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A NEW METHOD PREDICTING A PERCENTAGE OF DOMESTIC AND INTERNATIONAL AIRCRAFT BASED ALGORITHM FLETCHER REEVES FOR PASSENGERS AIRPORTS IN INDONESIA

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ABSTRACT

The increasing trend was not so significant at the time of the Covid-10 pre-pandemic. It is necessary to conduct an in-depth study of the percentage of flight movement trends in the pre-pandemic period using the previous year's flight data. This study uses the Fletcher Reeves method to predict the rate of domestic and international passenger flight movements using the Backpropagation algorithm. The data is sourced from the Indonesian Central Statistics Agency in the form of the number of domestic and international aircraft passengers in 2018-2022.

Keywords : *Covid 19, Flight Movement, Fletcher Reeves*

INTRODUCTION

The COVID-19 outbreak has spread worldwide, affecting the entire country and region. This outbreak was first identified in December 2019 in Wuhan, China. Governments around the world remind people to take responsive care. Public service strategies include washing hands, wearing face masks, maintaining physical distance, and avoiding mass gatherings. Lockdown and stay-at-home plans have been implemented as countermeasures to flatten the curve and control disease outbreaks [1].

The COVID-19 pandemic has affected air transportation as a whole. Many restrictions have already been implemented in aviation transportation, potentially leading to severe impacts on global airlines. COVID-19 is gradually affecting flight mobility in the EU, reaching its peak in April 2020, with the number of flights in the EU shrinking by more than 89%[2].

The COVID-19 pandemic has ushered in a wave of economic contraction across the country due to supply constraints and demand linkages for the shipping market. The research found that the pandemic inflicted heavy losses on universal aviation, reducing rates, closures, and the collapse of some airlines and airports due to heavy losses due to travel restrictions. Even though the factory is opening, the cure seems to be much slower than expected, which could see more jobs and airlines run aground due to the lack of relevant support. This research suggests that when these zones open, they do so responsibly, which puts measures that discourage tourists, reduce costs, and increase efficiency [3].

The Indonesian Central Statistics Agency data shows that the number of passengers has increased and decreased. In 2019 the most significant increase was 12.78% in June. In 2020,

January to May experienced a sharp decline, reaching the most significant reduction of 86.92% at the beginning of the covid-19 pandemic, while in 2021, from August to the end of the year, it continued to increase. The most significant increase was 73.04% in September. The pre-pandemic period, namely in 2022, has not substantially increased.

Study[4] proves that the Backpropagation artificial neural network with the Fletcher-Reeves method has better performance than the Backpropagation artificial neural network.[5],[6]using the gradient descent method. The Means Square Error indicates this (MSE) obtained from the proposed method, which is smaller than the MSE obtained from the Backpropagation neural network using the gradient descent method.

Study[7]The result of this research is the Prediction of Long Bean Crop Production in the Province of Sumatra Island with the Fletcher-Reeves algorithm. Tested with 4 models including 6-5-1, 6-10-1, 6-15-1, and 6-20-1. The best result from other models is the 6-5-1 model with an MSE/Performance value of 0.00711838.

Study[8], the present study shows that under mild conditions, we determined that the proposed method satisfies the sufficient descent condition and is globally convergent under the Wolfe line search condition. The evidence provided by the experimental results shows that our proposed method is superior to the classical approach.

Study[9], this study resulted that we considered a new type of Fletcher-Reeves (abbreviated FR) conjugate gradient method with errors, which is widely applied in neural network training. The global convergence property of this method is proved under light assumption conditions.

Based on the above problems, it is necessary to make an in-depth study of the prediction of the percentage increase/decrease in the number of aircraft using the Backpropagation algorithm with the Fletcher Reeves method. The results of predicting the percentage of domestic and international aircraft passengers are input for airline managers to determine policies to anticipate flight movements in Indonesia.

METHODOLOGY

The data used in this study is data on the number of passengers on domestic and international aircraft according to the main airports in Indonesia from 2018 to 2022. The data is taken from the Central Statistics Agency of Indonesia through the websitehttps://bps.go.id/. The following is a graph of data on the number of passengers on domestic and international flights. Years 2018-2022.

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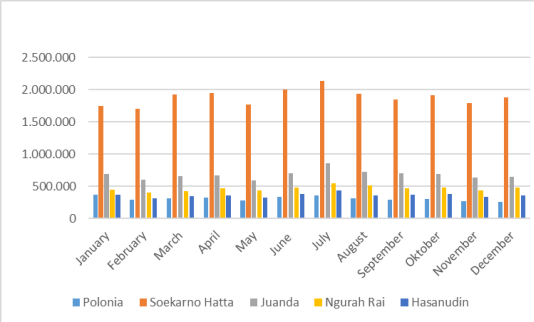

Figure 1. Graph of Domestic Airplane Passenger Data in 2018

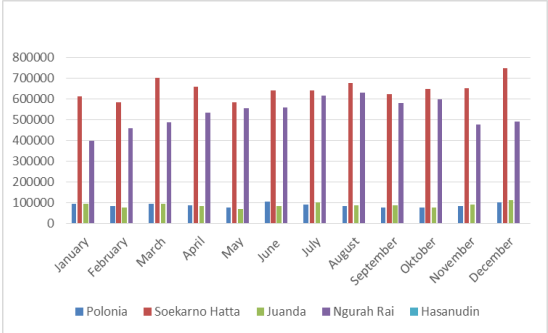

Figure 2. Graph of International Airplane Passenger Data in 2018

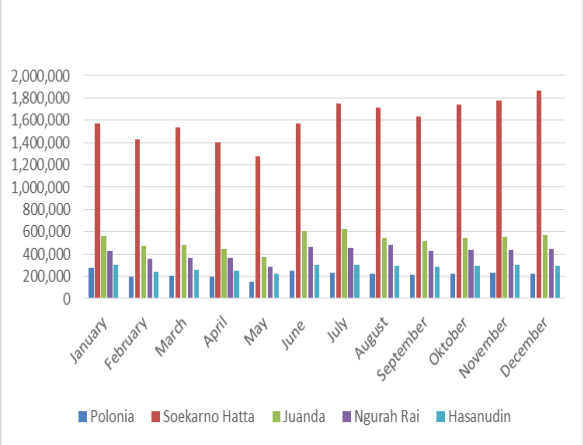

Figure 3. Graph of Domestic Airplane Passenger Data in 2019

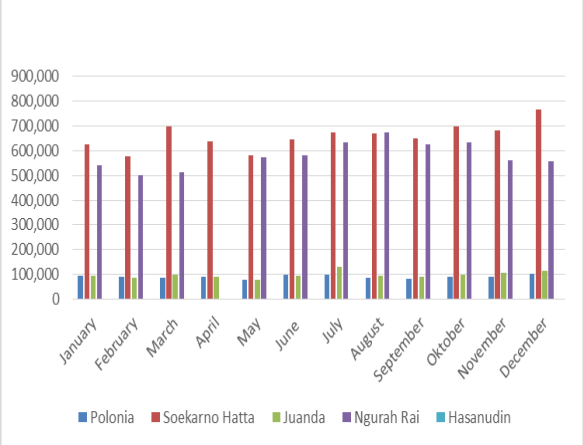

Figure 4. Graph of International Airplane Passenger Data in 2019

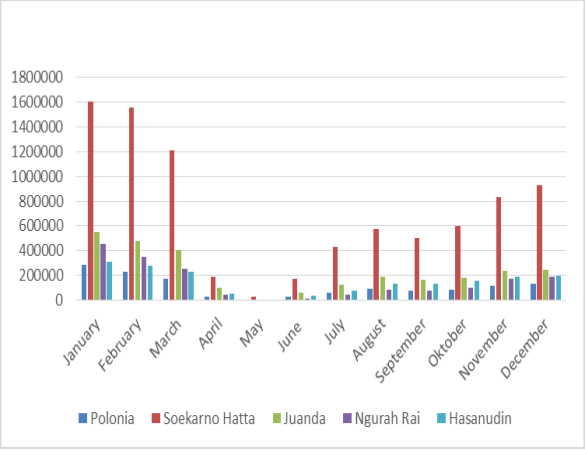

Figure 5. Graph of Domestic Airplane Passenger Data in 2020

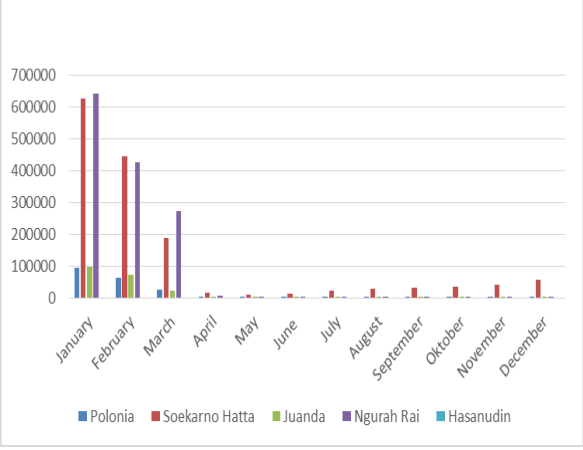

Figure 6. Graph of International Airplane Passenger Data in 2020

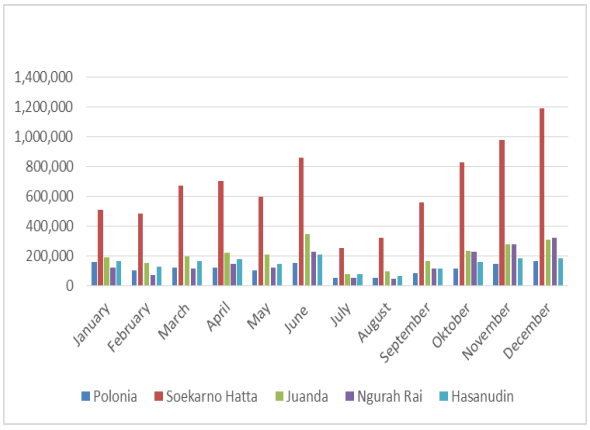

Figure 7. Graph of Domestic Aircraft Passenger Data in 2021

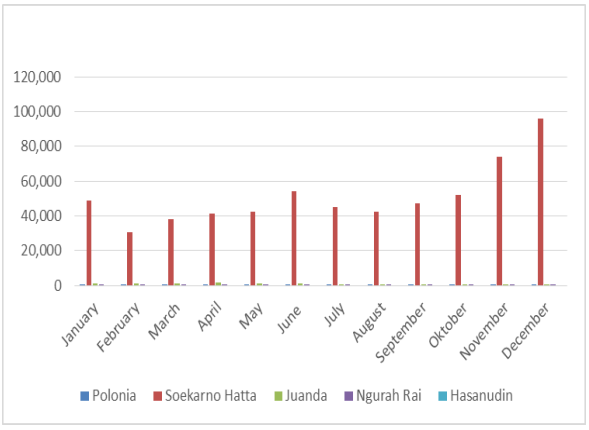

Figure 8. Graph of International Airplane Passenger Data in 2021

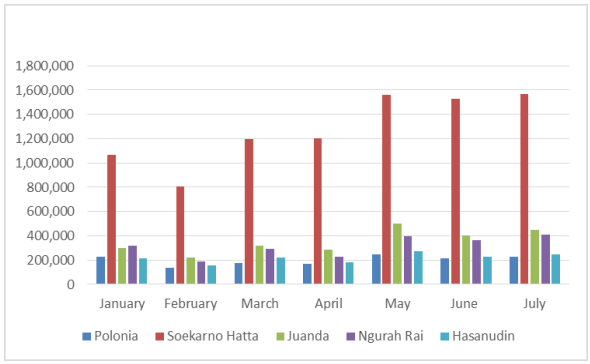

Figure 9. Graph of Domestic Aircraft Passenger Data in 2022

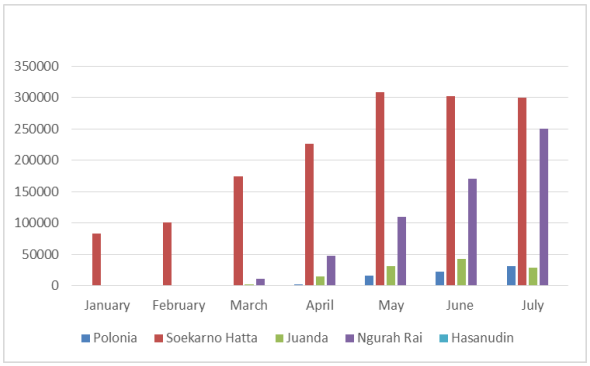

Figure 10. Graph of International Airplane Passenger Data in 2022

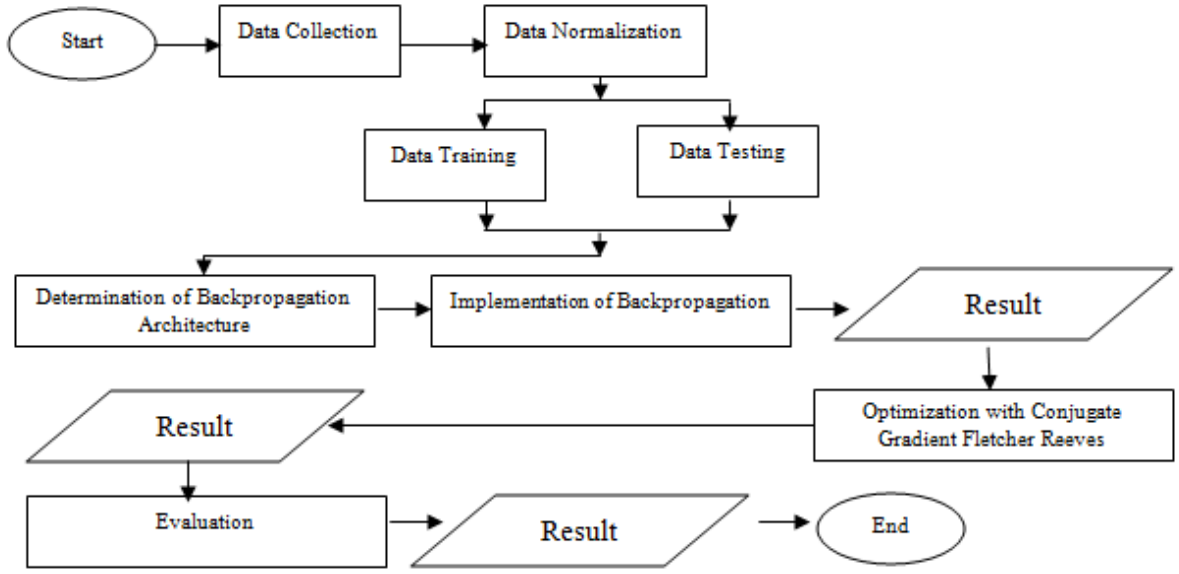

Figure 11. Framework Design

Backpropagation architecture in this study consists of 11-2-1, 11-3-1, 11-4-1, 11-5-1, 11-6-1, 11-7-1, 11-8-1, 11 -9-1, and 11-10-1 with Gradient Descent and Fletcher Reeves methods. Here is an example of an architectural example 11-3-1.

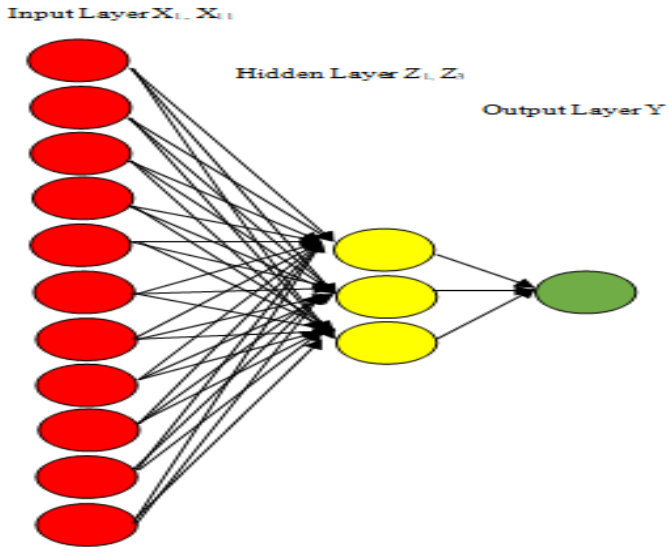

Figure 12. Architecture Backpropagation

RESULTS

3.1. Data Normalization

$$x' = \frac{0.8(x-a)}{b-a} + 0.1 \quad (1)$$

The results of the normalization of data on the number of domestic and international aircraft in 2018-2022 can be seen in the table below:

Table 1. Domestic Passenger Normalization Results 2018

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.2399	0.20091	0.2172	0.2217	0.2033	0.2264	0.2356	0.2191	0.2098	0.2152	0.2023	0.1966
Soekarno Hatta	0.7569	0.73072	0.8245	0.8314	0.7635	0.8498	0.9000	0.8248	0.7948	0.8190	0.7740	0.8065
Juanda	0.3588	0.32041	0.3479	0.3520	0.3224	0.3650	0.4212	0.3704	0.3652	0.3583	0.3379	0.3409
Ngurah Rai	0.2686	0.25008	0.2606	0.2753	0.2626	0.2798	0.3049	0.2912	0.2743	0.2807	0.2653	0.2785
Hasanuddin	0.2386	0.21063	0.2292	0.2346	0.2235	0.2418	0.2617	0.2357	0.2367	0.2411	0.2269	0.2349

Table 2. Results of Normalization of International Passengers 2018

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.1361	0.13021	0.1355	0.1336	0.1293	0.1398	0.1345	0.1316	0.1297	0.1294	0.1316	0.1382
Soekarno Hatta	0.3304	0.31098	0.3632	0.3481	0.3193	0.3414	0.3416	0.3541	0.3346	0.3443	0.3455	0.3812
Juanda	0.1357	0.12088	0.1353	0.1318	0.1272	0.1320	0.1381	0.1326	0.1332	0.1294	0.1352	0.1422
Ngurah Rai	0.2498	0.27022	0.2834	0.3010	0.3095	0.3097	0.3320	0.3370	0.3176	0.3252	0.2800	0.2853
Hasanuddin	0.1000	0.10000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 3. Domestic Passenger Normalization Results 2019

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.2054	0.1746	0.1759	0.1733	0.1584	0.1922	0.1885	0.1845	0.1804	0.1846	0.1862	0.1829
Soekarno Hatta	0.6889	0.6354	0.6771	0.6264	0.5787	0.6885	0.7565	0.7433	0.7116	0.7523	0.7674	0.8016
Juanda	0.3102	0.2775	0.2805	0.2664	0.2422	0.3277	0.3327	0.3031	0.2937	0.3040	0.3060	0.3153
Ngurah Rai	0.2608	0.2340	0.2388	0.2366	0.2086	0.2727	0.2723	0.2803	0.2594	0.2635	0.2633	0.2690
Hasanuddin	0.2125	0.1910	0.1982	0.1924	0.1832	0.2150	0.2154	0.2094	0.2087	0.2108	0.2123	0.2095

Table 4. Results of Normalization of International Passengers 2019

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.1351	0.1345	0.1331	0.1339	0.1300	0.1366	0.1375	0.1322	0.1304	0.1333	0.1340	0.1387
Soekarno Hatta	0.3342	0.3166	0.3610	0.3384	0.3175	0.3423	0.3534	0.3504	0.3431	0.3623	0.3562	0.3880
Juanda	0.1356	0.1330	0.1375	0.1343	0.1289	0.1361	0.1488	0.1358	0.1335	0.1364	0.1396	0.1436
Ngurah Rai	0.3031	0.2879	0.2927	0.3021	0.3155	0.3180	0.3375	0.3530	0.3348	0.3381	0.3111	0.3093
Hasanuddin	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 5. Domestic Passenger Normalization Results 2020

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.2084	0.1854	0.1647	0.1110	0.1013	0.1107	0.1236	0.1336	0.1280	0.1321	0.1439	0.1501
Soekarno Hatta	0.7005	0.6823	0.5546	0.1717	0.1103	0.1654	0.2605	0.3156	0.2878	0.3256	0.4110	0.4495
Juanda	0.3077	0.2808	0.2533	0.1367	0.1020	0.1241	0.1455	0.1700	0.1609	0.1686	0.1893	0.1918
Ngurah Rai	0.2700	0.2302	0.1951	0.1166	0.1009	0.1043	0.1155	0.1312	0.1304	0.1373	0.1636	0.1710
Hasanuddin	0.2157	0.2028	0.1866	0.1184	0.1025	0.1152	0.1300	0.1503	0.1487	0.1587	0.1726	0.1729

Table 6. International Passenger Normalization Results 2020

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.1362	0.1239	0.1095	0.1002	0.1001	0.1001	0.1001	0.1001	0.1001	0.1001	0.1001	0.1002
Soekarno Hatta	0.3349	0.2667	0.1705	0.1066	0.1035	0.1055	0.1085	0.1107	0.1120	0.1137	0.1158	0.1211
Juanda	0.1369	0.1269	0.1084	0.1004	0.1001	0.1001	0.1002	0.1001	0.1002	0.1006	0.1004	0.1003
Ngurah Rai	0.3405	0.2597	0.2029	0.1025	0.1006	0.1003	0.1008	0.1005	0.1001	0.1000	0.1001	0.1001
Hasanuddin	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 7. Results of Normalization of Domestic Passengers 2021

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.1591	0.1376	0.1460	0.1448	0.1393	0.1566	0.1193	0.1187	0.1304	0.1437	0.1539	0.1606
Soekarno Hatta	0.2903	0.2809	0.3522	0.3638	0.3246	0.4222	0.1938	0.2205	0.3103	0.4092	0.4658	0.5473
Juanda	0.1711	0.1572	0.1745	0.1823	0.1790	0.2301	0.1278	0.1366	0.1625	0.1869	0.2046	0.2147
Ngurah Rai	0.1446	0.1267	0.1439	0.1534	0.1456	0.1847	0.1188	0.1178	0.1427	0.1844	0.2029	0.2194
Hasanuddin	0.1615	0.1482	0.1623	0.1660	0.1536	0.1790	0.1277	0.1249	0.1421	0.1597	0.1684	0.1684

Table 8. Results of Normalization of International Passengers 2021

Airport	January	February	March	April	May	June	July	August	September	October	November	December
Polonia	0.1001	0.1002	0.1003	0.1002	0.1001	0.1001	0.1001	0.1000	0.1000	0.1000	0.1000	0.1000
Soekarno Hatta	0.1184	0.1116	0.1143	0.1154	0.1159	0.1203	0.1170	0.1159	0.1177	0.1195	0.1227	0.1360
Juanda	0.1005	0.1004	0.1004	0.1006	0.1004	0.1004	0.1002	0.1001	0.1001	0.1001	0.1000	0.1000
Ngurah Rai	0.1001	0.1000	0.1001	0.1000	0.1001	0.1002	0.1001	0.1002	0.1002	0.1001	0.1001	0.1001
Hasanuddin	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 9. Domestic Passenger Normalization Results 2022

Airport	January	February	March	April	May	June	July
Poloni a	0.1 845	0.15 16	0.1 665	0.1 623	0.1 921	0.1 815	0.1 865
Soeka rno Hatta	0.5 011	0.40 34	0.5 484	0.5 524	0.6 859	0.6 731	0.6 877
Juand a	0.2 130	0.18 26	0.2 197	0.2 070	0.2 880	0.2 516	0.2 680
Ngura h Rai	0.2 192	0.17 17	0.2 090	0.1 843	0.2 484	0.2 360	0.2 532
Hasan uddin	0.1 794	0.15 88	0.1 825	0.1 674	0.1 033	0.1 862	0.1 925

Table 10. Results of Normalization of International Passengers 2022

Airport	January	February	March	April	May	June	July
Poloni a	0.1 000	0.10 00	0.1 000	0.1 007	0.1 063	0.1 087	0.1 119
Soeka rno Hatta	0.1 311	0.13 78	0.1 653	0.1 850	0.2 155	0.2 132	0.2 125
Juand a	0.1 000	0.10 00	0.1 009	0.1 055	0.1 119	0.1 161	0.1 108
Ngura h Rai	0.1 002	0.10 04	0.1 043	0.1 180	0.1 414	0.1 641	0.1 939
Hasan uddin	0.1 000	0.10 00	0.1 000	0.1 000	0.1 000	0.1 000	0.1 000

3.2. Data Input and Output

Data on the number of domestic and international aircraft is divided into two, namely training data and test data. The training data consists of data on the number of domestic and international passengers from January 2018 to December 2019. The test data consists of data on the number of domestic and international passengers from August 2020 to July 2022. The training input data consists of data on the number of domestic passengers from January to December November 2018 and data on the number of domestic and international passengers from January to November 2018, while the output data consists of data on the number of domestic and international passengers in December 2018 and December 2019. Training and testing the prediction of the percentage of domestic and international aircraft passengers by major airports using the help of the Mathlab 2011b application.

3.3. Training and Testing Results

Results of training and testing using Mathlab 2011b using 11-2-1, 11-3-1, 11-4-1,11-5-1, 11-6-1, 11-7-1, 11-8- architecture 1, 11-9-1, 11-10-1 obtained the performance, epoch and time of each existing architecture. The results of training and testing can be seen in table 11 below:

Table 11. Results of Training and Testing

Model	11-2-1	11-3-1	11-4-1	11-5-1	11-6-1	11-7-1	11-8-1	11-9-1	11-10-1
Epoch	68	64	3	43	152	98	47	4	42
Performance/MSE Training	0.00008773	0.00009845	0.00384310	0.00009965	0.00009916	0.00009232	0.00009951	0.0023 3000	0.0000 9570
Performance/MSE Test	0.00008773	0.00009845	0.00384310	0.00009965	0.00009916	0.00009232	0.00009951	0.0023 3000	0.0000 9570
Time	00:00:10	00:00:09	00:00:01	00:00:07	00:00:20	00:00:12	00:00:07	00:00:01	00:00:07

From table 11 we can see that Model 11-2-1 is the best model to predict the percentage of domestic and international airplane passengers with the smallest performance/MSE training and testing, which is 0.00008773. The following is a comparison chart of the models of each of the existing architectures.

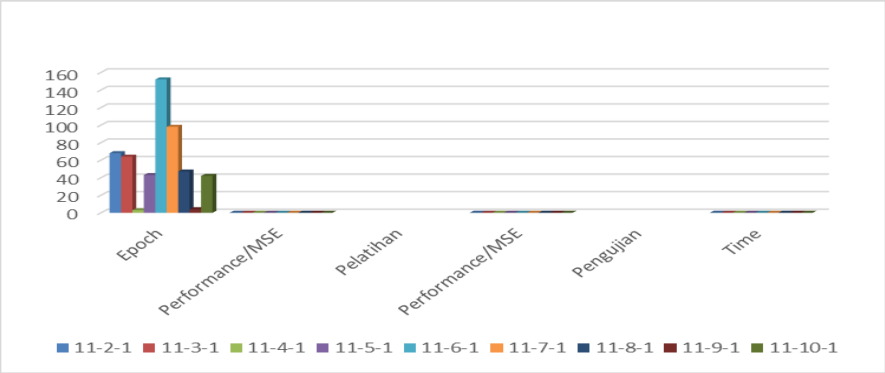

Figure 13. Model Comparison Graph

3.4 Prediction Results of Percentage of Domestic and International Aircraft Passengers

After knowing the best model from the results of the training and architectural testing above, it is continued with the prediction of the percentage of domestic and international aircraft passengers with the best model. The following is the prediction of the percentage of domestic and international air passengers for the following month.

Table 12. Prediction Results

No	Main Airport	Type Passenger	August 2022	The increase decrease (%)
1	Kuala Namu	Domestic	130,874	Down 43%
2	Soekarno Hatta	Domestic	1,089,369	Lead 30%
3	Juanda	Domestic	245.754	Down 45%
4	Ngurah Rai	Domestic	245,488	Down 40%
5	Hasanuddin	Domestic	164.192	Down 33%
6	Polonia	International	44,246	Up 40%
7	Soekarno Hatta	international	50.910	Down 83%
8	Juanda	international	42,647	Up 49%
9	Ngurah Rai	international	40.515	Down 84%
10	Hasanuddin	international	42,381	Up 100%
11	Performance/MSE		0.0095	

The average prediction of domestic and international airline passengers in August 2022 decreased by 37%.

CONCLUSION

The conclusions of this study are:

1. Backpropagation Neural Network with Conjugate Gradient Fletcher Reeves method predicts the percentage of domestic and international airplane passengers.
2. The best architecture is the 11-2-1 model with the most miniature performance/MSE training and testing, which is 0.00008773
3. Prediction results show that the average decline in domestic and international airline passengers in August is 37%, with a test performance of 0.0095.

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