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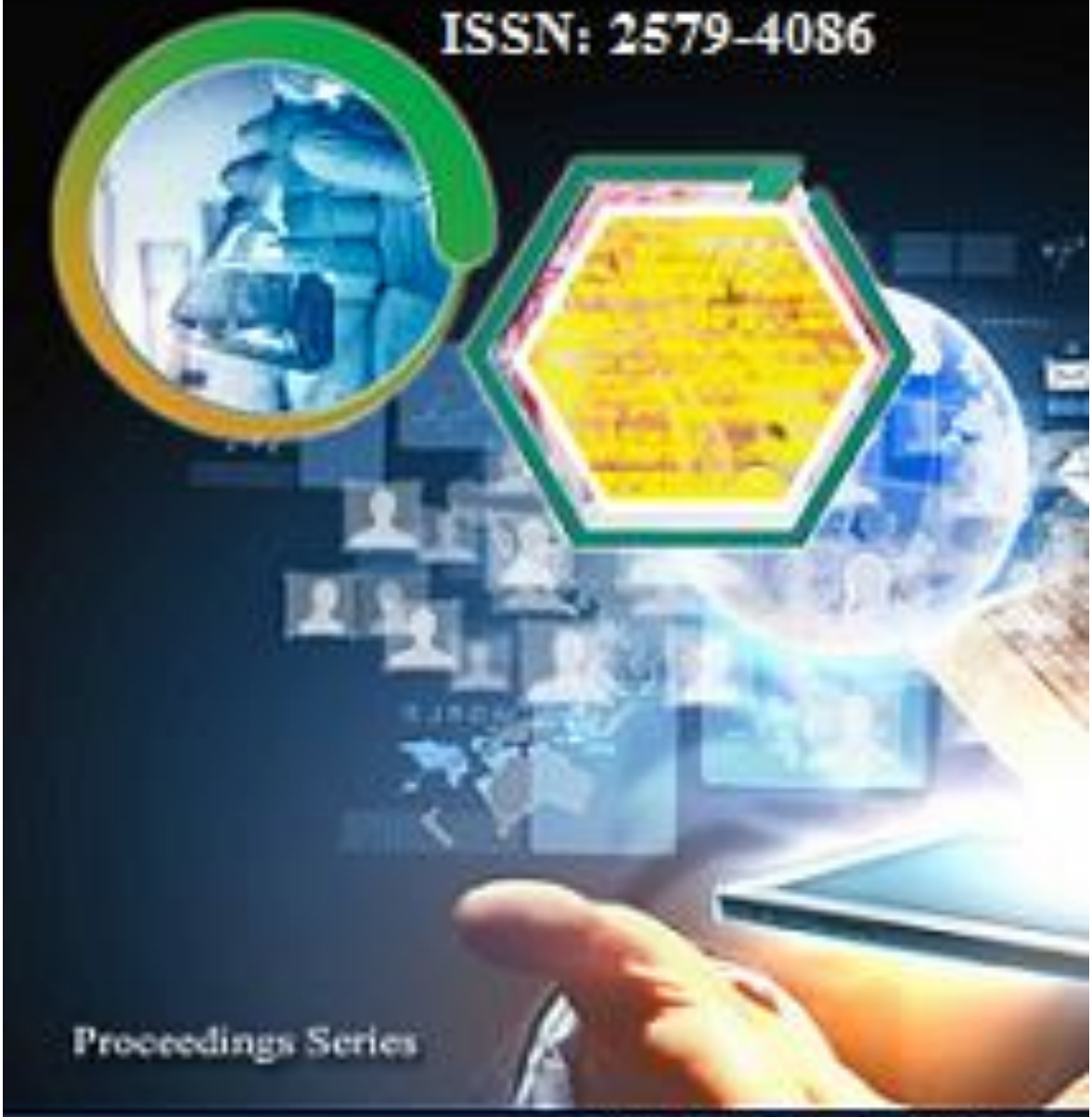

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Indexing:

The Application of Transportation Methods of PT Lion Air by Using Vogel's Method and Zero Suffix Method

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Abstract: The purpose of this paper is to assist the airlines in terms of minimizing the waiting time of aircraft to optimize the scheduling of flights by using the method of transportation, namely Vogel's method and Zero Suffix method. Then, both methods will be compared and selected the best method that minimizes waiting time on air. Vogel's method has a principle that is to choose the smallest cost price of first and second in each row and column and then calculate the difference between the the smallest cost price of first and second in each row and column. Zero Suffix method is one method of developing new transportation, the uniqueness of this method is to have a suffix value which is the sum of the entries are close to zero entry of the large number of entries which is close to zero entry in addition to other zero entries. From the results obtained in this paper, the Vogel's method obtain the total waiting time of 450 minutes on Pekanbaru to and from Jakarta routes flights, whereas with zero suffix method, waiting time gained as much as 630 minutes at Pekanbaru to and from Jakarta service flights. It can be concluded that the Vogel's method is more efficient than Zero Suffix method to optimize waiting time on air.

Keywords: Vogel's method; zero suffix method; transportation problem; waiting time.

1. Introduction

With the increasing number of airline companies, the level of competition will be intense, the airline will try to attract people to use the services of the airline as a means of transportation, from issuing cheap and affordable to improving service facilities. For that, the airline should be able to pay attention to operational issues management arrangements which are one of them is flight planning optimization. One way to optimize flight planning is to conduct flight scheduling. Scheduling can be defined as an indication of what should be done, by whom, and with what equipment is used to complete a job at a certain time [1, 2].

Some ways to prepare a good flight schedule is to look at the commercial, operational and engineering also minimizes the waiting time, but arranging the flight schedule by minimizing the waiting time has not been so cared for the airline so that this research will be focused on minimizing the waiting time on air.

Flight Scheduling can be categorized as an assignment problem [3], because there is a one to one relationship between the number of air flights when arriving by air flight number at the time of departure, where the aircraft cannot be flown both destination and transit at the same time is not taken into account [4]. Research previously by Nurasyiah and Sugiharto [5] discusses the application of the Hungarian method to minimize waiting time Indonesia Airlines Flight PT.Garuda focused on Denpasar Airport. Results from previous study show that the best waiting time can be shortened by 2,110 minutes.

In this study, applying the method Zero Suffix[6-8] and Vogel's method[8] to solve the scheduling problem to minimize waiting times on air for zero suffix method and Vogel's method can solve the

problem of scheduling the flight path of the aircraft, in general, every plane is allocated to the flight path. Once completed on the new track then the path will be allocated to the next track and so on until the optimal limit or known as the correspondence one-to-one, one source to one destination.

The formulation of the problem in this paper is how to apply the Zero Suffix method and Vogel's method on Air PT. Lion to minimize waiting time at Soekarno-Hatta (SH), Sultan Syarif Qasim (SSQ). Problems studied is in the scope of minimizing the waiting time on air at SH and SSQ. The data used is data of PT.Lion Air flight schedule from SH to SSQ in July 2016 without regard to transit.

The paper is organized as follows. In Section 2, we describe the step taken in conducting the research. In Section 3, we explain the results and discussion concerning with the methods. Finally, we describe the conclusion and possible future work for the next research in Section 4.

2. Material & Methodology

Steps taken in conducting the research are as follows. First we collect data from PT. Lion Air with the route from Soekarno-Hatta and Sultan Syarif Qasim (SSQ). Then, we reduce the data in scheduling table form and the length of time waiting for flight in minutes. Next, we find the optimum waiting time using zero suffix method and Vogel's method. Then, we compare of minimum total waiting time of each method. Lastly, we withdraw the conclusion to obtain the most optimal total waiting list.

3. Results and Discussion

3.1. Data Collection from PT. Lion Air Indonesia

We use secondary data flight of PT. Lion Air Indonesia at Sultan Syarif Qasim II (SSQ) in Pekanbaru and Soekarno-Hatta (SH) in Jakarta. The data used is the flight data of PT. Lion Air Indonesia in July 2016.

Tabel 1. Waiting Time of the Flight to and from SSQ

Depaerture from SSQ	Arrive at SSQ						
	i \ j	JT 388	JT 290	JT 292	JT 294	JT 392	JT 296
	JT 393	80	400	635	680	855	915
	JT 389	40	280	515	560	735	785
	JT 391	260	55	255	340	515	610
	JT 291	350	100	215	250	425	520
	JT 295	640	330	125	40	135	230
	JT 297	810	500	335	210	35	60

Table 2. Iteration 1 of Vogel's Method

Depaerture from SSQ	Arrive at SSQ							Supply	Row Difference
	i \ j	JT 388	JT 290	JT 292	JT 294	JT 392	JT 296		
	JT 393	80	400	635	680	855	915	1	320
	JT 389	40	280	515	560	735	785	1	240
	JT 391	260	55	255	340	515	610	1	200
	JT 291	350	100	215	250	425	520	1	115
	JT 295	640	330	125	40	135	230	1	85
	JT 297	810	500	335	210	35	60	1	25
Demand		1	1	1	1	1	1		
Column Difference		40	45	90	170	100	170		

4.2. Data Analysis with Vogel's Method

Table 1 sought the difference of the two smallest values for each row and column. In Table 1, for the smallest entry in the first row is 80 and the entry next smallest is 400, then the difference between the first line is 320. The smallest entry in the second row is 40 and the next small entry is 280 so the difference in the second line is 240. In the first column entry youngest is 40 and the next small entry is

80 so the difference in the first column is 40. In the second column is the smallest entry 55 and entry next smallest is 100, and the difference in the second column is 45. Similar steps are occurred in the other rows and columns. The result can be seen in Table 2. We continue the calculation until 9th iteration, to obtain the optimal waiting time as presented in Table 3.

Table 3. Result of Iteration 9

Depart from SSQ	Arrive at SSQ	
	j / i	JT 392
	JT 295	135
	JT 297	35

The results of the data analysis service flights to and from the airport SSQ, Pekanbaru using the method of Vogel can be seen in Table 4.

Table 4. Analysis result of Vogel

Depart from SSQ	Arrive at SSQ						Supply
	j / i	JT 388	JT 290	JT 292	JT 294	JT 392	JT 296	
	JT 393	80	400	635	680	855	915	1
	JT 389	40	280	515	560	735	785	1
	JT 391	260	55	255	340	515	610	1
	JT 291	350	100	215	250	425	520	1
	JT 295	640	330	125	40	135	230	1
	JT 297	810	500	335	210	35	60	1
Demand		1	1	1	1	1	1	

The optimal solution is the best scheduling in Table 4 using the Vogel's method that can produce five pairs of flight number, namely: JT 393 – JT 388, JT 391 – JT 290, JT 291 – JT 292, JT 295 – JT 294 and JT 297 – JT 296. A list of paired numbers indicate the sequence numbers of flying aircraft used by the first, second, third and fifth. For example the first plane departing from Pekanbaru to Jakarta with flight number JT 393, then departs from Jakarta to Pekanbaru with flight number JT 388. Likewise for the next flight, after a couple of low numbers obtained, the next step is to calculate the total waiting time on air. Total time waiting plane by using the Vogel's method is $Z = (1\ X\ 80) + (1\ X\ 55) + (1\ X\ 215) + (1\ X\ 40) + (1\ X\ 60) = 450$ minutes. So total waiting time minimum service flights to and from the airport SSQ, Pekanbaru is 450 minutes. The new schedule using the Vogel's method is in Table 5.

Table 5. New Flight Schedule by Using Vogel's Method

No	Flight No.	From	Departure Time	To	Arrival Time
1	JT 388	JKT	06:00	PKU	07:45
2	JT 393	PKU	06:25	JKT	08:15
3	JT 290	JKT	11:10	PKU	12:55
4	JT 391	PKU	12:05	JKT	13:55
5	JT 292	JKT	14:35	PKU	16:20
6	JT 291	PKU	13:35	JKT	15:25
7	JT 294	JKT	16:00	PKU	17:45
8	JT 295	PKU	18:25	JKT	20:15
9	JT 296	JKT	20:30	PKU	22:15
10	JT 297	PKU	21:15	JKT	22:15

Table 5 shows that the number of aircraft PT. Lion Air operating on the route Pekanbaru ↔ Jakarta are only five aircrafts, while the old schedule the number of aircraft in operation there are six aircrafts, meaning PT. Lion Air has saved the best care costs for the flight, so the damage that occurs will be reduced.

4.3. Data Analysis with Zero Suffix Method

The data used to complete the method Zero Suffix is Table 2. We find the entry value the smallest of each line and reducing the entry cost of each row and having generated a new table that has been reduced and locate the smallest entry value of each column then reduction with an entry fee of each column. Of the new table that has reduced both row and column there will be a least cost value 0 in each row and column, then locate the suffix value by dividing the additional costs that are closest to zero cost and total costs are added and then select the value of the suffix value most.

The smallest entry in the first row is 80 then the reduction of each entry on the first line with the reduction of 80 results each entry on the first line is 0, 320, 555, 600, 775, 835. Then, in the second line of the smallest entry is 40 and the reduction of each entry on line second with 40, the result of reduction of each entry is 0, 240, 475, 520, 695, 745. Similarly to the next line, later after all the lines reduced and we obtain a new table, then do the reduction column. In the first column, the second, fourth, and fifth already there is an entry fee of 0 and thus no longer be reduced. For the third column of the smallest entry so that the reduction is 85 per entry in the third column is 470, 390, 115, 30, 0, 215. For the sixth column smallest entry so that the reduction is 25 per entry sixth column is 775, 720, 530, 395, 165, 0. The results from the reduction of the rows and columns are also referred to as iteration – 1 can be seen in Table 7.

Table 7. Results Reduction Rows and Columns or Iteration - 1

	JT 388	JT 290	JT 292	JT 294	JT 392	JT 296
JT 393	0	320	470	600	775	815
JT 389	0	240	390	520	695	720
JT 391	205	0	115	285	460	530
JT 291	250	0	30	150	325	395
JT 295	600	290	0	0	95	165
JT 297	775	465	215	175	0	0

In the first iteration there are eight entries is 0 then the suffix value that will be obtained as well as eight. For the first suffix value is 320, then the second suffix value is 222.5 which is the quotient of the value closest to the cost of 0 in the second row of the first column is 240 + 205 with the number from the nearest entry to the cost of 0 is 2 pieces. For three to eight suffix value in the same manner as the first and second suffix value is 186, 190, 178.33, 151 667, 135, 165. The completion suffix value in the first iteration can be seen below:

1. $S = \frac{320}{1} = 320$
2. $S = \frac{240+205}{2} = 222.5$
3. $S = \frac{240+205+115}{3} = 186.67$
4. $S = \frac{30+290+215}{3} = 190$
5. $S = \frac{30+290+215}{3} = 178.33$
6. $S = \frac{150+175+95}{3} = 140$
7. $S = \frac{95+175}{2} = 135$
8. $S = \frac{165}{1} = 160$

Since suffix greatest value is obtained in the first row entry 0. The first column of the achievement of the first column and the first row is removed; the result of the first iteration can be seen in Table 8.

Table 8. Result of Iteration– 1

	JT 290	JT 292	JT 294	JT 392	JT 296
JT 389	240	390	520	695	720
JT 391	0	115	285	460	530
JT 291	0	30	150	325	395
JT 295	290	0	0	95	165
JT 297	465	215	175	0	0

The results of the first iteration shows that the allocation is not optimum for optimum allocation, say if there is at least one value of 0 in every row and column so it continued with the second iteration. And next iteration until we reach the optimal solution in fifth iteration.The results of the fourth iteration shows that the allocation is not optimum for optimum allocation say if there is at least one value of 0 in every row and column so it continued with the fifth iteration. At fifth iteration all rows have an entry value is 0, then note the entries in each column, the second column there are no entries zero and should be reduced by reducing each entry in the second column by 325 for an entry smallest in the second column, if all the columns and rows already reduced the fifth iteration of the table can be seen below:

Table 9. Iteration – 5

	JT 294	JT 392
JT 389	0	0
JT 391	0	0

Allocation in Table 9 has been optimized for each row and column has been reduced to zero without a trace only one entry-value is not zero. The optimal solution is the best scheduling in Table 9 using the method Zero Suffix produce five pairs of flight number, namely: JT 393 – JT 383, JT 389 – JT 294, JT 391 – JT 292, JT 295 – JT 392, JT 297 – JT 296. A list of paired numbers indicates the sequence numbers of first aircraft used until the fifth. For example, the first aircraft departing from Pekanbaru to Jakarta with flight number JT 393, then departs from Jakarta to Pekanbaru with flight number JT 383. It is also for subsequent flight number.

After each pair of numbers to come flying, then we calculate total waiting time on air. Total time waiting aircraft by using Zero Suffix method is Z = (80 x 1) + (100 x 1) + (255 x 1) + (135 x 1) + (60 x 1) = 630 minutes. So the total minimum waiting time obtained by using zero suffix Method isservice flights of Pekanbaru ↔ Jakarta is 630 minutes. Total waiting time of the flight by using Vogel's and zero suffix methods can be seen in Table 10.

Tabel 10. Total Waiting Time (in Minute)

Waiting Time using Vogel's	Waiting time using Zero Suffix
450	630

Based on Table 10, the best waiting time by using the method of Vogel is different with the waiting time with Zero Suffix Method with a total difference of 180 minutes. So in solving scheduling problems of PKU ↔ JKT Vogel's method is more efficient than the method of Zero Suffix.

4. Conclusion

From the results obtained in section 3, the method of Vogel obtain the total waiting time of 450 minutes on Pekanbaru to and from Jakarta routes flights, whereas with zero suffix method, waiting time gained as much as 630 minutes at Pekanbaru to and from Jakarta service flights. It can be concluded that the Vogel's method is more efficient Zero Suffix method in optimizing waiting time on air. Further research should address the possibility to reduce the number of tardiness in Lion Air flight schedule to with further extension to addition of the model.

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