1874-4478/20 *Send Orders for Reprints to reprints@benthamscience.net*

204

The Open Transportation Journal

Content list available at: https://opentransportationjournal.com

RESEARCH ARTICLE

Strategy for the Alignment of Singapore Flight Information Region Over Indonesian Airspace

A.A. Supriyadi[1,2,*], RAG. Gultom[1], MDM. Manessa[3] and A. Setyanto[2]

[1]*Defense Technology Faculty, Indonesia Defence University, Sentul, West Java, Indonesia*
[2]*Indonesia Counter Terrorism Agencies, Sentul, West Java, Indonesia*
[3]*Department of Geography, Faculty of Math and Natural Science, Depok, West Java, Indonesia*

Abstract:

Introduction:

The violation of the Flight Information Region (FIR) over Indonesian airspace is one of the strategic issues related to the sovereignty of Indonesia.

Methods:

It requires a strategy for the alignment of the Indonesian FIR. One of the difficulties associated with the alignment process is managing the FIR, which is completely determined by the International Civil Aviation Organization (ICAO) owing to safety reasons.

Results and Discussion:

It is necessary to examine the preparedness and strategy of the Indonesian government to convince the ICAO and the international community that Indonesia is capable of controlling, managing, and securing Indonesian FIR airspace.

Conclusion:

This study proposes a roadmap for this FIR alignment strategy in an effort to maintain the integrity and sovereignty of the Indonesian region.

Keywords: Strategy, Sovereignty, Flight information region, Indonesian airspace, Traffic flow, Indonesian government.

Article History	Received: April 21, 2020	Revised: August 17, 2020	Accepted: September 1, 2020

1. INTRODUCTION

Flight information region (FIR) refers to a specific area within airspace wherein information regarding air traffic flow is provided depending on the type of airspace [1]. Since 1947, FIR zoning has been determined based on international agreements through the International Civil Aviation Organization (ICAO), which bases its judgements on aspects of flight safety. Thus far, global airspace has been divided into more than 290 FIRs. The airspaces of several small countries are merged into a single FIR; for instance, the FIR ROBERTS comprises the airspaces of Guinea, Liberia, and Sierra Leone. In the case of countries with vast airspaces, the airspace is divided into several FIRs, such as Indonesia, which has two FIRs: Jakarta and Makasar (Fig. **1**) [2].

This study addresses the alignment of the Singapore FIR, focusing on the problems of the control of Indonesian airspace by foreign FIRs, particularly those above Batam, Riau Islands, and Natuna. Although Indonesia currently has demonstrated considerable capability in the field of technology, particularly information and communication technology, the speed and accuracy of the delivery of information technology and its alternatives, as well as a variety of practical solutions, need to be considered. In the past 1–2 decades, many developed countries and even developing countries have begun to devote considerable attention to the use of information and communication technologies (ICTs) and human resources in the fields of navigation, aviation safety technology, and others. Related to this, Indonesia is considered a sovereign nation. As such, any sovereign country is justified to take any action under the principles of international law and the United Nations Charter to maintain its sovereignty, including maintaining territorial integrity against all threats at any risk [3]. In addition, the Aviation Law allows the transfer of control

* Address correspondence to this author at the Defense Technology Faculty, Indonesia Defence University, Sentul, West Java, Indonesia;
E-mail: aadangsupriyadi@gmail.com

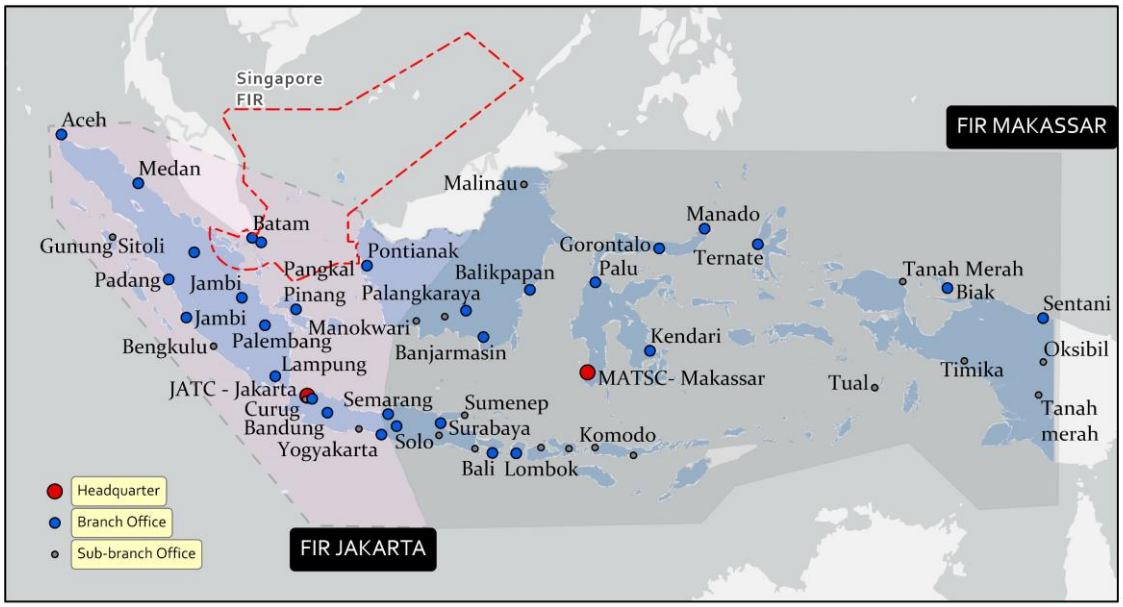

Fig. (1). FIR controlled by Indonesia Government. The AirNav office is shown as red, blue, and grey point. Also, the Singapore FIR is shown in red dash line (source: AirNav, 2018).

of the FIR from Singapore, including the confrontation of possible obstacles that may be presented in realizing that will.

The initial transfer of the control of the FIR over the Natuna Islands airspace to Singapore was discussed at the ICAO meeting in March 1946, in Dublin, Ireland, where the distribution and management of the FIR were addressed. As traffic in Malacca was increasing rapidly, the ICAO stressed the creation of an air traffic system (ATS); however, at that time, Indonesia had just become an independent country, and no Indonesian delegation was present at the meeting. Ultimately, the FIR above the Natuna Islands airspace was established under the name FIR Singapore, with sectors A, B, and C (Fig. **2**) given to Singapore, which was still a British colony.

In 1996, the FIR agreement between Indonesia and Singapore became a legal product (contractual treaty) binding the two countries. The main points listed in the Indonesia–Singapore FIR Agreement [4] are as follows:

(1) Limits in the agreement are set based on the United Nations Convention on the Law of the Sea 1982 treaty.

(2) Indonesian airspace above the Natuna Islands region is divided into sectors A, B, and C

(3) Indonesia delegates responsibility for providing flight navigation services within sector A to Singapore, from sea level to an altitude of 37,000 feet.

(4) Indonesia delegates responsibility for providing flight navigation services within sector B to Singapore, from sea level to an infinite altitude.

(5) Sector C is not included in the FIR agreement between Indonesia and Singapore. However, aviation traffic management in sector C must be coordinated between Indonesia, Singapore, and Malaysia.

On behalf of Indonesia, Singapore imposes a flight or route air navigation service charge in the Indonesian jurisdictional airspace, specifically sector A. As an area in the northern part of Singapore, whereas sector C covers the northern part of sector B, which is connected to the South China Sea. Over time, the FIR, which is controlled by Singapore, has become a strategic area and is busy with international flights. In 1973, joint management of the ABC sector by Singapore and Malaysia began, with Singapore controlling altitudes above 24,500 feet and Malaysia below 24,500 feet.

Indonesia once officially raised the issue in the Regional Air Navigation (RAN) Meeting held in May 1993 in Bangkok, which was attended by countries in the Asia and Pacific region. In the RAN meeting, the FIR alignment over Natuna was resolved bilaterally by Indonesia and Singapore; however, an agreement was not reached. This occurred not because Singapore intends to create complications for Indonesia. Nevertheless, the Natuna region has entered into an agreement with Malaysia that was agreed upon through the formulation of the Nusantara State Regime Law (Malaysian Rights in the Territorial Sea, Archipelago Waters, and Airspace Above the Waters and Territories of the Republic of Indonesia) signed in February 1982 and ratified through Law No. 1 of 1983 [5]. Therefore, Malaysia needs to be involved as well in discussions regarding the dispute of the FIR over Natuna. Consequently, the FIR issue above Natuna has become even more tangled with the increasing number of parties involved.

Referring to the FIR provisions determined under Article 28 of the Chicago Convention 1944 [6], which was further elaborated in Annex 11 concerning air traffic services [1], Indonesia is required to provide flight navigation facilities and services following the provisions of the Convention. However, in Annex 11 [1], Indonesia can delegate such supervision to an-

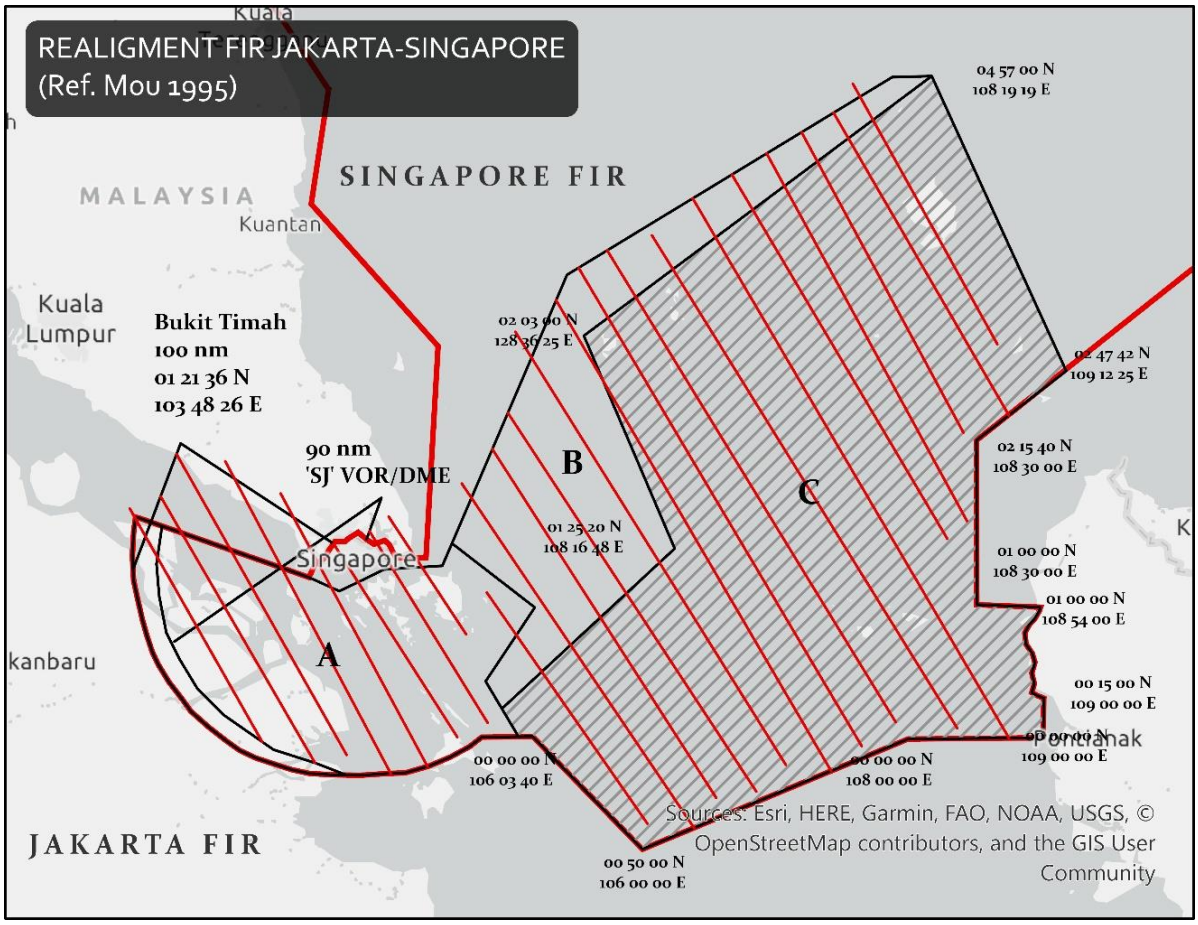

Fig. (2). Singapore FIR over the Indonesia Airspace area (Source: http://masyarakathukumudara.or.id/wp-content/uploads/2016/02/FIR.png).

other country (Singapore) if it deems itself unable to supervise air traffic over the sovereignty of the Republic of Indonesia, following Article 262 paragraph 1 letter a of the Aviation Law No. 1 of 2009 [7]. The FIR limit does not necessarily have to be aligned with the administrative or territorial boundary of a country. The definition of territory can be adjusted to the development of international provisions, following the provisions of the territorial states of the archipelago, while the airspace of sovereignty is located above the area. From the perspective of geopolitics, space is the core because it is a vehicle for political and military dynamics. De facto and de jure control of space is the legitimacy of political power. Increased or reduced state space can be caused by various aspects that are always associated with the honor and sovereignty of a state and nation [8].

According to international law, Indonesia has sovereignty over the airspace above the land and sea area to a height where the air reaches outer space. Until now, there has been no international agreement regarding the high airspace in the sky. However, there is an agreement that airspace does not cover outer space. Some countries claim airspace to an altitude of 100 km into the air; however, some theories state that the height of airspace depends on where fixed-wing aircraft can fly using aerodynamics. The national air space of a country is used either to support national interests or accommodate international aspirations, including flight security and safety regulated by international law and ratified into the national law of the country of concern [9]. The sovereignty of the air space gives each state exclusive right to its own air territory and aircraft within that territory without permission are seen and treated as intruders [10]. International airspace arrangements were established based on the 1944 Chicago Convention [11]. The violation of Indonesia sovereignty is shown in the influence of the Singapore Civil Authority on defense and security in Indonesian airspace, where the Singapore Civil Authority sets the Danger Area in MTA 1 (Military Training Area) and MTA 2 and the Flight Information Region, which is above the Indonesian territory as a military training area that makes the area an area a prohibited zone unilaterally without agreement with Indonesia [12, 13].

Several publications have discussed the hot issue of Indonesia – Singapore FIR alignment [12 - 18]. Novika Maharani examined the legal basis of FIR control in Singapore in the context of Singapore's FIR realignment in Indonesia and explained that Indonesia, as a sovereign island nation, had the right to manage its air space under Article 28 and Annex 11 [16, 17]. Thus, Singapore only had a legal basis in controlling the FIR from the 1946 RAN Meeting. The next step in the realignment effort was to form an inter-department working group consisting of the Ministry of Transportation, Ministry of

Foreign Affairs, Indonesian Air Force Headquarters, Ministry of Defense, BNPP (*Badan Nasional Pengelola Perbatasan* - National Border Management Agency), and other agencies in an effort to prepare the FIR realignment, especially the establishment of a roadmap and working papers [17]. This roadmap details the steps to prepare for realignment. Furthermore, the working paper is a proposal for a realignment to be submitted to the ICAO in the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) session. However, Bakhtiar *et al.* described that limitation of the Indonesian government is the defense tools capacity owned by the Air Force, who has not reached the minimum limit of the defense forces [18]. This fact shows the weakness of the Indonesian government in the alignment process.

Indonesia has the means to be able to take back the delegation of the FIR [13]. In addition to delegating the FIR to Singapore, Indonesia also gave Malaysia rights to sea and air communication connecting West Malaysia and East Malaysia, through areas that are a part of Singapore's FIR. Indonesia has a sound legal basis for taking over the FIR area above Natuna Island. Zone A is under the supervision of Singapore in return for services; however, it can still be returned if Indonesia can demonstrate its territorial control. Malaysia has given indications of continuing to support Singapore's control of the FIR for Natuna Island, which, in principle, contains parts in which Malaysia, Singapore, and Indonesia maintain sovereignty. The management of the FIR, which is part of the sovereignty of the Indonesian airspace above the Riau and Natuna islands, by Singapore, has a legal basis.

Referring to Law No. 1 of 2009, flight navigation services are delegated to other countries based on the agreement that must be evaluated and served by the flight navigation service provider no later than 15 years after this law is put into force or before the year 2024 [7]. Indonesia is currently ready (Human Resource and Technology) to take over the FIR above the Riau Islands airspace. However, several issues still need to be resolved. One is the lack of support and trust from the ICAO toward Indonesia. Aviation safety must be the basis of the FIR alignment. Proving to the ICAO that Indonesia is reliable in terms of safety considerations is a priority. In addition to the safety of the paths of aircraft landing or taking off at Changi Airport, this should be considered when determining the new Singapore FIR. The socialization of the ability of Indonesian navigation services has not been optimal. Few countries possess detailed awareness regarding Indonesia's ability to provide in-flight navigation services; thus, the support toward Singapore is currently strong.

Based on the abovementioned description supported by data and facts, this study was conducted with two aims. Firstly, we analyze the readiness of the Indonesian government to convince the ICAO and the international community that Indonesia can control, manage, and secure the Natuna FIR airspace with respect to flight safety in the Natuna FIR region. Secondly, we formulate a grand design and roadmap of the Natuna FIR air control alignment stage as a form of enforcement of national airspace based on safety. Based on the past study review [12 - 18], the grand design and roadmap of the Natuna FIR air control alignment have rarely, if at all, discussed in Indonesia – Singapore Alignment topics.

2. METHODOLOGY

In this study, two types of data were classified: quantitative and qualitative. Qualitative data were sourced from in-depth interviews with several key informants, namely the Commander of Tanjung Pinang Airbase, AirNav (Indonesia state-owned corporation that in charge of Aviation Navigation Services), and FIR practitioners. The quantitative data were sourced from primary and secondary data. Fundamental data in the form of interviews with pilots were obtained through previously prepared questions. This study randomly sampled pilots from the Indonesia pilot communities group mailing list. We asked pilots who have experienced communication with the ATC at Tanjung Pinang. Unfortunately, the online system questioner was not very desirable; then only 50 pilots were willing to participate. Secondary data are the data that have been processed or analyzed and stored in the form of writings, opinions, journals, books, and other literature for which the data have been tested and can be held accountable for its truth.

Miles and Huberman (1994) qualitative data analysis techniques consist of three stages: data reduction, data display, and conclusion drawing. Data reduction or data simplification is continuously performed during research, such that the data collected for research analysis and discussion can be clearly and concisely distinguished. Data display is the presence of data that have been previously filtered/simplified, in addition to analyses and explanations, to strengthen the arguments raised in the study. Conclusion drawing refers to summarizing the discussions and investigations conducted during research.

Data were collected from interviews and online media sources, in which verbatim and selected statements relevant to the topic and research needs were processed through the application of data reduction techniques. After the data were selected, the analysis was carried out by comparing the obtained data with the theories and concepts used in the study to reveal the correct direction for the FIR alignment. After analyzing and recognizing the level of readiness of the Indonesian government for FIR alignment based on the ideal concept of the theory used, conclusions were drawn.

To evaluate the validity and reliability of this study, the authors employed the Structural Equation Model (SEM) approach. SEM can also be used to analyze the model and determine the level of conformity of the model, commonly referred to as the suitability index [19]. Bollen stated that SEM can simultaneously analyze all variables to determine the correlation, variance, covariance, index of conformity, and level of confidence of the components of the model obtained [20]. This analysis was used to evaluate air traffic control (ATC) performance. Furthermore, a Geographic Information System (GIS) approach also implements to evaluate the spatial area of Indonesia – Singapore FIR. The GIS technique plays an important role in planning and managing the FIR [21, 22]. As in this study, a recommendation of Indonesia – Singapore FIR area represents in a spatial way using the buffer and dissolve technique.

3. RESULTS AND DISCUSSION

3.1. Indonesian Government Readiness

The government, through the Coordinating Ministry of Maritime Affairs acting as Coordinator, has formed three teams. A technical team, which includes AirNav, the Ministry of Transportation, and the KOHANUDNAS (*KOmando PertaHANan UDara NASional* - Indonesian National Air Defense Forces) Commander, prepares the facilities and infrastructure for this alignment, as the regulatory team formulates regulations. Finally, the diplomacy team negotiates with Singapore and Malaysia. In this case, the KOHANUDNAS Commander directly led the team of airspace control alignment.

The Commander of the Indonesian Air Force has expressed optimism in suggesting that control of the sector A FIR, which includes Batam and Natuna, will be transferred to Indonesia from Singapore, in 2019 [23]. It was further conveyed that the FIR for both sectors B and C up to a height of 20,000 feet (controlled by Malaysia) would have been taken over by Indonesia by March 2018. The positivism of the KOHANUDNAS Commander, stating that the control of the airspace around the islands would be assumed by Indonesia by that date, was contradicted by the Minister of Defense. The minister expressed that the FIR alignment could not be performed immediately, targeting completion by 2021 [24]. The statement of the Defense Minister indicated that during the process of aligning the FIR, there were obstacles that were significantly difficult to overcome and required an extended period. This notion is strengthened by the fact that the FIR for sectors B and C cannot be aligned according to targets.

The technical work that has been performed by the Indonesian government involves the plan to build a military base in Natuna in an effort to defend the border region. The masterplan for the construction of military bases included a plan to equip them with a variety of super-sophisticated combat equipment. The Indonesian government has demonstrated the urgency of strengthening the country's defense and security system.

There is no question regarding sovereignty; control of the Indonesian airspace should be in Indonesian hands. However, the determination of the FIR boundary emphasizes the technical and operational interests of aviation navigation services to ensure flight safety and efficiency. In the term of technology and safety, Indonesia is far behind Singapore. However, in the case of safety, since 2019, the number of flight accidents decreased significantly, as in 2019, only 2 accidents and until August 2020, accident number is 3 [25]. Based on the National Transportation Safety Committee (NTSC) report, the accident mostly happens in the Papua district, caused by the nature force [25]. Even the FIR does not have to coincide with national borders because it is not related to sovereignty issues (Andre Rahadian, Chair of the Indonesia Air Law Society). Indonesia needs to undertake further technical preparations to support the alignment of the FIR.

3.2. Performance of ATC

AirNav Indonesia manages all Indonesian airspace, which is divided into two FIRs. The total area of the FIR managed by ATC Jakarta and Makasar Indonesia reaches 2,219,629 km^2, with the number of flight vehicles in the airspace reaching more than 10,000 per day. ATC is an essential aspect of managing FIR. Various steps have been taken by AirNav to support the National Aviation Safety Program and the Safety Management System. One of the AirNav programs is to develop the EFFORT—Electronic Form for Occurrence Reports application system, which includes a mandatory reporting system and a voluntary reporting system. The mandatory reporting system is specially designed for internal AirNav reporting. In contrast, the voluntary reporting system was designed to accommodate safety reporting by external parties who are aware of safety incidents related to the organization of flight navigation services that will report to AirNav. AirNav understands the FIR alignment process must be determined by the ICAO, which is based on ensuring safety.

Evaluation of ATC performance was conducted on two levels, namely, the controller and manager from the perspective of the ATC pilot. The results show that the ATC performances from the manager (Fig. **3a**) and the controller (Fig. **3b**) are suitable, in which the majority of respondents gave positive responses, with the exception of the equality parameter for all airlines (X9). This is because the pilots considered that the ATC controller exhibited favoritism toward one of the airlines. Whereas controllers are often found to prioritize services to one airline, procedurally, this is not justifiable. However, based on the results of the survey, this incident occurred some time ago, and there have been many changes and improvements in the quality of ATC personnel.

Furthermore, this study also evaluated the relationship between the performance of the ATC controller, ATC manager, and ability of ATC to manage FIR above the Natuna area in terms of the SEM analysis techniques used by the ATC service user pilot (Fig. **4**). The performance of the ATC manager showed positive values for professionalism (Y1), accessibility (Y2), management (Y3), relations (Y4), and overall service (Y5), with regression coefficient values ranging from 0.87 to 1. The ATC controller also showed positive values with varying ranges. Professionalism (X1), ease of communication (X2), clarity of instructions (X3), time management (X4), applying FAA procedures (X5), responsiveness (X6), equality of all airlines (X7), and performance (X8) exhibited values ranging between 0.84 and 1, whereas (X9) showed a relatively low value of 0.39. The low value indicated partiality, as some pilots still found incidences of prejudice toward one of the airlines. The results further indicated that the evaluations of the controller and manager performances were sufficiently correlated, with a regression coefficient value of 0.75. Meanwhile, the relationships between the ability of Indonesia to manage the FIR and the ATC controller and ATC manager were shown to be uncorrelated, with regression coefficient values of −0.07 and 0.39, respectively, indicating that there are other considerations from pilots regarding aspects of FIR management besides ATC performance.

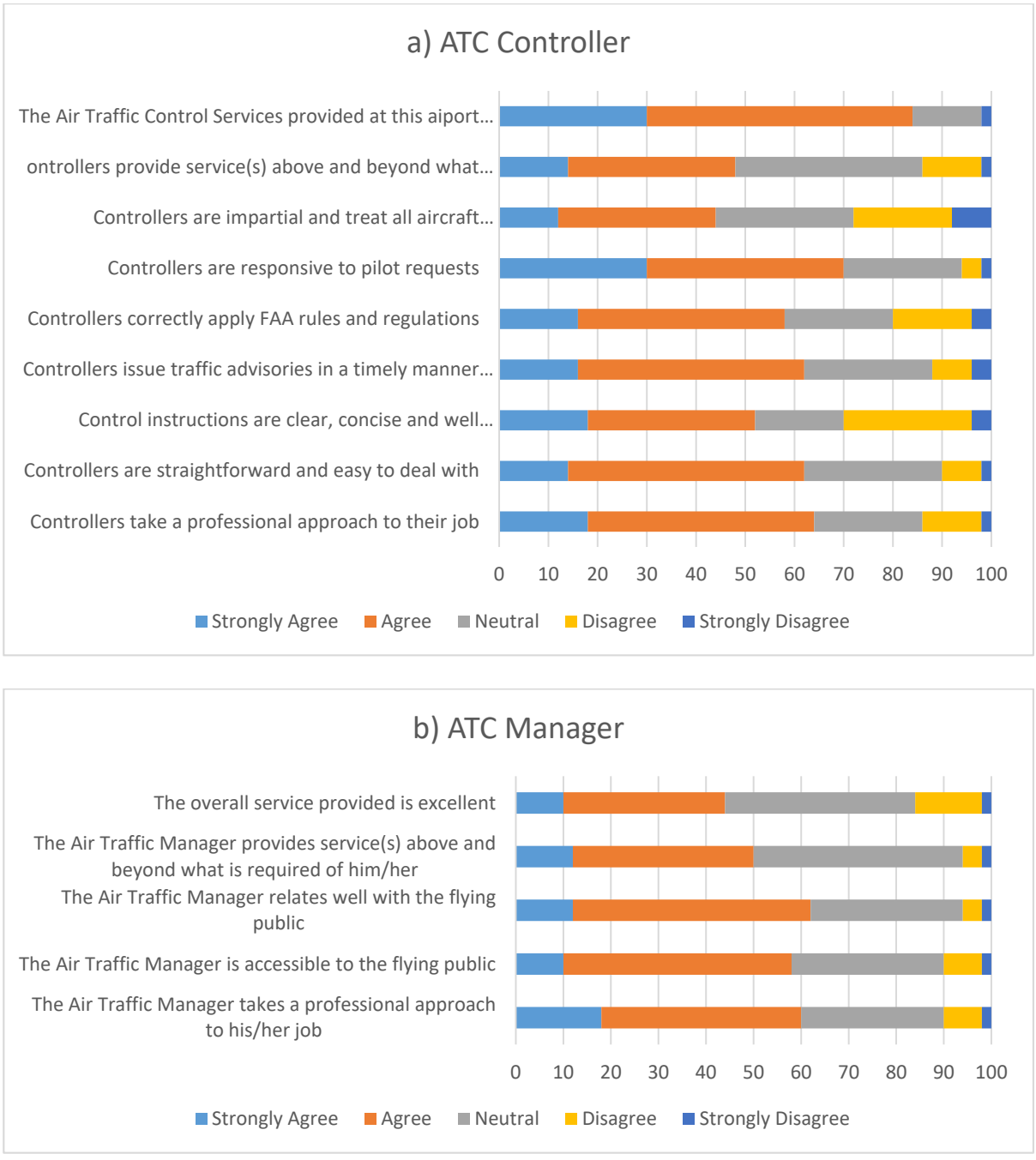

Fig. (3). Pilot evaluation of the performance of the **a**) ATC Controller **b**) ATC Manager.

The statistical test values of the SEM models are listed in Table **1**. Overall, the model meets the control standards for all test parameters. Therefore, this model can be used to evaluate the performance of ATC managers and controllers from the perspective of ATC service user pilots.

The results of a field visit to ATC Tanjung Pinang indicated the following interesting facts. Based on the technology and human resources, the Tanjung Pinang ATC is ready to manage the FIR over Natuna waters. Technology has been prepared to support the alignment process, including hardware (PC, radar, tower), software, frequency evaluation, and airspace monitoring capability using radar instruments to study the traffic flow over the Natuna Islands. The more detailed technology owned by ATC Natuna is as follows. Radar data were obtained from MSSR (Monopulse Secondary Surveillance Radar) and ADS-B (Automatic Dependent Surveillance–Broadcast). Ground-to-ground coordination communication used a very small aperture terminal (VSAT). ATC Natuna has further utilized the FPL (Flight Plan) and ATS message systems and connected them to the Aeronautical Fix Telecommunication Network (AFTN) and Electronic Flight Plan (EFPL), including data from BMKG Tanjung Pinang and BTH, which entered the ATC system through the

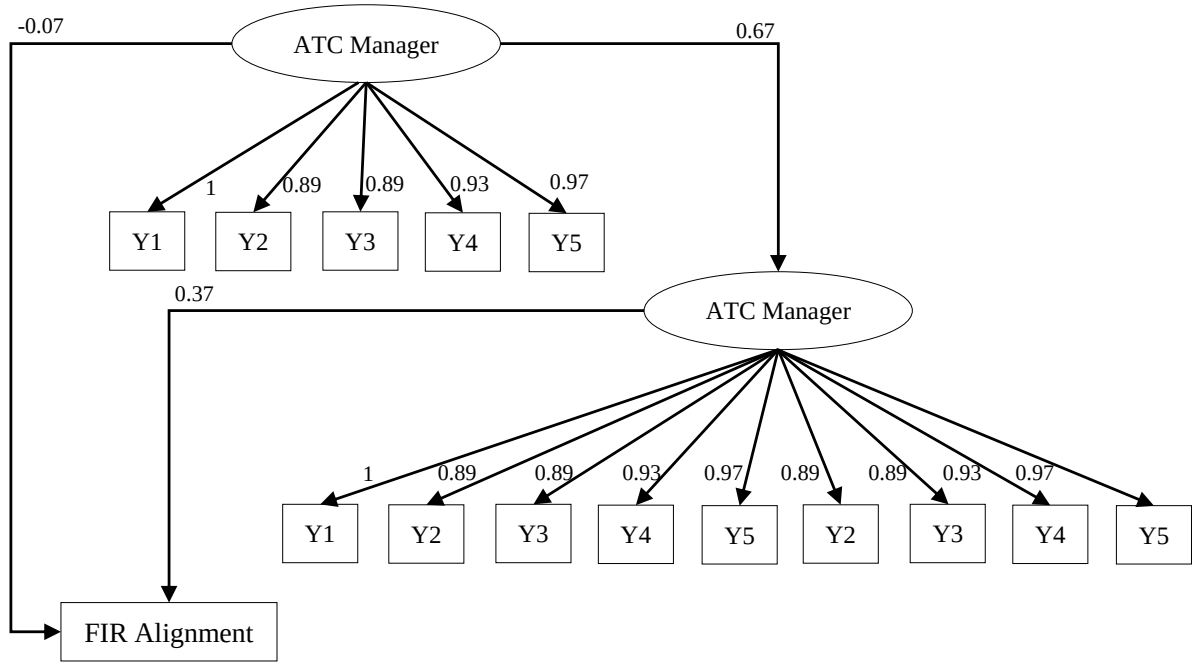

Fig. (4). SEM model over relationship between FIR alignment and ATC Manager/Controller.

Table 1. Statistics of the proposed SEM model.

Parameters	Model Values
Number of free parameters	32
Number of observations	50
Model fit test statistic	191.615
Degrees of freedom	88
Comparative fit index	0.962
Tucker–Lewis index	0.95
RMSE (Root Mean Square Error)	0.153
SRMR (Square Root Mean Residual)	0.059

AFTN. The MSSR radar data were obtained from the Tanjung Pinang MSSR, Pekanbaru MSSR, Palembang MSSR, Pontianak MSSR, and Natuna MSSR systems. Regarding human resources, the preparation for the management of all Natuna FIR is ready. Among a total of 70 personnel of a productive age (87% of staff aged 20-29 years), the readiness of ATC Tanjung Pinang is apparent; hence, hesitation is not warranted with regard to the Indonesian management of the FIR over the Natuna region.

Tanjung Pinang has a strategic location, with a range of supervision that can reach 100-250 nautical miles, such that it can cover the entire airspace above the Natuna region. The administration of regency capital would provide the support that would simplify the process of airspace management. Furthermore, Singapore has already handed over some control of the airspace over the Natuna Islands to Tanjung Pinang ATC but only to heights below 10,000 ft. This airspace range is not a potential area of aviation traffic and, thus, has low strategic and economic value. Based on ATC monitoring, the air traffic that Tanjung Pinang governs, below 10,000 ft, represents only 2% of the total flight traffic that passes through the airspace (Table **2**). This fact shows that Singapore's action of yielding FIR management rights under 10,000 ft is only a formality and has no impact on the essence of FIR alignment. The management of this altitude range is not so beneficial for Indonesia in terms of two aspects: the elevation range is only crossed by ATR and CASA aircraft, helicopters, and amphibious aircraft, in which the quantity is tiny and wasteful fuel consumption is evident for flights at altitudes less than 10,000 ft.

3.3. Alignment Roadmap

In terms of sovereignty, there is no doubt that Indonesia will take control of the FIR over the Riau Islands airspace from Singapore's surveillance. Appropriate steps have been enacted by the government, such as the formation of teams, development of radar, improvement of ATC quality standards,

Table 2. Number of flights above Natuna FIR during September 2018.

	Sectors B and C			**Sector A**
	LEVEL			
	< 10,000 ft	10,000 ft-FL200	> FL200	
Total	290	232	10645	17822
Average	9	7	343	594

Table 3. FIR Alignment steps.

Operational and tactical	a. Conducting socialization to provide understanding related to the international rules of FIR management issued by the ICAO. b. Make a list of competencies exhibited by Singapore, as a reference for improving the flight system in Indonesia. c. Equivalence of instrument aviation to be commensurate with Singapore, which includes infrastructure, technology, and quality of human resources. d. Local standard operating procedures and procedures are evaluated and compared with Singapore. e. Development of ATC in Tanjung Pinang as a sub-controller of ATC Jakarta. f. Manufacture of combat, helicopter, reconnaissance, and maintenance air squadrons at Natuna. g. Evacuation teams (SAR) based on flight routes, such as Tanjung Pinang. h. Secure acquisition of FIR Natuna sectors B and C. i. Singapore FIR recommendation 40 miles from SID (standard instruments departure) (Fig. 5).
Grand strategic	a. Integrated elements, such as defense, transportation, diplomacy, and planning. b. Direct correspondence with ICAO to confirm needs in order that the Singapore FIR can synchronize with Indonesia. c. Optimization of diplomacy by Indonesian representatives toward ICAO. d. Opening of ICAO branches in Indonesia to strengthen relationships. ICAO can continuously see and audit Indonesia's performance in aviation services. e. Diplomacy with Singapore through diplomats that are very knowledgeable regarding FIR, Indonesian sovereignty, and aviation safety. f. Building trust in all components (government, private, airlines) at the regional and global levels. g. Building cooperation in the field of capacity building with aviation organizations and developed countries. j. Implementation of the Airspace Boundary Act, which is a legal measure of Indonesian airspace management.

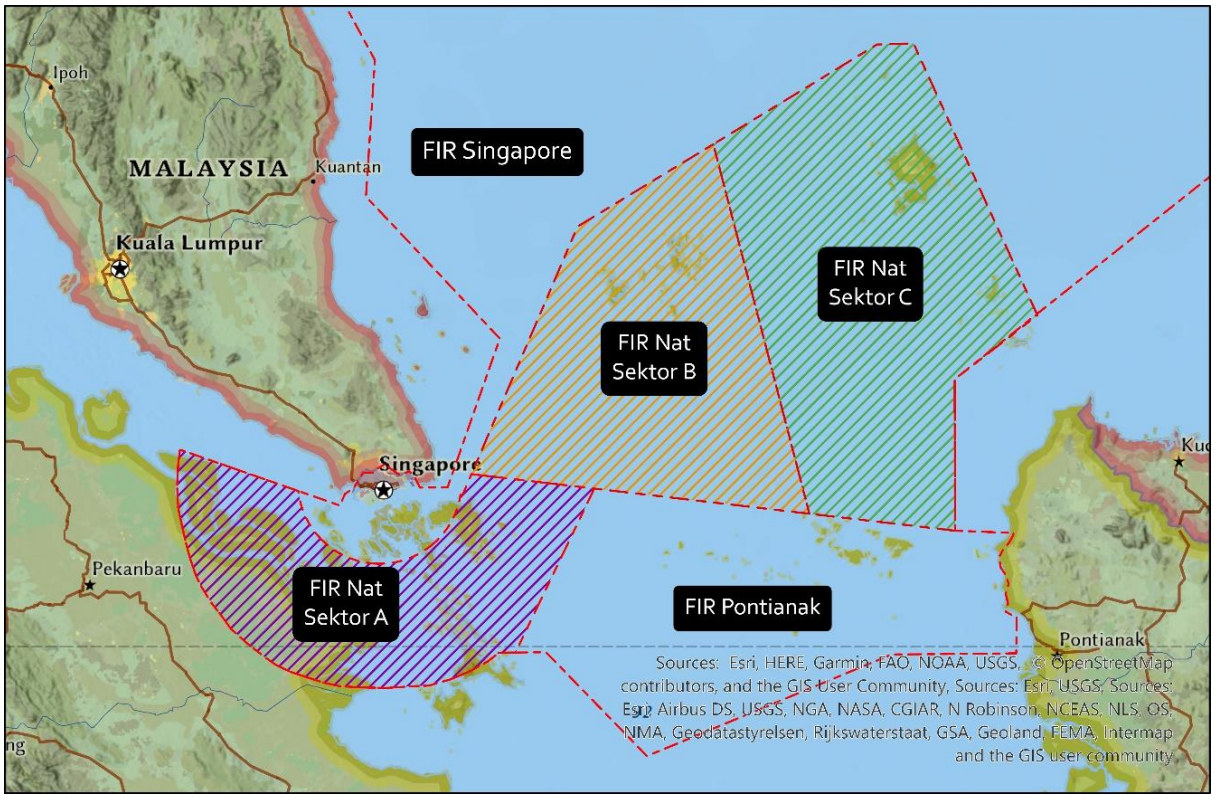

Fig. (5). Recommendation of Singapore FIR alignment over Indonesia Airspace.

and the creation of airbases. However, further operational, tactical, and strategic steps are needed to accelerate the alignment process.

The operational–tactical steps or action plans that need to be undertaken by the Indonesian government must focus on the development of facilities and infrastructure to support FIR management. As is well known, Singapore has extensively developed FIR management technology. Furthermore, Singapore can maintain its management performance with zero accidents. To gain the trust of the ICAO, Indonesia needs to equalize its facilities and infrastructure with those of Singapore. Furthermore, efforts to strengthen surveillance/monitoring activities carried out by the Indonesian Air Force are also needed to enhance Indonesia's position. These tactical, operational, and grand strategic steps are shown in Table **3**.

The strategic steps focus on the role of the state in conducting diplomacy and coordination between the sectors to accelerate the FIR alignment process. The Indonesian government needs to take a concrete approach to the ICAO to demonstrate that Indonesia is capable of managing its entire airspace. Although the ICAO is focused on safety, Indonesia must be able to submit arguments regarding the sovereignty and security of the country. With the management of Indonesian airspace above the Natuna region, it is difficult to combat aircraft and border control aircraft to move. Moreover, the high rate of violation of maritime boundaries in Natuna waters requires air control to effectively maintain the boundaries. With this foundation, Indonesia can effectively manage its airspace by asserting stronger sovereignty.

Regarding the safety and comfort factors of flight operations at Singapore's Changi Airport, the alignment of the airspace above Natuna as a whole needs to be considered. Indonesia needs to provide a portion of its airspace to make it easier for Singapore to manage flights around its airspace. Using a 40-mile radius from the Standard Instruments Departure (SID) is recommended, the proposed recommendation of Indonesia – Singapore FIR, as shown in Fig. (**5**). The SID is a published flight procedure that is followed by pilots who fly with Instrument Flight Rule (IFR) immediately after takeoff to transition from the terminal environment to the ATC route structure or directly to other nearby airports. SID will keep the plane away from the terrain, which is optimized for flight routes and ATC.

Furthermore, SID automatically adjusts the climbing gradient to low but achieves a balance between obstacle avoidance and airspace considerations. This is one form of diplomacy that can be used by the Indonesian government with Singapore's authority. In addition to sovereignty considerations, the importance of safety and comfort in flights through Changi Airport must be given priority in the negotiations.

This study only discusses the topic based on stakeholders and the opinion of pilots who communicate with the Indonesia site air controller and air management. However, we admit that this topic can be discussed in a wider perspective, such as the point of view of the operator/airline. This issue became one of the lacks in this study.

CONCLUSION

Although the sovereignty of Singapore's FIR alignment is not an issue, the determination of the FIR is under the control of the ICAO. Aviation safety has become the only important concern in the harmonization of the Singapore FIR with that of Indonesia. Even Indonesia has proven the improvement of flight safety performance. Until now, the Indonesian government has not been able to carry out the alignment process because of diplomacy factors with ICAO and Singapore. The alignment–stage roadmap is composed of operational, tactical, and strategic stages that were provided in this study. Commitment from all stakeholders is needed to demonstrate to the ICAO that Indonesia is worthy of managing the Singapore FIR. Better coordination between agencies included in the Indonesia FIR alignment team is required. To facilitate the alignment process, tactical steps are needed to build a safe affiliate system that meets ICAO safety standards. Lastly, the recommended FIR area that is based on a 40-mile radius from the Standard Instruments Departure became an interesting finding in this study. Based on this approach, the safety factor of the Singapore side and the sovereignty of Indonesia will be accommodated.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The authors confirm that the data supporting the findings of this research is available from the corresponding author (A.A.S) upon a reasonable request.

FUNDING

The Indonesia Defence University financially supported this study through grant number SPRIN/1012/IV/2018.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

Declared none.

REFERENCES

[1] ICAO, *Annex 11: Air traffic services,* 2001.

[2] A. INDONESIA, *Ruang Udara,* 2018. Available from: www.airnavindonesia.co.id

[3] Subejo, "Uses and determinants of information and communication technology utilization in commercial agriculture areas to support food security in rural yogyakarta - penggunaan dan faktor penentu pemanfaatan teknologi informasi dan komunikasi pada kawasan pertania", *J. Ketahanan Nas.,* vol. 24, no. 1, p. 62, 2018.

[4] I.P. Yani, *Yanyan Mochamad, Ian Montratama, Whose Indonesian Sky? The strategic meaning of the Indonesia-Singapore Air Control Area (FIR) - Langit Indonesia Milik Siapa? Makna strategis wilayah pengendalian udara (FIR) Indonesia-Singapura.,* PT Elex Media Komputindo: Jakarta, 2016.

[5] R. of Indonesia, *Undang-undang no 1 tahun 1983 tentang pengesahan perjanjian antara republik indonesia dan malaysia tentang rejim hukum negara nusantara dan hak-hak malaysia di laut teritorial dan perairan nusantara serta ruang udara di atas laut teritorial.,* Perairan Nusa: Indonesia, 1983.

[6] ICAO, *Article 28 of the chicago convention,* 1944.

[7] R. of Indonesia, *Undang-undang No.1 tahun 2009 tentang penerbangan,* 2009.

[8] E.E. Prabowo, "Indonesian defense policies and strategies (case study of the conflict in the south china sea) - kebijakan dan strategi pertahanan indonesia (studi kasus konflik di laut cina selatan)", *J. Ketahanan Nas.,* vol. 19, no. 3, p. 117, 2013.

[9] H. Djalal, "Determine national boundaries to improve oversight, enforcement, law and sovereignty of the republic of indonesia - menentukan batas negara guna meningkatkan pengawasan, penegakan, hukum dan kedaulatan nkrI", *J. Ketahanan Nas.,* vol. 11, no. 2, p. 2, 2006.

[10] A. Engvers, *The principle of sovereignty in the air.,* University of Lund, 2001.

[11] D. Ahmad, "Arrangement of air space above the indonesian archipelago sea pathway - pengaturan ruang udara diatas alur laut kepulauan indonesia (ALKI)", *J. Ketahanan Nas.,* vol. 16, no. 3, pp. 1-16, 2011.

[12] M. Fahrazi, "Flight information region management in the riau and natuna islands region - pengelolaan flight information region di

wilayah kepulauan riau dan natuna", *J. Huk. Ius Quia Iustum,* vol. 26, no. 2, pp. 391-409, 2019.

[13] L. Husna, and A. Riyanto, "The role of the government in singapore flight information region (FIR) taking the riau islands airport - peran pemerintah dalam upaya pengambilalihan flight information region (FIR) singapura atas wilayah udara kepulauan riau", *J. Cahaya Keadilan,* vol. 7, no. 2, p. 395, 2019. [http://dx.doi.org/10.33884/jck.v7i2.1418]

[14] A.A. Supriyadi, M.D.M. Manessa, and R.A.G. Gultom, "Issues in aligning flight information region above the natuna region - Isu penyelarasan flight information region di atas wilayah natuna", *J. Manaj. Transp. Logistik,* vol. 5, no. 3, pp. 255-260, 2019.

[15] E. Silalahi, *Implications of international law on the flight information region (FIR) of Singapore on indonesian airspace against the sovereignty of the unitary republic of indonesia - Implikasi hukum internasional pada flight information region (FIR) Singapura atas W.,* Riau University, 2015.

[16] A.R. Surbakah, "Indonesian interests take over flight information region (FIR) in singapore - kepentingan indonesia mengambil alih flight information region (FIR) di singapura", *J. Asia Pac. Stud.,* vol. 3, no. 1, 2019.

[17] N. Maharani, *Legal basis for flight information region singapore control in the context of singapore flight information region realignment by indonesia - dasar hukum pengendalian flight information region singapura dalam rangka realignment flight information region Si.,* Universitas Sebels Maret, 2015.

[18] H. Bakhtiar, S. Noor, and A. Magassing, "Violation of the sovereignty of indonesia airspace by foreign aircraft", *Int. J. Adv. Res. (Indore),* vol. 5, no. 2, pp. 2107-2113, 2017. [http://dx.doi.org/10.21474/IJAR01/3383]

[19] C. Fornell, and D.F. Larcker, "SEM with unobservable variables and measurement error: Algebra and statistics", *J. Mark. Res.,* vol. 18, no. 3, pp. 382-388, 1981. [http://dx.doi.org/10.1177/002224378101800313]

[20] K.A. Bollen, "A new incremental fit index for general structural equation models", *Sociol. Methods Res.,* vol. 17, no. 3, pp. 303-316, 1989. [http://dx.doi.org/10.1177/0049124189017003004]

[21] S. Aronoff, "Geographic information systems: A management perspective", *Geocarto Int.,* vol. 4, no. 4, p. 58, 1989. [http://dx.doi.org/10.1080/10106048909354237]

[22] K.Y. Huang, "Evaluation of the topographic sheltering effects on the spatial pattern of Taiwan fir using aerial photography and GIS", *Int. J. Remote Sens.,* vol. 23, no. 10, pp. 2051-2069, 2002. [http://dx.doi.org/10.1080/01431160110076207]

[23] Sucipto, "Indonesia certainly will take over fir from singapore - Indonesia dipastikan akan ambil alih fir dari singapura", *sindonews.com,* Jakarta, 2002.

[24] SAH, "Indonesian defense minister promises slowly take over fir from singapore - Menhan janji indonesia perlahan ambil alih fir dari singapura", *cnnindonesia.com,* 2018.

[25] NTSC, *Case archives,* 2020. Available from: http://knkt.dephub.go.id/knkt/ntsc_aviation/aaic_case.htm