
5	Set bonding cable into bonding point		
6	Do sampling from each compartment.		
7	Conduct visual test. If there are water and materials, conduct filtration until there has no water and materials.		
8	Conduct temperature and density tests from each compartment		
9	Check that the density 15ºC difference between the test in discharge point and AFRS should not exceed 3 kg/m^3. If the difference exceeds 3 kg/m^3, product should not be accepted. The product is able to be accepted if the investigation finds the source and there is a written explanation from supplier.		
10	Conduct electrical conductivity test on every first filling of each new batch.		
11	Record the result of the test into Bridger Quality Control Before Receipt Record Form.		
12	Check that discharge pipe is ready to operate and there has been ullage in the storage tank		
13	Make sure that fire extinguisher is ready to operate. The fire extinguisher is prepared in a place that is easy to see and reach.		
14	Set Bottom Loader after all discharge requirements are met.		

TABLE III. DISCHARGE OPERATION PROCEDURE

No	Procedure	Yes	No
1	The driver and co-driver have to be ready and have to stay in the discharge point.		
2	Start the pump to begin discharge operation.		
3	Observe the PDG and the possibility of a leak or spill.		
4	Stop pumping and do investigation and anticipation if PDG arrives at maximum limit (15 psi/ 103kPa), PDG increases or decreases significantly, or a leak happens		

TABLE IV. AFTER DISCHARGE OPERATION PROCEDURE

No	Procedure	Yes	No
1	Stop pump to end the discharge operation..		
2	Check the bridger's tank to convince that the whole aviation fuel is already discharged.		
3	Drain the products left in the pipe and bottom loader until there has no product in the pipe and bottom loader.		
4	Release bottom loader		
5	Release bonding cable		
6	Close inlet valve and outlet valve on storage tank		
7	Measure volume to determine the amount of aviation fuel that is received in the storage tank.		
8	Do product settling in the storage tank.		
9	Do good receipt into MySAP.		

In addition, there are a number of documents required for aviation fuel receiving operations. The documents are: (1) Proof of Aviation Fuel Delivery. This is the document for shipping aviation fuel by land which includes the type and quantity of aviation fuel. This document is made by supplier and signed by the Operation Head of the depot. (2) Aviation Fuel Release Statement. This is the document stating that the aviation fuel has been released. This document is made and signed by Quantity and Quality Supervisor. (3) Finance Document. This is the form used to summarize the aviation fuel received from the bridger, (4) Aviation Fuel Acceptance Report. This is the report stating the type and quantity of aviation fuel received whether or not in accordance with the aviation fuel sent by supplier. The report is signet jointly by the party at the depot and the party responsible for transporting the aviation fuel [7].

3. RESEARCH METHOD

This research is a descriptive research that does not determine correlation between research variables. The research was conducted to solve the problems faced by Depot X then the result was described in number. The research first was conducting by forecasting the amount of aviation fuel that will be sold to the airliners during Hajj Flight for the next five years. This forecast will help to determine the number of bridgers 24 KL that is effectively needed to transport aviation fuel from Terminal Y to the Depot X during Hajj Flight period for the next five years. In addition, the aviation fuel receiving operation during current Hajj Flight was evaluated to determine the effectiveness of this operation in supporting distribution of aviation fuel to the airliner.

The data for forecasting aviation fuel sales was generated from documentation of the Depot X's aviation fuel sales during Hajj Flight Period 2014-2016. The data regarding forecasting the number of bridgers was collected through: (1) interview with the bridger's driver to get the information about the time needed to transport aviation fuel from the Terminal Y to Depot X, (2) documentation the frequency of aviation fuel receiving through bridgers 24 KL each day during Hajj Flight period in Depot X.

Finally, the data regarding determination the effectiveness of aviation fuel receiving operation was collected through observing the implementation of Standard of Operating Procedure (SOP) that was used in the aviation fuel receiving operation as shown from table I to table IV. The SOP of aviation fuel receiving operation through bridger consists of three phases, including: (1) before the discharge phase, (2) during the discharge phase, and (3) after the discharge phase. The observation was conducted using check list consisting of two criteria, (1) yes, if the procedure is implemented in the operation, and (2) no, if the procedure is not implemented in the operation.

Forecasting of aviation fuel demand during Hajj Flight Period was calculated using forecasting time series pattern including linear trend and exponential trend. The trend with the least Average Absolute Error (AAE) would be used to forecast aviation fuel demand

The result of demand forecasting would be used to evaluate the bridger's' adequacy to transport aviation fuel from Terminal Y to Depot X. The evaluation was conducted through few steps [8]. Those steps are:

1. Calculate the number of ritase

$$\text{Ritase} = \frac{\mathit{Operational\ Hour\ of\ Depot}}{\text{Round Trip Days}} \quad (1)$$

2. Calculate the occupancy of bridger

$$\text{Bridger's Occupancy} = \frac{\text{DOT}}{\text{Bridger's Capacity}} \times 100\% \quad (2)$$

while:

DOT = Daily Objective Thruput (the amount of aviation fuel distributed to the airliner each day)

Capacity = Number of bridger x bridger's capacity x ritase

According to standard used in the aircraft refueling depot, the occupancy of bridger is effective at 85%. If the occupancy is between 85% and 100%, the depot will be at the critical level; whereas the occupancy that is higher than 100% indicates that the depot needs additional bridgers.

3. Calculate the need of bridger

$$\text{MT} = \sum_{s=1}^{n} \frac{\text{DOTs x Ts}}{\text{Kaps x Ops}} \quad (3)$$

while:

DOT = Daily Objective Thruput

Kaps = Bridger's maximal capacity
T = Time to receive aviation fuel in each cycle
Ops = Depot's operational hour
MT = Number of bridger's needed

The effectiveness of aviation fuel receiving operation was analyzed descriptively by calculating the effectiveness level using this formulae:

$$\frac{\textit{The number of implemented criteria}}{\text{The number of criterias should be implemented}} \times 100\% \qquad (4)$$

4. RESULTS AND DISCUSSION

4.1. Forecasting the Aviation Fuel Demand

Hajj Flight period in this research is divided into two periods: departure and arrival periods. Table V shows the equation model to forecast aviation fuel demand using linear and exponential trends.

TABLE V. FORECASTING MODEL DURING DEPARTURE PERIOD

Trend	Forecasting Model	AAE
Linear	Y = 2.462.388 + 212.040,5 X	60.055,33
Exponential	Y = 2.455.672 (1,099^{X})	56.408,72

Since AAE of exponential trend is less than AAE of linear trend, the exponential forecasting model is used to forecast the demand of aviation fuel during departure time. The result of forecasting is shown at Table VI. Table VI shows that the demand of aviation fuel during departure Hajj Flight period increases 28.96% for the next five years.

TABLE VI. THE FORECASTING OF AVIATION FUEL DEMAND DURING DEPARTURE PERIOD

Year	Demand (L)
1	2.909.365,87
2	3.166.739,42
3	3.446.881,21
4	3.751.805,40
5	4.083.704,35

Forecasting equation model for arrival Hajj Flight period using linear and exponential trends is shown at Table VII. Since AAE of linear trend is less than AAE of exponential trend, the linear forecasting model is used to forecast the demand of aviation fuel during arrival time. The result of forecasting is shown at Table VIII. It can be seen that the demand of aviation fuel increases 17.55% during the arrival period of Hajj Flight for the next five years. Determining the demand of aviation fuel during departure and arrival Hajj Flight Period enables Depot X to anticipate the amount of aviation fuel needed by airliners so its effectiveness will be maintained.

TABLE VII. FORECASTING MODEL DURING ARRIVAL PERIOD

Trend	Forecasting Model	AAE
Linear	Y = 2.462.388 + 212.040,5X	8808
Exponential	Y = 57.757.738(1,049^{X})	11.782

TABLE VIII. THE FORECASTING OF AVIATION FUEL DEMAND DURING ARRIVAL PERIOD

Year	Demand (L)
1	6.316.905
2	6.594.253
3	6.871.601
4	7.148.949
5	7.426.297

4.2. Forecasting the Number of Bridgers

The increase demand of aviation supply during Hajj Flight period as shown at Table VI and VIII has a consequence for the depot to evaluate the number of bridgers that will be needed to transport aviation fuel from terminal Y to depot X. Bridger used to supply aviation fuel to Depot X is rented from the Terminal Y. Terminal Y has five bridgers 24 KL that serves two depots. Therefore, it is necessary to calculate how many bridgers serving only Depot X

Bridger the Depot X

$$= \frac{\text{Number of Supply in Depot X}}{\text{Number of Supply in 2 Depots}} \text{ x number of bridger}$$

$$= \frac{5}{17} \text{ x } 5$$

= 2 *bridgers*

The calculation of bridger's occupancy to evaluate bridger's performance in fulfilling the aviation fuel during Hajj Flight period for the next five years is shown at Table IX. Table IX provides information that bridger's occupancy during departure Hajj Flight period for year 1 is forecasted to arrive at 72%. This means the supply of aviation fuel through bridger will be effective using two bridgers. However, the bridger's occupancy in the arrival Hajj Flight period is forecasted to arrive at 157% which means the number of bridgers to transport aviation fuel from terminal Y to Depot X will be not sufficient to be serviced using two bridgers. Depot X needs two additional bridgers to increase the effectiveness of aviation fuel supply. Tabel IX also informs that bridger's occupancy during Hajj Flight period for year 5 will not effective since the occupancy exceeds 100%. This implies that Depot X should add the number of bridgers to transport aviation fuel from terminal Y to Depot X. Based on the formula to calculate the number of bridger needed by Depot X, Depot X needs three bridgers during departure Hajj Flight period and four bridgers during arrival Hajj Flight period.

TABLE IX. THE FORECASTING OF BRIDGERS DEMAND DURING HAJJ PERIOD

	Year 1		Year 5	
	Departure	Arrival	Departure	Arrival
Ritase	3	3	3	3
Bridger's Occupancy	72%	157%	101%	184%
Bridger's Demand	2	4	3	4

4.3. Evaluation of the Effectiveness of Aviation Fuel Receiving Operation

The aviation fuel receiving procedure through bridger consists of the availability of equipment, before discharge procedure, discharge procedure, and after discharge procedure. The effectiveness of these procedures should be evaluated to determine the steps that were not conducted in the receiving operation. The source of step that was not conducted should be determined and the corrected action should be suggested to Depot X. Table X shows the effectiveness of aviation fuel receiving operation in Depot X.

TABLE X. THE EFFECTIVENESS OF RECEIVING OPERATION

Procedure	Yes (Item)	No (Item)	Effectiveness
Equipment Availability	7	0	100%
Before Discharge	12	2	86%
Discharge	4	0	100%
After Discharge	9	0	100%
Total	32	2	94%

Tabel X shows that the aviation fuel receiving operation through bridger in Depot X is effective with 94% effectiveness level. However, few attentions should be derived to Depot X due to few steps that were not conducted in the operation. First, settling procedure for 10 minutes after the bridger has parked in discharge point was not conducted. This procedure was not conducted because of some reasons, including: (1) Historical experiences show that aviation fuel has never been off-spec even settling was not implemented and (2) Aviation fuel that is pumped to the the storage tank, must pass filter water separator first. Filter water separator functions as the equipment to filter water and materials contained in aviation fuel. The settling procedure should have conducted to convince that aviation fuel is on-spec before entering filter water separator. The absence of filter procedure may increase the possibility of filter water separator damage. Water in the aviation fuel that is not filtered is able to damage filter water separator. Second, the fire extinguisher should be located near bridger, so it is easier for the operator to operate them when fire happens. However, in the real operation, the fire extinguisher is four to five meters from bridger so the operator may need some times to operate them when fire happens. As a consequence, there may be delay time to operate fire extinguisher and the fire will be harder to be handled.

5. CONCLUSION

The result of the research shows that the aviation fuel demand increases 28,96% and 17,55 % during departure and arrival Hajj Flight Period for the next five years. As a result, the number of bridger 24 KL that will be needed to transport aviation fuel from Terminal Y to Depot X increases to four bridgers during arrival Hajj Flight period. For the departure time during Hajj Flight period year 1, the number of bridger is still effective to be served by two bridgers. However, Depot X should consider adding to three bridgers to maintain its effectiveness in year 5. As a whole, the effectiveness of aviation fuel receiving operation through bridger during Hajj Flight period reaches 94% effectiveness. In order to achieve 100% effectiveness, Depot X should consider conducting settling for 10 minutes after bridger has stopped at discharge point and locating its fire extinguisher near the bridger.

This research has some limitations. First, ritase calculations did not recognize traffic forecasting in the future. So, it is advisable to forecast traffic condition in the future, so that the ritase calculation will be more accurate. Second, the way the depot to acquire additional bridgers has not become the scope of the research. The next research should conduct the feasibility study to acquire additional bridgers, so Depot X may get complete information to help them to make decision.

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