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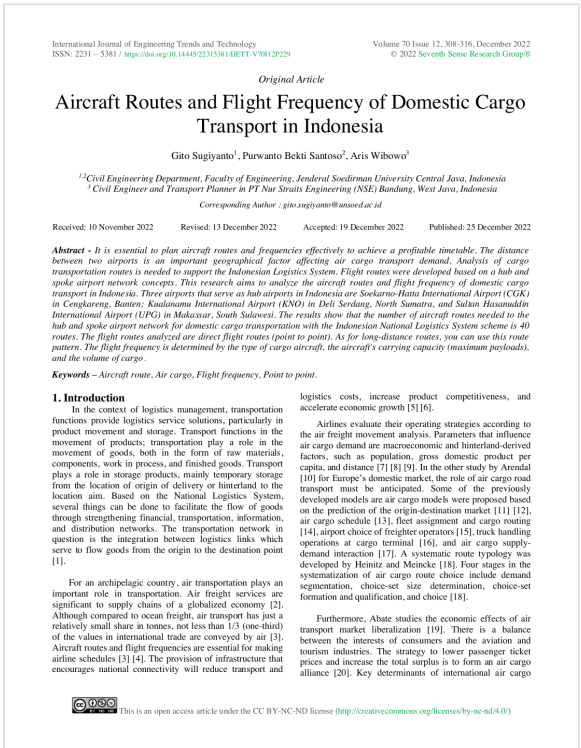

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Original Article

Aircraft Routes and Flight Frequency of Domestic Cargo Transport in Indonesia

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Abstract *- It is essential to plan aircraft routes and frequencies effectively to achieve a profitable timetable. The distance between two airports is an important geographical factor affecting air cargo transport demand. Analysis of cargo transportation routes is needed to support the Indonesian Logistics System. Flight routes were developed based on a hub and spoke airport network concepts. This research aims to analyze the aircraft routes and flight frequency of domestic cargo transport in Indonesia. Three airports that serve as hub airports in Indonesia are Soekarno-Hatta International Airport (CGK) in Cengkareng, Banten; Kualanamu International Airport (KNO) in Deli Serdang, North Sumatra, and Sultan Hasanuddin International Airport (UPG) in Makassar, South Sulawesi. The results show that the number of aircraft routes needed to the hub and spoke airport network for domestic cargo transportation with the Indonesian National Logistics System scheme is 40 routes. The flight routes analyzed are direct flight routes (point to point). As for long-distance routes, you can use this route pattern. The flight frequency is determined by the type of cargo aircraft, the aircraft's carrying capacity (maximum payloads), and the volume of cargo.*

Keywords *– Aircraft route, Air cargo, Flight frequency, Point to point.*

1. Introduction

In the context of logistics management, transportation functions provide logistics service solutions, particularly in product movement and storage. Transport functions in the movement of products; transportation play a role in the movement of goods, both in the form of raw materials, components, work in process, and finished goods. Transport plays a role in storage products, mainly temporary storage from the location of origin of delivery or hinterland to the location aim. Based on the National Logistics System, several things can be done to facilitate the flow of goods through strengthening financial, transportation, information, and distribution networks. The transportation network in question is the integration between logistics links which serve to flow goods from the origin to the destination point [1].

For an archipelagic country, air transportation plays an important role in transportation. Air freight services are significant to supply chains of a globalized economy [2]. Although compared to ocean freight, air transport has just a relatively small share in tonnes, not less than 1/3 (one-third) of the values in international trade are conveyed by air [3]. Aircraft routes and flight frequencies are essential for making airline schedules [3] [4]. The provision of infrastructure that encourages national connectivity will reduce transport and logistics costs, increase product competitiveness, and accelerate economic growth [5] [6].

Airlines evaluate their operating strategies according to the air freight movement analysis. Parameters that influence air cargo demand are macroeconomic and hinterland-derived factors, such as population, gross domestic product per capita, and distance [7] [8] [9]. In the other study by Arendal [10] for Europe's domestic market, the role of air cargo road transport must be anticipated. Some of the previously developed models are air cargo models were proposed based on the prediction of the origin-destination market [11] [12], air cargo schedule [13], fleet assignment and cargo routing [14], airport choice of freighter operators [15], truck handling operations at cargo terminal [16], and air cargo supply-demand interaction [17]. A systematic route typology was developed by Heinitz and Meincke [18]. Four stages in the systematization of air cargo route choice include demand segmentation, choice-set size determination, choice-set formation and qualification, and choice [18].

Furthermore, Abate studies the economic effects of air transport market liberalization [19]. There is a balance between the interests of consumers and the aviation and tourism industries. The strategy to lower passenger ticket prices and increase the total surplus is to form an air cargo alliance [20]. Key determinants of international air cargo

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For an archipelagic country, air transportation plays an important role in transportation. Air freight services are significant to supply chains of a globalized economy [2]. Although compared to ocean freight, air transport has just a relatively small share in tonnes, not less than 1/3 (one-third) of the values in international trade are conveyed by air [3]. Aircraft routes and flight frequencies are essential for making airline schedules [3] [4]. The provision of infrastructure that encourages national connectivity will reduce transport and logistics costs, increase product competitiveness, and accelerate economic growth [5] [6].

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Furthermore, Abate studies the economic effects of air transport market liberalization [19]. There is a balance between the interests of consumers and the aviation and tourism industries. The strategy to lower passenger ticket prices and increase the total surplus is to form an air cargo alliance [20]. Key determinants of international air cargo

flows include air freight rate, population, and dummy variables, i.e., regional economic bloc, long-established colonial links, and open sky agreements [21]. This research aims to analyse the aircraft routes and flight frequency of domestic cargo transport in Indonesia.

2. Materials and Methods

2.1. Location of the Study

The study location in this research is in three airports that serve as hub airports in Indonesia Soekarno Hatta International Airport (CGK), Cengkareng in Tangerang Banten, Kualanamu International Airport (KNO) in Deli Serdang Regency North Sumatra, and Sultan Hasanuddin International Airport (UPG) in Makassar, Maros Regency, South Sulawesi, Indonesia.

2.2. Data Collection

Data required in this study includes the production data for domestic flights from 38 airports in Indonesia which are divided into 12 airports on the island of Sumatra, 8 airports on the island of Java, 5 airports on the island of Kalimantan, 6 airports on the island of Sulawesi, 3 airports on the island of Bali and Nusa Tenggara, and 4 airports on the island of Maluku and Papua. Flight traffic data consist of the number of passengers, baggage (kg), aircraft traffic movement, and cargo (kg). Data production of each airport is obtained from the Directorate General of Civil Aviation, Ministry of Transportation Republic of Indonesia, PT (Persero) Angkasa Pura I Indonesia, and PT (Persero) Angkasa Pura II Indonesia [22]. National airport arrangements in Indonesia based on the Ministry of Transportation Republic of Indonesia PM Number 39 of 2019 [23].

2.3. Analysis Approach

The analysis approach of this research, according to Bazargan, stated there are four stages of the flight planning management process:

flight schedules,
fleet assignment,
aircraft route determinations, and
crew scheduling [24].

3. Results and Discussion

3.1. Air Cargo Route Analysis: Hub and Spoke Concepts

Analysis of cargo transportation routes in Indonesia to support the National Logistics System or *Sistem Logistik Nasional* based on the Presidential Regulation Republic of Indonesia Number 26 of 2012 [1] requires justification and assumptions about what kind of hub and spoke system will be applied in the field. Based on the Indonesia National Logistics System, the number of hubs developed in 2011-2015 is 3 airports. Thus, the concept of the hub can be derived with a combination of 3 hub airports and 35 spoke airports and flight routes could be assumed as presented in Figure 1 as follows.

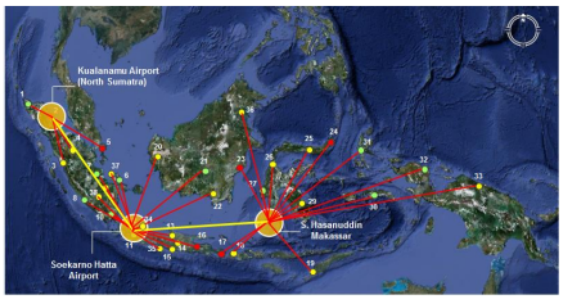

Fig. 1 Hub and spoke airport network based on the National Logistics System.

Soekarno Hatta International Airport (CGK) in Cengkareng, Banten, is a central hub in Indonesia because all of the spoke airports in all of the cities in Indonesia fly into Soekarno Hatta International Airport (SHIA). There are route flights from Soekarno Hatta International Airport in Cengkareng to all cities in Indonesia [25]. Sugiyanto *et al.* stated that the percentage of cargo volume at Soekarno Hatta International Airport in Cengkareng, Banten is 38.229% for domestic flight [26]. Based on Herfindahl-Hirschmann Index (HHI), Kualanamu International Airport (KNO) in Deli Serdang, North Sumatra, is a hub airport for a domestic flights in Sumatra Island, Indonesia [27].

According to Martin and Roman's study, two parameters influencing the hub location are airport location and competition [28]. The economic crisis has affected price behavior both in terms of the price level and dispersion, with a clear increase in price level and decrease in price dispersion [29]. Road infrastructure is one of the factors that must be considered in determining the airport's location, besides the accessibility factor [30] [31]. Low aircraft frequencies substantially negatively affect waiting costs and scheduling costs at hub airports [32]. The advantages of the application of hub and spoke in airport networks are decreased number of routes [33], increased demand (frequent flights), decreased costs [34], and externality costs [35] [36]. Three airports that serve as hub airports in Indonesia are Soekarno Hatta International Airport (CGK), Kualanamu International Airport (KNO), and Sultan Hasanuddin International Airport (UPG). Distribution and justification for the hub and spoke airport networks in Indonesia can be described in **Table 1** as follows.

3.2. Flight Route Needs for Domestic

Flight routes based on the hub and spoke airport network concept is presented in **Table 2**. The routes delivered are direct flight routes (point to point) and 2-way trips. As for long-distance routes, you can use this route pattern. For example, in the case of flights from Padang to Gorontalo, the route that needs to be taken is Padang –Jakarta - Makassar - Gorontalo. This means that the routes that occur are Padang - Jakarta, Jakarta - Makassar, and Makassar - Gorontalo. For other intercity flight cases, refer to Table 2 as follows.

Table 1. Distribution and justification for the hub and spoke airport network in Indonesia.

Hub Airport (IATA Code)	Spoke Airport	
	Airport (Location)	IATA
Soekarno Hatta International Airport (CGK) Cengkareng, Banten	Depati Amir Airport (Pangkal Pinang, Kep. Bangka Belitung)	PGK
	Sultan Thaha Saifuddin Airport (Jambi)	DJB
	Fatmawati Soekarno Airport (Bengkulu)	BKS
	Sultan Mahmud Badaruddin II International Airport (Palembang, South Sumatra)	PLM
	Raden Inten II International Airport (Bandar Lampung, Lampung)	TKG
	Husein Sastranegara International Airport (Bandung, West Java)	BDG
	Ahmad Yani International Airport (Semarang, Central Java)	SRG
	Adi Sumarmo International Airport (Surakarta/ Solo, Central Java)	SOC
	Adi Sutjipto International Airport (Sleman, Special Region of Yogyakarta)	JOG
	Yogyakarta International Airport (Kulon Progo, Special Region of Yogyakarta)	YIA
	Juanda International Airport (Surabaya, East Java)	SUB
	Supadio International Airport (Pontianak, West Kalimantan)	PNK
	Raja Haji Fisabilillah International Airport (Tanjung Pinang, Kepulauan Riau)	TNJ
	Abdul Rachman Saleh Airport (Malang, East Java)	MNG
	[1)] Hang Nadim International Airport (Batam, Kepulauan Riau)	BTH
	[2)] Tjilik Riwut Airport (Palangkaraya, Central Kalimantan)	PKY
	[3)] Syamsudin Noor International Airport (Banjarmasin, South Kalimantan)	BDJ
	[4)] Ngurah Rai International Airport (Badung, Denpasar, Bali)	DPS
Kualanamu International Airport (KNO), Deli Serdang, Medan, North Sumatra	Sultan Iskandar Muda International Airport (Banda Aceh, Nanggroe Aceh Darussalam)	BTJ
	Sultan Syarif Kasim II International Airport (Pekanbaru, Riau)	PKU
	Minangkabau International Airport (Padang, West Sumatra)	PDG
	Hang Nadim International Airport (Batam, Kep. Riau)	BTH
	Halim Perdanakusuma International Airport (East Jakarta, DKI Jakarta)	HLP
Sultan Hasanuddin International Airport (UPG) Makassar, South Sulawesi	Sultan Aji Muhammad Sulaiman Sepinggan International Airport (Balikpapan, East Kalimantan)	BPN
	Tjilik Riwut Airport (Palangkaraya, East Kalimantan)	PKY
	Juwata Airport (Tarakan, North Kalimantan)	TRK
	Syamsudin Noor International Airport (Banjarmasin, South Kalimantan)	BDJ
	Ngurah Rai International Airport (Denpasar, Bali)	DPS
	Zainuddin Abdul Madjid Lombok International Airport (Mataram, West Nusa Tenggara)	LOP
	El Tari International Airport (Kupang, East Nusa Tenggara)	KOE
	Sam Ratulangi International Airport (Manado, North Sulawesi)	MDC
	Djalaluddin Airport (Gorontalo)	GTO
	Mutiara SIS Al-Jufrie Airport (Palu, Central Sulawesi)	PLW
	Mampa Padang Airport (Mamuju, West Sulawesi)	MJU
	Haluoleo (Wolter Monginsidi) International Airport (Kendari, South East Sulawesi)	KDI
	Pattimura International Airport (Ambon, Maluku)	AMQ
	Sultan Babullah Airport (Ternate, North Maluku)	TTE
	Sentani Airport (Jayapura, Papua)	DJJ
	Rendani Airport (Manokwari, West Papua)	MKW
	Juanda International Airport (Surabaya, East Java)	SUB

[1-4)]: Considering the 4 spoke airports that can make direct flights to 2 different hubs from Soekarno-Hatta International Airport (CGK) Cengkareng, Banten; Sultan Hasanuddin International Airport (UPG) Makassar, South Sulawesi and Kualanamu International Airport (KNO), Deli Serdang, Medan, North Sumatra, namely: Hang Nadim International Airport in Batam, Kep. Riau; Tjilik Riwut Airport in Palangkaraya, Central Kalimantan; Syamsuddin Noor International Airport in Banjarmasin, South Kalimantan, and Ngurah Rai International Airport in Denpasar, Bali.

From Table 2, it can be seen that the number of routes needed to form a hub and spoke system of cargo transportation according to the Indonesia National Logistics System or Sistem Logistik Nasional based on Presidential Regulation No. 26 of 2012 [1] scheme is 40 routes (2-way trip or round trip). There are 18 routes from Jakarta, 5 routes from Medan, and 17 routes from Makassar. The result of this study is similar to Yan et al. [37], which combines fleet routing, airport selection, and timetable setting to develop an integrated scheduling model [37]. The selection of the best air transport logistics distribution concept is one of the keys to success in reducing logistics and high economic costs [38]. The punctuality of air traffic is one of the essential criteria in selecting air services [34].

Table 2. Identification of the flight route needs to support air cargo transportation for domestic flights in Indonesia.

Flight Route	Airport Network (Round Trip)	IATA Code
1. Jakarta - Pangkal Pinang	Soekarno Hatta International Airport - Depati Amir Airport	CGK - PGK
2. Jakarta - Jambi	Soekarno Hatta International Airport - Sultan Thaha Saifuddin Airport	CGK - DJB
3. Jakarta - Bengkulu	Soekarno Hatta International Airport - Fatmawati Soekarno Airport	CGK - BKS
4. Jakarta - Palembang	Soekarno Hatta International Airport - Sultan Mahmud Badaruddin II Inter. Airport	CGK - PLM
5. Jakarta - Lampung	Soekarno Hatta International Airport - Raden Inten II International Airport	CGK - TKG
6. Jakarta - Bandung	Soekarno Hatta International Airport - Husein Sastranegara International Airport	CGK - BDG
7. Jakarta - Semarang	Soekarno Hatta International Airport - Ahmad Yani International Airport	CGK - SRG
8. Jakarta - Surakarta	Soekarno Hatta International Airport - Adi Sumarmo International Airport	CGK - SOC
9. Jakarta - Yogyakarta	Halim Perdanakusuma International Airport - Adi Sutjipto International Airport	HLP - JOG
	Soekarno Hatta International Airport - Yogyakarta International Airport	CGK - YIA
10. Jakarta - Surabaya	Soekarno Hatta International Airport - Juanda International Airport	CGK - SUB
11. Jakarta - Pontianak	Soekarno Hatta International Airport - Supadio International Airport	CGK - PNK
12. Jakarta - Tanjung Pinang	Soekarno Hatta International Airport - Raja Haji Fisabilillah International Airport	CGK - TNJ
13. Jakarta - Malang	Soekarno Hatta International Airport - Abdul Rachman Saleh Airport	CGK - MNG
14. Jakarta - Makassar	Soekarno Hatta International Airport - Sultan Hasanuddin International Airport	CGK - UPG
15. Jakarta - Batam	1) Soekarno Hatta International Airport - Hang Nadim International Airport	CGK - BTH
16. Jakarta - Palangkaraya	2) Soekarno Hatta International Airport - Tjilik Riwut Airport	CGK - PKY
17. Jakarta - Banjarmasin	3) Soekarno Hatta International Airport - Syamsudin Noor International Airport	CGK - BDJ
18. Jakarta - Denpasar	4) Soekarno Hatta International Airport - Ngurah Rai International Airport	CGK - DPS
19. Medan - Banda Aceh	Kualanamu International Airport - Sultan Iskandar Muda International Airport	KNO - BTJ
20. Medan - Pekanbaru	Kualanamu International Airport - Sultan Syarif Kasim II International Airport	KNO - PKU
21. Medan - Padang	Kualanamu International Airport - Minangkabau International Airport	KNO - PDG
22. Medan - Batam	Kualanamu International Airport - Hang Nadim International Airport	KNO - BTH
23. Medan - Jakarta	Kualanamu International Airport - Halim Perdanakusuma International Airport	KNO - HLP
	Kualanamu International Airport - Soekarno Hatta International Airport	KNO - CGK
24. Makassar - Balikpapan	Sultan Hasanuddin International Airport - Sultan Aji Muhammad Sulaiman Sepinggan International Airport	UPG - BPN
25. Makassar - Palangkaraya	Sultan Hasanuddin International Airport - Tjilik Riwut Airport	UPG - PKY
26. Makassar - Tarakan	Sultan Hasanuddin International Airport - Juwata Airport	UPG - TRK
27. Makassar - Banjarmasin	Sultan Hasanuddin International Airport - Syamsudin Noor International Airport	UPG - BDJ
28. Makassar - Denpasar	Sultan Hasanuddin International Airport - Ngurah Rai International Airport	UPG - DPS
29. Makassar - Mataram	Sultan Hasanuddin International Airport - Zainuddin Abdul Madjid Lombok International Airport	UPG - LOP
30. Makassar - Kupang	Sultan Hasanuddin International Airport - Eltari International Airport	UPG - KOE
31. Makassar - Manado	Sultan Hasanuddin International Airport - Sam Ratulangi International Airport	UPG - MDC
32. Makassar - Gorontalo	Sultan Hasanuddin International Airport - Djalaluddin Airport	UPG - GTO
33. Makassar - Palu	Sultan Hasanuddin International Airport - Mutiara SIS Al-Jufrie Airport	UPG - PLW
34. Makassar - Mamuju	Sultan Hasanuddin International Airport - Tampa Padang Airport	UPG - MJU
35. Makassar - Kendari	Sultan Hasanuddin International Airport - Haluoleo (Wolter Monginsidi) International Airport	UPG - KDI
36. Makassar - Ambon	Sultan Hasanuddin International Airport - Pattimura International Airport	UPG - AMQ
37. Makassar - Ternate	Sultan Hasanuddin International Airport - Sultan Babullah Airport	UPG - TTE
38. Makassar - Jayapura	Sultan Hasanuddin International Airport - Sentani Airport	UPG - DJJ
39. Makassar - Manokwari	Sultan Hasanuddin International Airport - Rendani Airport	UPG - MKW
40. Makassar - Surabaya	Sultan Hasanuddin International Airport - Juanda International Airport	UPG - SUB

The parameters used to find efficient and effective routes are by calculating flight distance, flight time, and block fuel. Block fuel is the total fuel required for the flight and is the sum of the taxi fuel, the trip fuel, the contingency fuel, the alternate fuel, the final reserve fuel, the additional fuel, and any extra fuel carried [39].

Air transport liberalization will benefit the aviation industry and consumers in the region, albeit not necessarily on an equal basis across or within groups [40]. Most air routes have high allocation and passenger transport efficiency while low freight transport efficiency [41]. The network's physical topology and the functional network with

traffic information correlate highly to a country's Gross Domestic Product (GDP) [42].

3.3. Volume of Cargo Movement by Flight Route

Flight routes based on the concept of hub and spoke above are presented in Table 3. The routes delivered are direct flight routes or point-to-point. As for determining the volume of movement on each of these routes, it can be calculated from the origin-destination matrix (O-D matrix), which has been modified to fill the entire contents of the cells. With this approach, the volume of cargo per route can be traced according to the location of the transit airport (hub). The results of the calculation of the volume of cargo on each route on the implementation of the hub and spoke concept are presented in Table 3 as follows.

Table 3. Estimation of cargo volume per flight route on the implementation of the hub and spoke.

Hub Airport	Flight Route (Round Trip)	Cargo Volume (kg)
Soekarno Hatta International Airport (CGK) Cengkareng	(1) Jakarta - Pangkal Pinang	10,953,514
	(2) Jakarta - Jambi	7,839,043
	(3) Jakarta - Bengkulu	4,169,709
	(4) Jakarta - Palembang	14,487,719
	(5) Jakarta - Lampung	2,220,708
	(6) Jakarta - Bandung	984,742
	(7) Jakarta - Semarang	11,812,651
	(8) Jakarta - Surakarta/ Solo	3,713,475
	(9) Jakarta - Yogyakarta	27,964,316
	(10) Jakarta - Surabaya	61,641,931
	(11) Jakarta - Pontianak	10,140,923
	(12) Jakarta - Batam	36,694,985
	(13) Jakarta - Palangkaraya	3,947,012
	(14) Jakarta - Banjarmasin	9,035,662
	(15) Jakarta - Makassar	163,780,168
Kualanamu International Airport (KNO) Deli Serdang	(1) Medan - Banda Aceh	9,565,893
	(2) Medan - Batam	3,131,018
	(3) Medan - Padang	18,009,487
	(4) Medan - Pekanbaru	17,638,019
	(5) Medan - Jakarta	79,605,768
Sultan Hasanuddin International Airport (UPG) Makassar	(1) Makassar - Balikpapan	46,611,765
	(2) Makassar - Palangkaraya	2.234.313
	(3) Makassar - Banjarmasin	11,203,851
	(4) Makassar - Surabaya	22,507,664
	(5) Makassar - Denpasar	125,766,545
	(6) Makassar - Mataram	12,473,297
	(7) Makassar - Kupang	23,359,566
	(8) Makassar - Palu	10,081,714
	(9) Makassar - Manado	12,141,161
	(10) Makassar - Gorontalo	3,293,239
	(11) Makassar - Mamuju	182,214
	(12) Makassar - Kendari	4,133,452
	(13) Makassar - Ambon	5,887,131
	(14) Makassar - Ternate	6,636,896
	(15) Makassar - Jayapura	83,692,447
	(16) Makassar - Manokwari	3,684,065

3.4. Analysis of Flight Frequency Needs

Flight frequency is determined by the type of cargo aircraft to be used. Different types of aircraft have various cargo capacities. Cargo transportation can use the same aircraft as passenger aircraft ("combi aircraft") or with particular cargo aircraft are aircraft that can be used to carry either passenger as an airliner or cargo as a freighter and may have a partition in the aircraft cabin to allow both uses at the same time in a mixed passenger/freight combination [43].

Combi aircraft typically feature an oversized cargo door and tracks on the cabin floor, allowing the seats to be added or removed quickly. The luggage is the most vulnerable place where threatening objects could be hidden inside [44]. To get the type of aircraft, it is necessary also to consider the types of aircraft commonly used in Indonesia. There are quite a few pilots or aircraft technicians ready to work for cargo transportation.

3.5. Consideration of Existing Aircraft Type

Cargo aircraft can basically use aircraft that are used for passenger transport. The aircraft type selection is generally based on the aircraft's efficiency and the distance of the route to be served. Currently, several types of aircraft are used by airlines in Indonesia to serve scheduled domestic flight routes.

Figure 2 shows the number of routes served by various types of aircraft. Based on the existing routes and the type of aircraft, it can be concluded that the most widely used aircraft type today is the B-737-300 type (there are 147 routes).

Figure 3 shows the relationship between the type of aircraft and the average mileage on various domestic flight routes in Indonesia. The most widely used B-737-300 aircraft generally travel an average of 768 km. Meanwhile, the Airbus A320 aircraft type is generally used for longer flights with an average flight distance of 1,297 km.

Determining the flight frequencies and aircraft types on individual routes of their air service networks is one of the most important problems airlines encounter [45] [46] [47]. One of the airport-airline choice models that can be used in an area with multiple airports is based on a nested Multinomial Logit (MNL) model to examine airport and airline competition [48]. These decisions will affect the cost and quality of airline passenger flight services [49].

Air transport not only contributes to the national economy directly in terms of employment and tax revenue but also plays important roles in regional development by providing essential inputs to other sectors such as trade, logistics [50], and tourism [51]. Aviation activities positively affect regional economies [52].

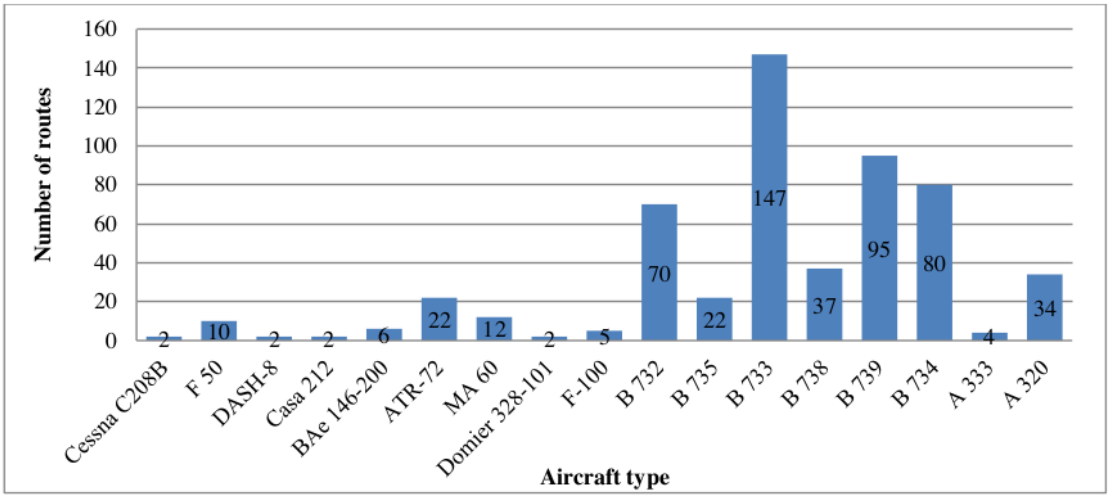

Fig. 2 Number of routes served by different types of aircraft.

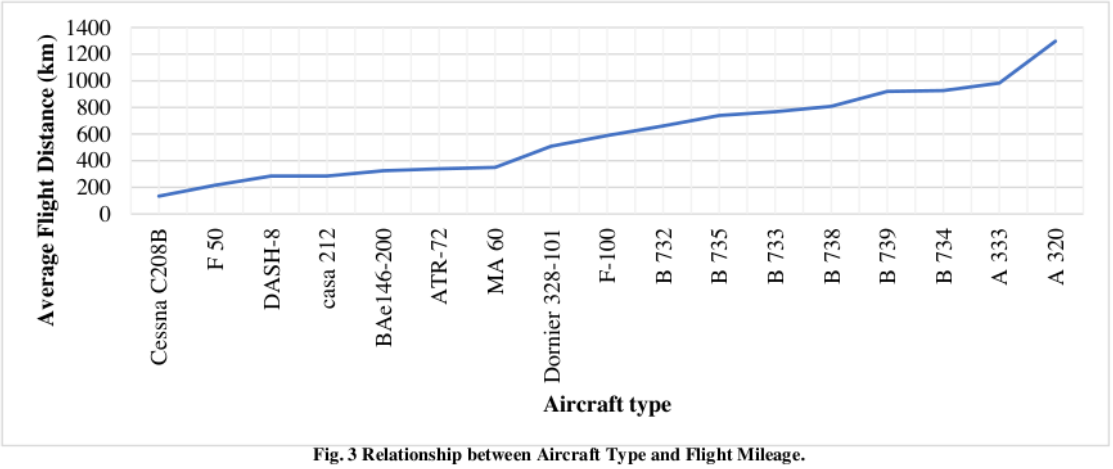

Fig. 3 Relationship between Aircraft Type and Flight Mileage.

4. Conclusions and Further Research

Three airports that serve as hub airports in Indonesia are Soekarno Hatta International Airport (CGK) in Cengkareng, Banten; Kualanamu International Airport (KNO) in Deli Serdang, North Sumatra, and Sultan Hasanuddin International Airport (UPG) in Makassar, South Sulawesi. The results show that the number of aircraft routes needed to the hub and spoke airport network for domestic cargo transportation with the scheme of the National Logistics System is 40 routes. The flight routes analyzed are direct flight routes or point-to-point concepts. The number of routes needed to form a hub and spoke airport network system of cargo transportation according to the National Logistics System scheme is 40 routes (round trip).

Further research is focused on determining the flight frequencies on an airline network with demand-supply interactions between passenger demand and flight frequencies. This is done because the logistics transportation system in Indonesia uses combi aircraft (passengers and cargo).

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References

[1] Ministry of State Secretariat of the Republic of Indonesia, "Regulation of the President of the Republic of Indonesia Number 26 of 2012 Concerning the Blueprint for the Development of the National Logistics System," Jakarta: Ministry of State Secretariat of the Republic of Indonesia, 2012.

[2] Florian Heinitz, Marcus Hirschberger, and Christian Werstat, "The Role of Road Transport in Scheduled Air Cargo Networks," *Procedia Social and Behavioral Sciences*, vol. 104, pp. 1198-1207, 2013. *Crossref,* https://doi.org/10.1016/j.sbspro.2013.11.216

[3] Shangyao Yan, and Chung-Rey Wang, "The Planning of Aircraft Routes and Flight Frequencies in an Airline Network Operations," *Journal of Advanced Transportation*, vol. 35, no. 1, pp. 33-46, 2001. *Crossref,* https://doi.org/10.1002/atr.5670350104

[4] Dušan Teodorović, and Emina Krčmar-Nožić, "Multi-Criteria Model to Determine Flight Frequencies on an Airline Network Under Competitive Conditions," *Transportation Science*, vol. 23, no. 1, pp. 14-25, 1989. *Crossref,* https://www.jstor.org/stable/25768344

[5] John T.Bowen, "The Geography of Freighter Aircraft Operations in the Pacific Basin," *Journal of Transport Geography*, vol. 12, no. 1, pp. 1-11, 2004. *Crossref,* https://doi.org/10.1016/S0966-6923(03)00024-3

[6] William E.Bendinelli, Humberto F.A.J.Bettini, and Alessandro V.M.Oliveira, "Airline Delays, Congestion Internalization and Non-Price Spillover Effects of Low Cost Carrier Entry," *Transportation Research Part A: Policy and Practice*, vol. 85, pp. 39-52, 2016. *Crossref,* https://doi.org/10.1016/j.tra.2016.01.001

[7] Hidenobu Matsumoto, "International Urban Systems and Air Passenger and Cargo Flows: Some Calculations," *Journal of Air Transport Management*, vol. 10, no. 4, pp. 239-247, 2004. *Crossref,* https://doi.org/10.1016/j.jairtraman.2004.02.003

[8] Hidenobu Matsumoto, "International air network structures and air traffic density of world cities," *Transportation Research Part E: Logistics and Transportation Review*, vol. 43, no. 3, pp. 269-282, 2007. *Crossref,* https://doi.org/10.1016/j.tre.2006.10.007

[9] Katsuhiro Yamaguchi, "International Trade and Air Cargo: Analysis of US Export and Air Transport Policy," *Transportation Research Part E: Logistics and Transportation Review*, vol. 44, no. 4, pp. 653-663, 2008. *Crossref,* https://doi.org/10.1016/j.tre.2007.05.006

[10] R. T. Arendal, "The role of RFS in the Europe of Tomorrow, *Cargo Network Solution,*" *FOCUS*, vol. 7, no. 2, pp. 12-18, 1992. *Crossref*,https://core.ac.uk/download/pdf/82503690.pdf

[11] M. Diamond, "*TRR E-C040: Aviation Demand Forecasting-A Survey of Methodologies*," Network Simulation Models, Washington, 2002.

[12] Florian M. Heinitz, and Peter A. Meincke, "Modeling Framework of Origin and Destination Air Cargo Routing," *Transportation Research Record*, vol. 2336, n. 1, pp. 83-90, 2013. *Crossref,* https://doi.org/10.3141/2336-10

[13] Manoj Lohatepanont, "*Airline Fleet Assignment and Schedule Design: Integrated Models and Algorithms*," Doctoral Theses, MIT Cambridge, 2002.

[14] D. Li et al., "Simultaneous Fleet Assignment and Cargo Routing using Benders Decomposition," *OR Spectrum*, vol. 28, no. 3, pp. 319-335, 2006. *Crossref,* https://doi.org/10.1007/s00291-006-0041-8

[15] Franziska Kupfer et al., "The Airport Choice of Freighter Operators: A Multinomial Logit Model," *in the 91st Conference Transportation Research Board (TRB)*, Washington, 2012.

[16] Gregor Selinka, Axel Franz, and Raik Stolletz, "Time-Dependent Performance Approximation of Truck Handling Operations at an Air Cargo Terminal," *Computers & Operations Research,* 2014. *Crossref,* https://doi.org/10.1016/j.cor.2014.06.005

[17] Peter A. Meincke, Florian M Heinitz, and Dirk Steiger, "Interaction of Air Cargo Demand and Global Trade in the Light of Current Modeling Approaches," *11th Annual World Conference of the Air Transport Research Society*, Berkeley CA, 2007.

[18] Florian M Heinitz, and Peter A. Meincke, "Systematizing Routing Options in a Global Air Cargo Network Model," *Aerlines Magazine*, Amsterdam, vol. 49, no. 1, pp. 1-5, 2011.

[19] Megersa Abate, "Economic Effects of Air Transport Market Liberalization in Africa," *Transportation Research Part A: Policy and Practice*, vol. 92, pp. 326-337, 2016. *Crossref,* https://doi.org/10.1016/j.tra.2016.06.014

[20] Anming Zhanga, Yer Van Hui, and Lawrence Leung, "Air Cargo Alliances and Competition in Passenger Markets," *Transportation Research Part E: Logistics and Transportation Review*, vol. 40, no. 2, pp. 83-100, 2004. *Crossref,* https://doi.org/10.1016/S1366-5545(03)00034-6

[21] Cherng-Chwan Hwang, and Guo-Chou Shiao, "Analyzing Air Cargo Flows of International Routes: An Empirical Study of Taiwan Taoyuan International Airport," *Journal of Transport Geography*, vol. 19, no. 4, pp. 738-744, 2011. *Crossref,* https://doi.org/10.1016/j.jtrangeo.2010.09.001

[22] Ministry of Transportation Republic of Indonesia, "*Air Freight Traffic in Indonesia 2021*," Jakarta: Directorate General of Air Transport Republic of Indonesia, 2021. [Online]. Available: http://hubud.dephub.go.id/?id/produksi/index

[23] Ministry of Transportation Republic of Indonesia, "*Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 39 of 2019 concerning National Airport Arrangements*," Jakarta: Ministry of Transportation Republic of Indonesia, 2019.

[24] Massoud Bazargan, "*Airline Operations and Scheduling*," Ashgate, Burlington, Unites States of America (USA), 2004.

[25] Gito Sugiyanto, Purwanto Bekti Santosa, and Mina Yumei Santi, "Hub and Spoke Airport Networks in Sulawesi Island, Indonesia Based on Freight Ratio," *ARPN Journal of Engineering and Applied Sciences*, vol. 15, no. 10, pp. 1201-1209, 2020.

[26] Gito Sugiyanto et al., "Airport Classification based on Federal Aviation Administration and Freight Ratio (case study in Indonesia)," *ARPN Journal of Engineering and Applied Sciences*, vol. 12, no. 2, pp. 579-587, 2017.

[27] Gito Sugiyanto et al., "Evaluation of Hub-Spoke Airport Networks in Sumatra Island, Indonesia to Increase Efficiency of Air Transportation," *MATEC Web of Conferences*, vol. 195, pp. 1-9, 2018. *Crossref,* https://doi.org/10.1051/matecconf/201819504009

[28] Juan Carlos Martín, and Concepción Román, "Analyzing Competition for Hub Location in Intercontinental Aviation Markets," *Transportation Research Part E: Logistics and Transportation Review*, vol. 40, no. 2, pp. 135-150, 2004. *Crossref,* https://doi.org/10.1016/s1366-5545(03)00037-1

[29] José-Luis Alfaro Navarro, María-Encarnación Andrés Martínez, and Jean-François Trinquecoste, "The Effect of the Economic Crisis on the Behavior of Airline Ticket Prices: A Case-Study Analysis of the New York-Madrid Route," *Journal of Air Transport Management*, vol. 47, pp. 48-53, 2015. *Crossref,* https://doi.org/10.1016/j.jairtraman.2015.04.004

[30] Gito Sugiyanto, "Marshall Test Characteristics of Asphalt Concrete Mixture with Scrapped Tire Rubber as a Fine Aggregate," *Jurnal Teknologi (Sciences and Engineering)*, vol. 79, no. 2, pp. 55-64, 2017. *Crossref,* https://doi.org/10.11113/jt.v79.6965

[31] Gito Sugiyanto, Wahyu Widarini, and Eva Wahyu Indriyati, "The Effect of Sea Water Immersion on Buton Asphalt (As-Buton) Mixture," *Jurnal Teknologi (Sciences and Engineering)*, vol. 84, no. 1, pp. 29-39, 2022. *Crossref,* https://doi.org/10.11113/jurnalteknologi.v84.16802

[32] Piet Rietveld, and Martijn Brons, "Quality of Hub-and-Spoke Networks: The Effects of Time Table Co-Ordination on Waiting Time and Rescheduling Time," *Journal of Air Transport Management*, vol. 7, no. 4, pp. 241-249, 2001. *Crossref*, https://doi.org/10.1016/S0969-6997(01)00012-6

[33] Gito Sugiyanto et al., "Analysis of Hub-and-Spoke Airport Networks in Java Island, Indonesia Based on Cargo Volume and Freight Ratio," *Procedia Engineering*, vol. 125, pp. 556-563, 2015. *Crossref,* https://doi.org/10.1016/j.proeng.2015.11.061

[34] Morton E.O' Kelly, "Air Freight Hubs in the Fedex System: Analysis of Fuel Use," *Journal of Air Transport Management*, vol. 36, pp. 1-12, 2014. *Crossref,* https://doi.org/10.1016/j.jairtraman.2013.12.002

[35] Gito Sugiyanto, "The Effect of Congestion Pricing Scheme on the Generalized Cost and Speed of Motorcycle," *Walailak Journal of Science & Technology*, vol. 15, no. 1, pp. 95-106, 2018. *Crossref,* https://doi.org/10.48048/wjst.2018.2347

[36] Gito Sugiyanto, Jajang, and Mina Yumei Santi, "The Impact of Lowering Speed Limit on Mobility and the Environment," *the 1st International Conference on Material Science and Engineering for Sustainable Rural Development in AIP Conference Proceedings* vol. 2094, p. 020019, pp. 1-8, 2019. *Crossref,* https://doi.org/10.1063/1.5097488

[37] Shangyao Yan, Shin-Chin Chen, and Chia-Hung Chen, "Air Cargo Fleet Routing and Timetable Setting with Multiple On-Time Demands," *Transportation Research Part E: Logistics and Transportation Review*, vol. 42, no. 5, pp. 409-430, 2006. *Crossref,* https://doi.org/10.1016/j.tre.2005.02.002

[38] Gito Sugiyanto et al., "Hub and Spoke Airport Networks in Indonesia Based on Herfindahl-Hirschman Index (HHI)," *Journal of Engineering and Applied Sciences*, vol. 11, no. 8, pp. 1804-1810, 2016. *Crossref,* https://doi.org/10.36478/jeasci.2016.1804.1810

[39] Nur Feriyanto et al., "The Route Analysis Based on Flight Plan," *in IOP Conference Series: Materials Science and Engineering*, vol. 114, p. 012147, 2016. *Crossref,* https://doi.org/10.1088/1757-899X/114/1/012147

[40] Nicole Adler et al., "Air Transport Liberalization and Airport Slot Allocation: The Case of the Northeast Asian Transport Market," *Transportation Research Part A: Policy and Practice*, vol. 62, pp. 3-19, 2014. *Crossref,* https://doi.org/10.1016/j.tra.2014.02.003

[41] Yanmin Shao, and Changfu Sun, "Performance Evaluation of China's Air Routes Based on Network Data Envelopment Analysis Approach," *Journal of Air Transport Management*, vol. 55, pp. 67-75, 2016. *Crossref,* https://doi.org/10.1016/j.jairtraman.2016.01.006

[42] Sebastian Wandelt, Xiaoqian Sun, "Evolution of the International Air Transportation Country Network from 2002 to 2013," *Transportation Research Part E: Logistics and Transportation Review*, vol. 82, pp. 55-78, 2015. *Crossref,* https://doi.org/10.1016/j.tre.2015.08.002

[43] [Online]. Available: https://en.wikipedia.org/wiki/Combi_aircraft

[44] D. Sobya, B. H. Prakash, and S. Nallusamy, "Detection of Airport Disguise and Threat Objects using Shortwave-Infrared Imaging and Machine Learning Techniques," *International Journal of Engineering Trends and Technology*, vol. 70, no. 3, pp. 284-294, 2022. *Crossref,* https://doi.org/10.14445/22315381/IJETT-V70I2P232

[45] Patrick Jaillet, Gao Song, and Gang Yu, "Airline Network Design and Hub Location Problems," *Location Science*, vol. 4, no. 3, pp. 195-212, 1996. *Crossref,* https://doi.org/10.1016/S0966-8349(96)00016-2

[46] Chaug-Ing Hsu, and Yuh-Horng Wen, "Application of Grey Theory and Multiobjective Programming Towards Airline Network Design," *European Journal of Operational Research*, vol. 127, no. 1, pp. 44-68, 2000. *Crossref,* https://doi.org/10.1016/S0377-2217(99)00320-3

[47] Chaug-Ing Hsu, and Yuh-Horng Wen, "Reliability Evaluation for Airline Network Design in Response to Fluctuation in Passenger Demand," *Omega: The International Journal of Management Science*, vol. 30, no. 3, pp. 197-213, 2000. *Crossref,* https://doi.org/10.1016/S0305-0483(02)00027-0

[48] Eric Pels, Peter Nijkamp, and Piet Rietveld, "Airport and Airline Competition for Passengers Departing from a Large Metropolitan Area," *Journal of Urban Economics*, vol. 48, no. 1, pp. 29-45, 2000. *Crossref,* https://doi.org/10.1006/juec.1999.2156

[49] Chaug-Ing Hsu, and Yuh-Horng Wen, "Determining Flight Frequencies on an Airline Network With Demand–Supply Interactions," *Transportation Research Part E: Logistics and Transportation Review*, vol. 39, no. 6, pp. 417-447, 2003. *Crossref,* https://doi.org/10.1016/S1366-5545(02)00060-1

[50] Wai Hong KanTsui et al., "Hong Kong's Aviation and Tourism Growth - An Empirical Investigation," *Journal of Air Transport Management*, vol. 93, p. 102036, 2021. *Crossref,* https://doi.org/10.1016/j.jairtraman.2021.102036

[51] Vinolia Kilinaivoni Salesi et al., "The Nexus of Aviation and Tourism Growth in the South Pacific Region," *Asia Pacific Journal of Tourism Research*, vol. 26, no. 5, pp. 557-578, 2021. *Crossref,* https://doi.org/10.1080/10941665.2021.1876745

[52] Xiaowen Fu et al., "Do Airport Activities Affect Regional Economies? Regional Analysis of New Zealand's Airport System," *Regional Studies*, vol. 55, no. 4, pp. 707-722, 2021. *Crossref,* https://doi.org/10.1080/00343404.2020.1851359

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