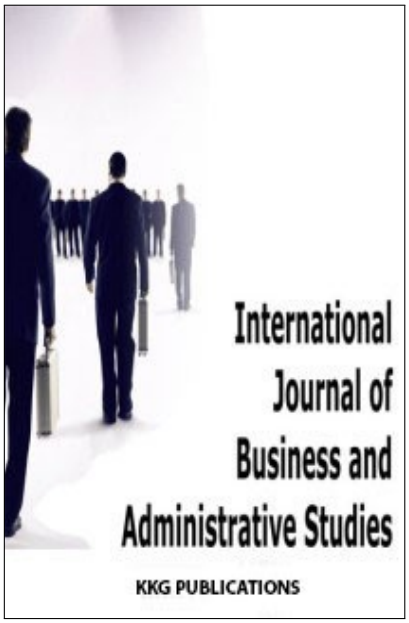

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AIR TRAFFIC AND ECONOMIC OUTPUT: PROJECTIONS FOR ASEAN

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Abstract. The transportation sector is significant for development purpose. Over the past decade, there has been a considerable growth in passenger traffic, which has in turn uplifted the aircraft movements across destinations. Our study aims to analyze the growth in aircraft movements across top five country pairs in the ASEAN region. The literature review indicated that gross domestic product plays a significant role in determining the air traffic. Hence, a simple econometric model using real GDP, modified to include time dummies, was used to forecast the air traffic across chosen origin-destination country pairs. The results of the study supported the increasing aircraft movements and the positive effect of economic output on air traffic. The forecasts in this paper can be helpful in long-term airway capacity planning, while simulation and modeling offer an understanding of flight movements across countries in ASEAN.

INTRODUCTION

Over the last decade, air transportation demand forecasting has been an intense subject worldwide. Air transport has been long recognized as an important sector of ASEAN economies. Boeing expects 4.8 percent growth in world passenger traffic and 4.2 percent annual increase in world cargo traffic over the next 20 years (Boeing, 2016). Airbus projections of passenger traffic 20-year growth by 2035 stand at 5.5 percent for Asia-pacific region (Airbus, 2016).

This concentration of air traffic is bound to create congestion and delay, which increases the operating cost and uncertainties in air traffic management. Under such condition, the air traffic forecast is one of the most comprehensive sets of projections on how aviation industry will develop over the years. The way air traffic is distributed between regions in ASEAN will evolve in the future and further advanced studies are required to enhance the capacity of air traffic flow between countries and regions. This paper focuses on forecasting the air traffic between country-pairs in ASEAN to better understand the future traffic patterns. The forecasts were obtained from modeling and evaluation of the relation between air traffic and its one of the most widely used determinants.

LITERATURE REVIEW

Economic growth has a long history of being a key determinant of air traffic demand and continues to play a vital role in the forecasting models. Factors affecting air travel demand can be classified into geo-economic and service-related factors (Jorge-Calderon, 1997). The most commonly used determinants related to air traffic in the literature are gross domestic product, population, consumption expenditure, prices and proxy variables (Cheze, Gastineau, & Chevallier, 2010; Abed, Ba-Fail & Jasimuddin, 2001; Sivrikaya & Tunc, 2013; Cheze, Gastineau & Chevallier, 2011; Ismaila, Warnock-Smith & Hubbard, 2014; Cline, Ruhl, Gosling & Gillen, 1998).

Cheze, et al. (2010) identified several factors for air transport growth and found that GDP and jet fuel prices play a central role. Ismaila, et al. (2014) developed a cross-sectional model with macroeconomic factors such as GDP and trade, historical links, distance and ASAs (a proxy for liberalization) serving as independent variables and passenger traffic as the dependent variable.

Cline, et al. (1998) formed a passenger forecast model using GDP per capita, which showed that a 1% increase in GDP per capita would result in a 1.1% increase in the number of enplaned passengers per capita. Similarly, Lian and Denstadli (2010) showed that economic growth, reduced airfares and the advent of LCCs are important in explaining the growth rates of incoming tourism by air between countries. In their logarithmic model, a dummy variable was used to account for changes in the LCC share of traffic. Valdes (2015), developed an interpretation of air travel demand in middle-income countries and found that in all the estimations, GDP per capita had a significant and positive effect.

According to Horner and Swarbrooke (1999), in tourism, on the demand side, analysis and forecasting of economic development are important. Air traffic and economic growth not only have a long term but also a short term relationship and the economic growth plays an important role in stimulating the

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growth of new travelers beyond the GDP growth level (Graham, 2006).

Dealing with country-pair traffic typically involves the use of causal models (Doganis, 2002). In addition, Grancay (2009), stated that when country-pair data are available, causal models such as gravity models and multiple regression models are appropriate. This paper, therefore, isolates the impact of economic output on air traffic growth of top country-pairs in ASEAN. Regression analysis was used for forecasting air traffic demand considering the impact of further economic development in Southeast Asian countries .

Data

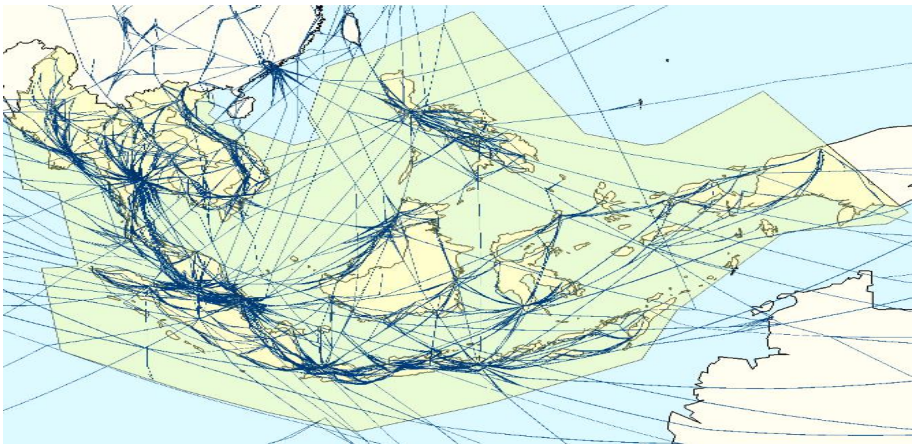
The data used in this study were gathered from multiple sources. The air traffic was measured in terms of the total number of flights between the chosen origin-destination. To get a more accurate viewpoint of aviation traffic within ASEAN, both passenger and cargo flights were taken into account. This study employs an econometric model to give future projections for air traffic from the period of 2016-2030. Hansman and Ishutkina (2009), elaborated the general interdependency between air transport and Gross Domestic Product (GDP) and described a feedback relationship between both using cross-sectional data for 137 countries. In order to consider the effect of economic factors in this study, gross domestic product at constant 2010 US dollar was taken as a variable. The data for air traffic and gross domestic product from 2004 to 2015 were obtained from FlightGlobal Innovata database (2016) and World Bank Database (2016) respectively.

METHODOLOGY

Infrastructure within ASEAN region is expected to grow faster than global average according to World Travel and Tourism Council (WTTC), (2016). This will not only increase tourism prospects for ASEAN member states but will also put pressure on air traffic flow capacity. Hence, an elaborative study is required to forecast the future demand of air traffic within the ASEAN region.

Figure 1 shows the air traffic flow pattern in ASEAN region for one-week using data from 1-7 December 2015. Based on traffic analysis using the 'System for Traffic Assignment and Analysis at Macroscopic Level' (SAAM) software from Eurocontrol, the country-pairs that fall within ASEAN airspace were determined. With the preliminary analysis, the top five country-pairs with the highest air traffic were selected in this study.

FIGURE 1
Traffic simulation in ASEAN region using SAAM



A large number of studies had aimed to develop the models for forecasting air traffic (Sivrikaya & Tunc, 2013; Grubb & Mason, 2001; Huth & Eriksen, 1987; Cheze et al., 2011). Fildes, Wei and Ismail (2011), evaluated the performance of econometric models to forecast country-pair air passenger traffic and found that structural econometric models when correctly specified can improve forecasting performance. Similarly, Hsu and Wen (1998), compared the forecasts for traffic from the United States to 10 country-pairs in Asia-Pacific countries using ARIMA, multiple regression, and grey prediction models. However, very few studies have aimed to give projections for flights between two destinations, especially for ASEAN countries. This study aims to analyze the characteristics of economic factors to determine how air traffic flow varies across different countries. Since causal models have a distinct advantage as compared to time series models for providing air traffic forecasts, an econometric model using GDP was formed to provide future projections for country-pairs (Huth & Eriksen,

1987).

The forecasts were computed using the econometric model shown in equation 1.

$$Y_t = B_0 + B_1 X'_{1t} + \gamma_i \alpha'_{it} + u_t \quad (1)$$

t = 1,2,3, …., T

Y_t= Aircraft movements between origin-destination country pair

X'_{1t} = Average of real GDP of origin and destination country.

α'_{it} = Time dummies that take the value 0 or 1 in any observation and capture the economic fluctuations that lead to significant changes in air traffic, where, i = 1,2,3, …., T-1

u_t= Error term.

Model selection was done after careful consideration and the coefficients' estimation for each country-pair projection was done using simple Ordinary Least Squares (OLS) regression analysis. The model development was in line with the framework and evaluation elaborated by Karlaftis, Zografos, Papastavrou and Charnes (1996). Air traffic and economic growth have a strong correlation, but whether this means simultaneity between both is not entirely clear (Green, 2007). Over the years, researchers had reviewed their primary focus on air transport demand forecasting and model formation (Lee, 2011; Kopsch, 2012). Schafer and Victor (2000), showed a shift towards a faster mode of transportation as GDP increases. Hu, Xiao, Deng, Xiao and Wang, (2015) studied the connection between passenger demand and economic activities and showed that real GDP has a granger causal relationship with passenger traffic. Similarly, Chi and Baek (2013), showed that in the long run, an increase in air passenger services is associated with an increase in economic growth. Since the strong connection between aviation demand and economic variables has already been proved, our study assumes a co-integration relationship between the chosen dependent and independent variables. As a measure of model diagnostic, dummy variables were included in the model for sudden changes in air traffic due to economic fluctuations during the sample period. Gillen and Lall (2003), showed how negative shocks are transmitted to the airline industry. Cheze et al. (2011), proved that shocks and counter-shocks had a significant effect on air traffic.

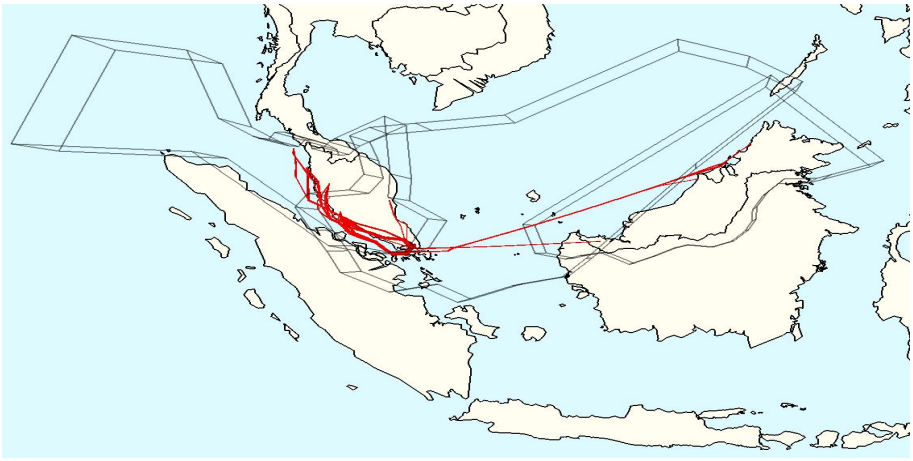
The out-of-sample forecasts for the independent variable X'_{1t} at country level from 2016 to 2030 were done by taking average of yearly growth rate from 2000 to 2015 and forming a linear trend till 2030. The important point in these projections was the re-assessment of economic climate in individual countries and then between two countries using real GDP in constant US dollar as a statistical indicator.

RESULTS AND DISCUSSION

The data analysis using Innovata and query results from SAAM indicated that air traffic between Malaysia and Indonesia was the highest amongst all the country pairs in ASEAN. Around 179 flights were observed on the highest traffic day of the selected week and the traffic increased at an average annual growth rate of 7.3% from 2010 to 2015. However, the air traffic average annual growth rate was highest between Malaysia and Thailand standing at 9.83% from 2010 to 2015, but with only 101 flights on the observed highest traffic day.

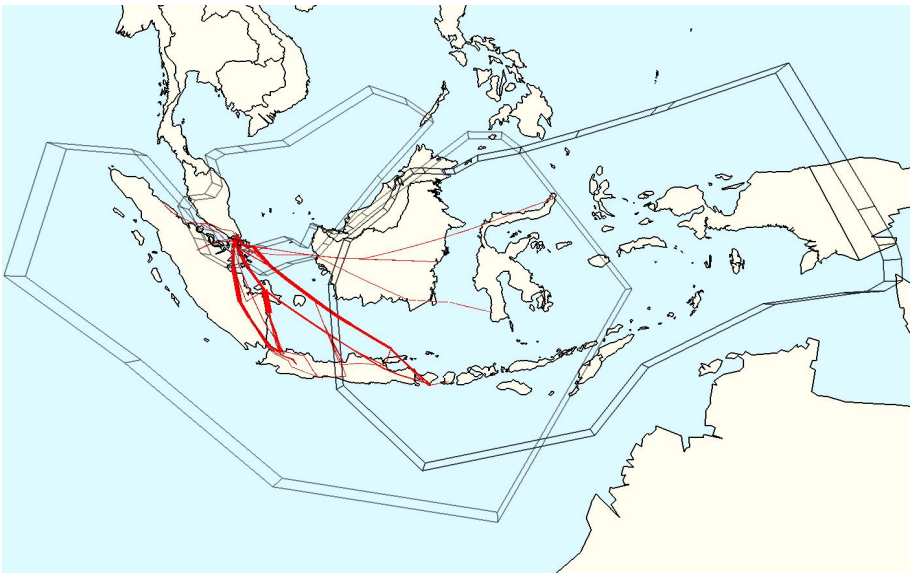
Figure 2 shows the loaded network for aircraft movements between Singapore and Malaysia for one week. There were 1138 flights in that week. The average annual growth rates were 6.68% and 14.04% from 2010 to 2015 and 2005 to 2015 respectively, with 69.12% increase in flight movements in 2009.

FIGURE 2
Singapore and Malaysia Loaded Network



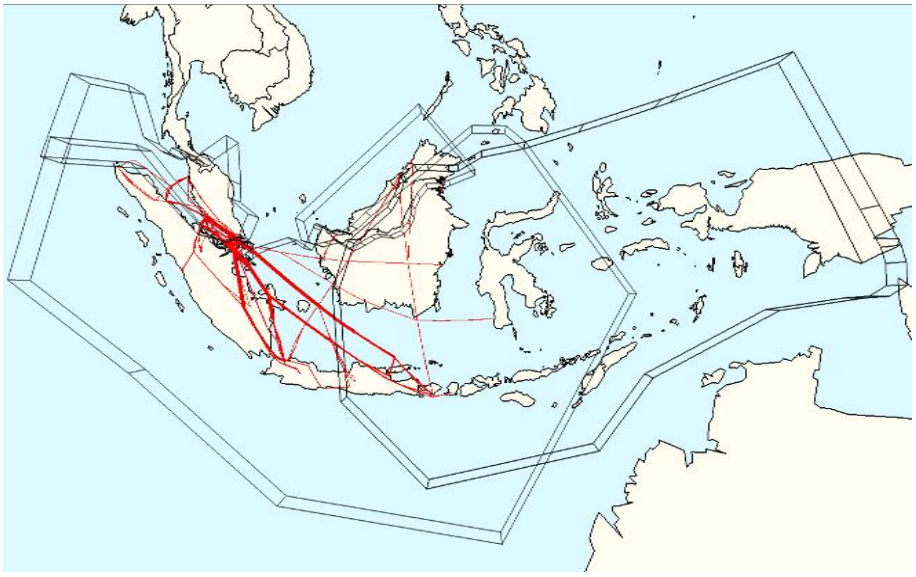
Weekly air traffic loaded network between Singapore and Indonesia is shown in figure 3 with 1086 flights a week. The aircraft movement average annual growth rates were observed to be around 8.02% from 2010 to 2015 and 6.72% from 2005 to 2015. The highest traffic growth was observed in the year 2013.

FIGURE 3
Singapore and Indonesia Loaded Network



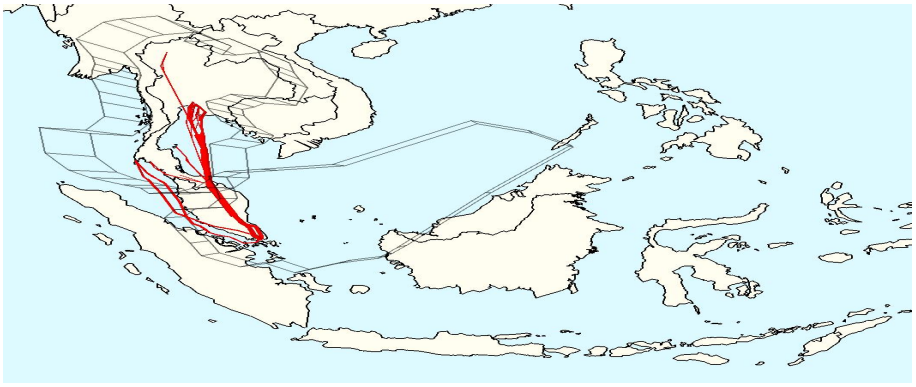
Malaysia and Indonesia experienced 7.3% and 11.75% average annual growth rates of air traffic from 2010 to 2015 and 2005 to 2015 respectively. The weekly traffic analysis showed 1177 flights in the observed week and highest yearly traffic growth in 2008. The loaded network for aircraft movements between Malaysia and Indonesia is shown in figure 4.

FIGURE 4
Malaysia and Indonesia Loaded Network



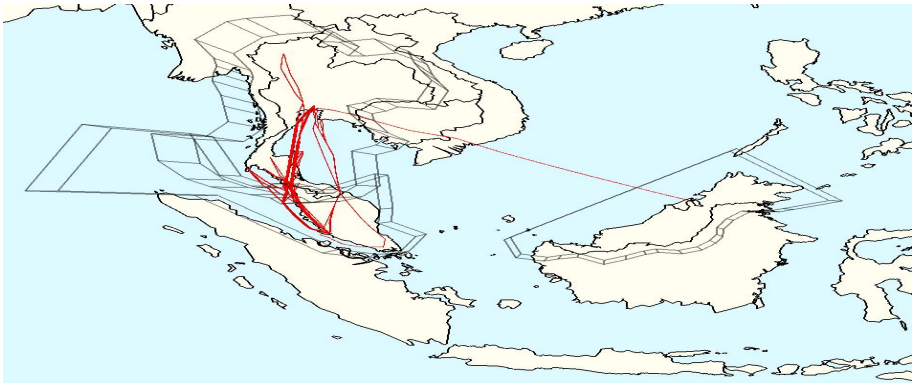
Average annual traffic growth between Singapore and Thailand was 9.31% from 2010 to 2015 and 5.43% from 2005 to 2015. The highest annual traffic growth of 22.29% was seen in the year 2005. Weekly traffic analysis in the form of loaded network, as shown in figure 5, showed 707 flights in the observed week.

FIGURE 5
Singapore and Thailand Loaded Network



The loaded network for aircraft movements between Malaysia and Thailand is shown in figure 6 with average annual traffic growth rate of 9.83% and 11.73% between 2010-2015 and 2005-2015 respectively. The highest traffic growth of 36.06% was observed in 2005. Query results from SAAM showed 662 flights during the week.

FIGURE 6
Malaysia and Thailand Loaded Network



As ASEAN pushes towards deeper economic integration and connectivity, much faster growth in air transport is expected. In 2015, the top four markets for country-pair air traffic flow were Indonesia, Malaysia, Singapore, and Thailand. Table 1 illustrates the summary of major traffic flow within ASEAN. It shows more than 10 percent average annual growth for flights between Malaysia & Indonesia, Singapore & Malaysia, and Malaysia & Thailand between 2005 and 2015.

TABLE 1
Major Air Traffic Flow within ASEAN*

Country-Pair	2005	2015	(Average Annual Growth 2005-2015 (%))
MY ↔ IN	21,257	62,360	11.75
SG ↔ IN	27,204	55,191	6.72
SG ↔ MY	18,462	54,611	14.04
SG ↔ TH	25,289	34,939	5.43
MY ↔ TH	14,207	33,891	11.73

Note: MY: Malaysia, SG: Singapore, IN: Indonesia, TH: Thailand.
*Scheduled passenger and cargo flights
Source: Innovata

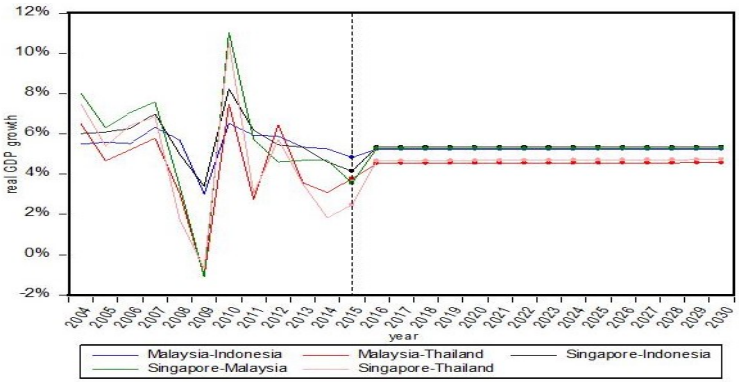
To provide future projections for ASEAN top country-pairs, we forecasted the air traffic movements using the model discussed above. Consistent with the strengthening ASEAN economic environment, the country-level economic indicators for selected countries seemed optimistic. Table 2 shows the sign of regression coefficient and the explanatory power of country-pair regression models. The coefficient B_1 was found positive and significant for each country pair regression. All the models showed adjusted R-square of more than 0.90.

TABLE 2
Country-Pair Regression Summary

Country-Pair	Sign of B_1 coefficient	Adjusted R-square
MY ↔ IN	positive	0.98
SG ↔ MY	positive	0.95
SG ↔ IN	positive	0.98
SG ↔ TH	positive	0.96
MY ↔ TH	positive	0.98

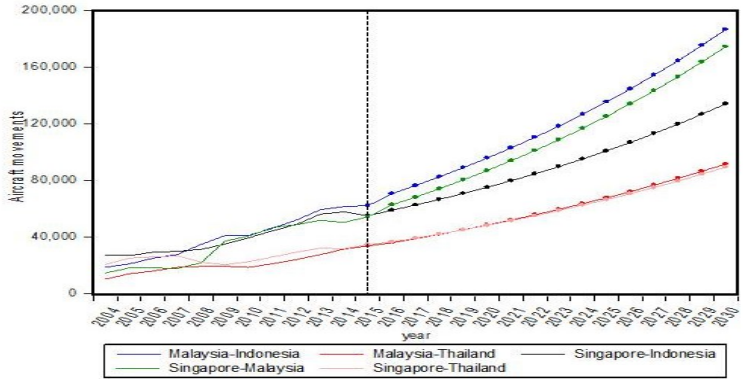
Note: MY: Malaysia, SG: Singapore, IN: Indonesia, TH: Thailand.

FIGURE 7
Forecasts for Country-Pair GDP Growth from 2016 to 2030



The average GDP growth rate forecasts for selected country pairs are shown in figure 7. Based on the projections of independent variables, the aircraft movements' forecasts between two countries were derived using the quantitative method of forecasting described above. Figure 8 shows the air traffic forecasts between selected country pairs.

FIGURE 8
Forecasts for Aircraft Movements from 2016 to 2030



Note: For model diagnostic purpose, sample adjustment to regression model was made for Singapore - Thailand traffic projections

The results indicate that flights between Singapore and Malaysia will experience the highest aircraft movements with an average annual growth rate of 9.8% from 2016 to 2020. However, the long-term growth stands at 8% from 2016 to 2030. The expected completion of the high-speed rail between Singapore and Kuala Lumpur by 2026 might hinder the future growth rate of air transport. An average annual growth rate of 6.7% is expected for aircraft movements between Singapore and Thailand from 2016 to 2020 and 6.4% from 2016 to 2030. Air traffic between Singapore and Indonesia is projected to grow at an average annual growth rate of 6.1% from 2016 to 2020. However, the long-term growth stands at 6.3% from 2016 to 2030. Flights between Malaysia and Indonesia are expected to grow at average annual growth rates of 9% and 7.6% from 2016 to 2020 and 2016 to 2030 respectively. The flights between Thailand and Malaysia can expect an average annual growth rate of 7.5% from 2016 to 2020 and 6.8% from 2016 to 2030.

CONCLUSION

The potential air traffic demand is an important input for planning. Although many studies have focused on developing models to forecast air traffic between two countries, very few studies have particularly aimed towards providing projections for air traffic flow within the ASEAN region. This study contains the forecasting results for top five country-pairs in Southeast Asia to support a variety of air navigation decisions and long-term capacity planning. Although statistical measures have been adopted, forecasts of aircraft movements can only produce approximations. Consequently, errors are inevitable, particularly when forecasts are made for more than a year. The results of this study suggest a broad direction for the growth of air traffic which might affect airway capacity and airport capacity as well. Further research into incorporating more sophisticated methods such as ARIMA should be applied for the explanatory variables. This is to ensure the relative accuracy of different forecasting models chosen to provide air traffic projections. Hence, there is a further scope in modeling and the inclusion of more independent variables.

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