Air transportation and its role for islands connectivity in supporting regional development

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Abstract. Air transportation plays important role in connectivity among islands and remote area in Indonesia. The presidential decree regulates the distance between airport and other airports. This decree statements drive the government to follow. The problem raise when the approval of the selection of airport location leads to unattractive business either for airlines or passengers. This paper aims to review the decree through comprehensive literature review. The competition between airports is discussed through rigorous insight into the current day complexities, synergies, and potential conflicts present within the relationship between the airport location and its user. This issue is then brought to bigger perspective in discussing potential development through the availability of airport facilities in remote area. The reviews provide the variables considered in building the regional connectivity.

1. Introduction

The global air transportation network provides global connectivity and increasing links between regions. The increasing value reaches 140% based on data from 1990 to 2012 [1]. This global connectivity drives development in trading as well as tourism. The evidence of a relationship between connectivity thus defined, and important economic outcome measures such as labour productivity, and competitiveness of the travel and tourism sector [2].

Indonesia has 288 airports, 26 of those are operated by private company owned by government. These airports serve less than 17,000 islands in Indonesia. Some areas still not accessible or difficult to be reached. Therefore, those areas face slower development and some tourism spots have not been exposed. The problem of connectivity in Indonesia region also related to political aspect. These sensitive area need to be connected to the established area in order to maintain the sustainability of outermost region.

This research aims to review some methods in modelling the air connectivity. The review is essential to identify the correlation of the connectivity index with airport size. The airport size become a consideration since it is measured traditionally by number of passengers. On the other hand, number of passengers in an airport is generated by the accessibility of the respected airport. The accessibility comprises of two components, those are land accessibility and air accessibility. Land accessibility refers to the reliability time of the airport ground access in facilitating the air traveller. Air accessibility indicate the choice of routes and frequency of each available routes. The higher the accessibility, the higher the number of passengers. The 280s Indonesian airports have high range accessibilities, therefore, this paper may assist in understanding the methods available to measure the connectivity of each airport.
2. Tourism as an Economic Driven

Tourism Organization (UNWTO) predicts that the total number of international tourists, which includes both business and leisure travellers, is expected to reach 1.8 billion by 2030. Based on ICAO’s latest forecasts, aircraft departures are expected to grow from 33 million in 2015 to 60 million by 2030 [3]. This means, Indonesia has to be ready in preparing the regulation and facility to anticipate the multiplication of the number of air travellers. Otherwise, Indonesia will not become a part of global economic development.

Facilities and regulation related to support for air transportation system in Indonesia will stimulate additional traffic. More tourists will require hotel, transportation and other fast information. These drive the possibility of opening work place and increase employment. Figure 1 pictures the relationship of these issue briefly.

![Figure 1. The circle correlation between supporting policy and economic development [3]](image)

WTO indicated that 43% of global international tourism do long haul travel by air transportation [4]. Indonesia are very potential to become the tourist destination. However, most of the tourist coming to Indonesia still using air charter. This limits the number of tourists since air charter is quite expensive. The charter system usually is adopted since there is a competition between transportation modes available. A case of this competition was between air charter route Rote Island – Kupang and express boat. This competition only applicable from March to November since December to February is danger to travel by boat due to extreme whether [5]. Domination of air charter in these three months is potential in scaling up the air ticket. Rote Island has a potential tourist attraction. Once the
government decided to have scheduled air flight, the number of tourist increased significantly. This condition drives economic development in that area.

The case of Rote Island is an example that the connectivity determine better tourist experience. As Indonesia has large number of tourist attraction, there is a need an identification the places that may potential to be facilitated by air transportation. Only air transportation that offer time/space convergence in the world transport system. Tourist tend to travel long haul flight to have intriguing experience in visiting new places with natural beauty. However, they only have limited time, therefore, air transport is the answer. The World Travel & Tourism Council sets out some of the key aspects of responsible ‘tourism for tomorrow’ which, while growing [6]: Impacts natural and cultural environments in a positive way; Provides benefits to all sectors of society, including young people, women and indigenous peoples; Attracts and develops a skilled workforce to support growing demand; Stimulates consumer demand for sustainable products; Uses latest technology to find innovative solutions to future challenges. Analysis of the connectivity to those area is a necessity to meet the key aspects mentioned.

3. The Remote Area and Air Transportation

Remote areas can be classified as outermost territories, islands, and region with political demand [7]. Remote area in Indonesia needs support in order to make balance in receiving service related to health, education, and economic issues. The connectivity to the remote area need a priority due to a lifeline service [7]. Other access modes may not suitable in dealing with the terrain and whether. On the other hand, the low demand may not enough for airlines to make a route to those remote areas. Therefore, a government policy to guarantee an air connectivity needs to be designed by considering a sustainable service to those areas.

The air transport situation in Indonesia face financial problem that cause declining the number of passengers. The ticket fare increases near double the regular price. Number of schedules decrease and the competition with other transportation modes shifted the demand of airlines. Some routes also disappear due to a low number of demand. This uncertain situation thread the sustainability the services to the remote area.

The development of some new airports and other transportation infrastructure increase the competitiveness among airlines and other transportation modes. The competition is tighter since ICAO (International Civil Aviation Organisation) provides the facilitation of international agreements to liberalize the current restrictions through policy and guidance material [8]. This needs to have deep discussion to consider the connectivity issues related to internal establishment, both from economics and politics point of views.

4. Measuring Air Connectivity

Connectivity is the ability of a network to move a passenger from one point to another with the lowest possible number of connections and without an increase in fare, focusing on, from a commercial perspective, minimum connecting times with maximum facilitation ultimately resulting in benefits to air transport users [7]. Connectivity for air transport has three categories, those are [8,9]:

- Direct connectivity that reflects the direct services available from a given country, city, or airport. It depends on the number of destinations served. The destination, as well as frequency or capacity become the variable of measurement of this type of connectivity.
- Indirect connectivity that incorporates those destinations that can only be reached with one or more stops. The measurement of connectivity will consider key factors being connecting time at the transit airport and the degree of diversion involved.
- Hub connectivity that is relevant for those cities or airports that function as hubs, and reflects the number of flight combinations that can be connected into credible itineraries, taking into account minimum and maximum connecting times.

In order to have strong connectivity, there should be an optimization navigation system, airports, airlines, and security system. The connectivity is measured based on the criteria as shown in Figure 2.
that presents ten keys criteria index for air connectivity. Those ten criteria require big data and cover number of entities to provide data. ICAO prefer to determine the connectivity index based on utilization rate of connectivity opportunities by air carrier [3]. The utilization rate here is the ratio between the available market and the real market served by the air carrier. The available market in this context is the potential market due to the liberalization of air transport by providing open sky term. However, not all available markets are attracted airline to serve the routes.

Figure 2. Air Connectivity Index Key Criteria [9]

Chu presents another approach in determine the connectivity by collaboration amongst airlines to guarantee seamless travel [1]. Reeves et al [10] consider differently that connectivity means availability and cost of air travel. These are influenced by taxation (policy), regulatory framework, and infrastructure. As mentioned earlier that the tourism generates economic growth, however, the leisure travellers are considered price-elastic. The higher the ticket fare leads to lesser the demand, but not applicable for business travellers.

Burghouwt and Redondi [11] presented some measurement method of connectivity. Number of authors attempted to determine the connectivity through different approaches. Table 1 present the list of the methods.

| Model                        | Short Definition                                                                 | Main Reference                       |
|------------------------------|----------------------------------------------------------------------------------|---------------------------------------|
| Hub potential                | Incoming and outgoing frequency                                                  | Dennis (1998)                         |
| ‘Doganis & Dennis’ connectivity | Number of connections. Indirect connections meet conditions of minimum & maximum connecting time and routing factor | Dennis & Doganis (1989); Dennis (1994a&amp;b) |
| ‘Bootsma’ connectivity       | Number of connections. Indirect connections meet conditions of minimum & maximum connecting time and are classified as ‘excellent’, ‘good’ and ‘poor’ | Bootsma (1997)                        |
| WNX (weighted number of connections) | Number of direct and indirect connections weighed by their quality in terms of transfer and | Burghouwt & De Wit (2004); Burghouwt (2007) |
| Model                          | Short Definition                                                                 | Main Reference                                                                 |
|-------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Netscan connectivity units    | Number of direct and indirect connections weighed by their quality in terms of transfer and detour time relative to a theoretical direct flight | Veldhuis (1997); IATA (2000); Burghouwt & Veldhuis (2006); Matsumoto et al. (2008); Veldhuis & Kroes (2002) |
| WCN (Weighted Connectivity Number) | Number of direct and indirect connections weighed by their quality in terms of transfer and detour time | Danesi (2006) |
| Shortest Path Length centrality | Number of connections lying of O-D shortest paths. The shortest path is the path involving the minimum number of steps from O to D | Cronrath et al. (2008); Malighetti et al. (2008); Shaw (1993), Shaw & Ivy (1994) |
| Shortest Path Length accessibility | Average number of steps to reach any other airport in the network | Cronrath et al. (2008); Malighetti et al. (2008); Shaw (1993), Shaw & Ivy (1994) |
| Quickest Path Length centrality | Number of connections lying of O-D quickest paths. The quickest path is the path involving the lower travel time from O to D | Malighetti et al. (2008); Paleari et al. (2008) |
| Quickest Path Length accessibility | Average travel time to reach any other airport in the network | Malighetti et al. (2008); Paleari et al. (2008) |
| Gross vertex connectivity    | Sum of all possible paths (of any number of steps) to other airports weighted by a scalar value that lessen the importance of indirect connections | Ivy (1993); Ivy et al. (1995) |
| Number of connection patterns | Number of statistical significant patterns incoming and outgoing flights | Budde et al. (2008) |

5. Discussions for Indonesia Airport Connectivity

Indonesia with near 300 airports to be managed and maintain has classification of its airports into commercial airports, state owned airports, private company airports, and pioneer airports. The nature of each group of airports may not the same. The number of flight to private and pioneer airports are not available to disclose to public. The connectivity is then analysed limited to airports served by air carriers.

Airports served as privates and pioneers always connected to the closest commercial or state owned airports. Therefore, the routes can be assumed from the available closest airports. The problem is that there is no information related to the frequency of the services. Some resorts islands are also served by private airline that land on the sea, this type of services are not required airport.

For those commercial airports served by airlines, the routes available are not fully follow hub and spoke system. Some airports provide direct routes to central of tourist area. This situation will need to further in deep analysis since the model available as presented in Table 1 may not applicable to all types of airports in Indonesia.
Based on the characteristics of Indonesia airports, the analysis needs to be conducted in two approach model. First adopts method that based on hub connectivity model. The second one follows accessibility models. Each methods may provide different results due to information loss in terms of connection quality, the number of hub connection, and quickest or shortest performance.

Building the model for Indonesia airport connectivity requires some steps of research since the model cannot be developed through the available data of routes and frequency. The preliminary research required are how the airline schedule development, airline hub operation, method in forecasting connecting traffic, variation on hub service in domestic air transportation network, and quality of hub-spoke network related to time-table coordination.

**Concluding Remarks**

Indonesia airports serve huge variation of travel pattern. The function of those airports also vary and has its complexity. However, the connectivity of those airports are necessary to be analysed in order to maintain the sustainability of Indonesia territory. The connectivity level also provide information related to the required improvement of the management system of air transport authority.

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