

*Review Article*

# Circular Airport Concept Analysis for Indonesian Archipelago

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Received: 8 March 2021; Accepted: 19 May 2021; Published: 30 June 2021

**Abstract:** Circular Airport Concept has been issued in 2014. It divides the expert opinion, but the project is still running. The idea is how visible to engage this concept into Indonesian Archipelago. To build airport within limit area for several islands in Indonesia is a big challenge. Some pioneer routes which connecting remote areas with a small aircraft is still searching for some development. Another challenge is the environmental sustainability. This paper proposes a comprehension analysis regarding the application of circular airport concept into Indonesian Archipelago, and how this concept might be a solution. The discussion will cover analysis of airport design, aircraft to operate, and area to be treated.

**Keywords:** circular airport concept, pioneer routes, lagging regions, environmental sustainability

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## 1. Introduction

Since appeared (again) in 2014, the concept of circular airport is still developing and provoke argumentations [1]. The concept is about making an endless runaway, by bend it into circular shape. Diameter of the shape must be well defined, as the velocity and the mass of aircraft are given. Background of the research was built from weather difficulties while approach, landing, and take off [2]. Other reasons are environmental sustainability and population problem [3].

Review the archipelago of Indonesia, there are many regions or of small islands, conservation of plants and animal, and conservation of culture. International study concluding importance of nature conservation in the country for sustainability of entire world nature and climate [4]. Some areas classified as lagging regions, due to gaps of regional development in Indonesia. Building an airport around the area might support the development. Recently, the pioneer route in Indonesia have already grown. Small airports were built in remote areas, there are hundreds around archipelago mainly in Sumatera, Sulawesi, Kalimantan, Papua, and Java, are recently built [5]. But there are still many areas can be reached to equalize the development of Indonesia as an archipelago country.

Applying circular airport concept to the Indonesia will be the new idea which is grow with the development by the concept itself. The uniqueness of geography, demography, and environmental aspect of this country will bring more study and analysis. This paper will be a part of a research of investigating the feasibility of building airport in islands of Indonesia. Firstly, the paper will refer the concept, and secondly will describe Indonesia by geography, demography, and environment factors. In the last part, a discussion to apply the concept will be presented.

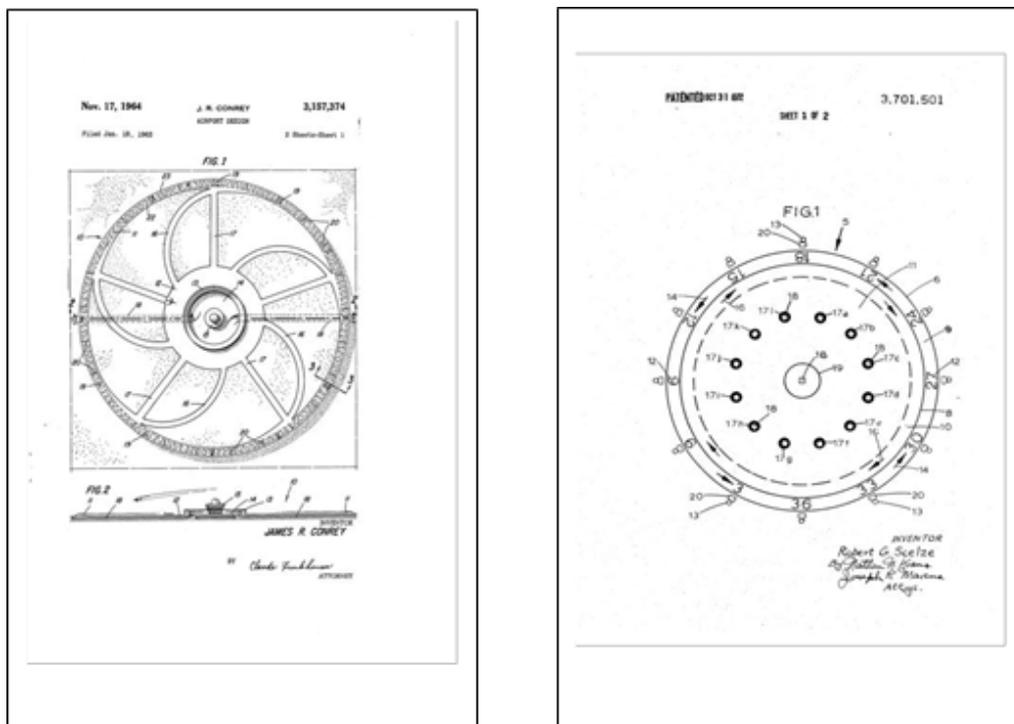


**Figure 1.** Pioneer Airports in Province of Papua, in (a) Timika and (b) Intan Jaya  
[Source: <https://www.voaindonesia.com/a/pesawat-rimbun-air-cargo-hilang-kontak-di-intan-jaya/6227802.html>]

Today airports are built conventionally, but Figure 1 are samples of pioneer airport in Province Papua, which are surrounded by mountain and small villages.

## 2. Analyzing Concept of Circular Airport

Circular Airport is an old concept of airport design, which appear and disappear by many reasons. Refer to US Patent, there are many designs of circular airport have been issued [3,5]. As the illustration in Figure 1, the designs are perfectly circular. Terminals are placed in the center of runways. This concept refers to the previous study that designed the new concept with more modern, actual policy, and assessment [6-8].



**Figure 2.** Old circular airport design: (a) Airport design by James S. Conrey, US Patent 3157374, 1964 [6], and (b) Two Circular Runways design by Robert G. Scelze, US Patent 3701501, Oct 1972 [7]

### 2.1. Airport Design

Predicting to solve many problems of airport, this concept has many challenges as it considered safety, and sustainability. But the major challenge is to increase available airport capacity by optimizing the use of the existing runway system throughput within the limits of safety, emissions and noise [3]. The concept also considering many factors which are cause the problems directly or un- directly. Internal and external factors to be considered divided in three topics. First topic is airport design itself, aircraft characteristics, and air traffic management (ATM) procedures.

$$F = \frac{mv^2}{R} \quad (1)$$

where  $F$  is a centripetal force,  $m$  is mass of the body, and  $v$  is linier velocity.

In the application, the designer had to calculate parameter of friction, and the limitation of aircraft mass and dimension. Using formula (1), radius of the airport circle, runaway width, and runaway bank angle can be determined. The other factors of airport design are layout of taxiways, aprons, location of control tower, terminal buildings, hangars, maintenance area, fire building, and the access to the airport. These factors closely manage by regulation and safety, combining by architecture and efficiency [2].

### 2.2. Aircraft Characteristic

Second topic is aircraft characteristics. Passenger comfort must be calculated into consideration of landing circular. The parameters of calculation are speed, bank angle, take-off and landing parameters, landing gear, engine, take-off and landing best point, ground clearance, and pilot situational awareness.

Speed and bank angle are directly affected passenger comfort. When passenger sensing 1 G in normal linier position, bank angle will give addition of G factor, slightly [3]. To determine take-off and landing parameters, type of the aircraft must be identified, as important as landing gear and engine specification. And the last factor of the aircraft is the pilot.

### 2.3. Air Traffict Management Procedures

The third topic is ATM Procedures. The topic covers runway operations, paths and routing (departure/arrival/curved approaches), take-off and touchdown point determination, missed approach procedures, navigation aids, necessary separation, situational awareness of air traffic controllers, different meteorological conditions handling (strong wind, low wind), environmental aspects (air pollution, noise, third-party risk).

To cover all the aspect, runaway subdivided into segments, for example 18 segment [8], to arrange schedule of take off and landing around di airport. Each segment can be chosen as a touch down point or take off point. The points are chosen depends on weather and wind as environmental aspect, or on rapid schedule of the airport.

## 3. Indonesia Archipelago

Refer to Indonesia Archipelago, this section will review the country from geographical, demographical, and environmental aspect.



Figure 1. Map of Indonesian Archipelago

[Source: dive-the-world.com]

### 3.1. Lagging Regions and Environmental Aspect

Observing the condition of Indonesia, there are many regions which still have not meet the standard development of the country. Indonesian government concern to equalize development by assigning a ministry of developing lagging regions. This objective can be reached by building transportation facilities around the areas, which are economic, safe, and frequently available. In Indonesia, there are 34 provinces, and 23 provinces of them consist of one or more districts classified as lagging region [9].

Some areas have been reached by pioneer route. Recently, identified more than 150 pioneer airports spread around Indonesia archipelago. Most of them located in Papua, and others are scattered around Sumatera, Sulawesi, Kalimantan, Nusa Tenggara, and Maluku. The idea of reaching standard of national development, is how the capital of province can reach the entire area of the region. For some province, form as islands, the problem is transportation. Using naval transportation is limited in speed, directly limited in time.

Besides lagging region and pioneer route, there are many animals and plants conservation spread across this country. Naturally, conservation needs a silent environmental, and remote. But in some cases, conservation also need transportation availability to support medicine supply and their staff mobility.

### 3.2. Dense Population

Some airports which had built in Indonesia are surrounding by dense population. According to the study of air pollution, noise exposure, and regulation concerning them, dense population should not be growth around airports. Especially when the population covering public social services, as schools and hospitals.

On the other hand, massive civilization with high frequency of mobility needs availability of supporting transportation, like bus station, and airport. Building a new airport in the city center is not possible, according to environmental effect.

## 4. Circular Airport Concepts

### 4.1. Circular Airport for Supporting Lagging Region and Environmental Sustainability

Pioneer routes for several lagging areas have been built and have been operating. Part of them are operated by Indonesian military. Further study on applying circular airports for remote areas in Indonesia has been planned. The consideration is about environmental sustainability. When the region is conservation area of rare animals, plants, or cultures, so quite airport and its boundary circumference is well accepted [9,10].

Refer to endless runaway concept, the assessment of environmental aspects exposed to be satisfied. The assessment covering air pollution and noise mitigation. Comparing with conventional airport are still can be measured, since many variables are involved. But for weather risk take-off and landing, the concept of circular airport is leading. The concept could minimize the risk of accident caused by side wind.

### 4.2. Circular Airport for Dense Population

In Indonesia, dense population sometimes grow uncontrolled around airport. Not only public housing, but also schools and even hospital. The exposure of noise and air pollution could be reached human comfort limitation. Circular airport among the rush of busy city will be more environmentally friendly [10]. The study of airport design even reached the idea, that airport construction could be high lifted and support by pillars [11].

## 5. Conclusions

Many studies and more discussion could be built to meet the optimal solution for some problems in Indonesia Archipelago. Besides, the conclusion might support country development. Recently the concept seems like more difficult than current technology, but further study has a probability of simplifying technology. Assessment on circular airport is specific depends on natural condition or urban planning. The next study must be applied on specific case of location, whether on a city of a small island, a remote area to support logistic, or a conservation project around the archipelago.

## Acknowledgments

This work is supported by the University of Suryadarma, Jakarta, and great opportunity and advice from ITB and Unila, Indonesia.

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