Financial and institutional scheme of aerotropolis conceptual design

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Abstract. The concept of aerotropolis expected to create an integrated transport, effective and efficient airport. It facilitates higher mobility and generates new economic center for regional development. Aerotropolis concept in Indonesia is facing some obstacles such as complex bureaucracy, inadequate infrastructure, and limited funding. This research aims to produce an alternative concept of aerotropolis by taking into account the project feasibility. The research will use life-cycle cost method and involved initial cost, operational, maintenance cost and revenue for project evaluation. The aerotropolis in Indonesia shall consist of the airport, industrial development, mixed-use and supporting infrastructure. The result shows that 15.81% of the internal rate of return might be obtained from this conceptual design. The study also formulates a suitable institutional scheme by considering the cost-sharing between public and private in the project life cycle.

1. Introduction

The role of transportation is significant as the core of economic, social, political, cultural, defense, and security of a nation [1, 2]. The government of Indonesia attempt to create an effective and efficient transportation system for national competitiveness. The transport system should improve human mobility, goods, and services and translate by land, sea, and air transportation systems. Each mode of transportation has its advantages and characteristics. Compared with other modes of transportation, air transport mode offers faster and more efficient system, and capability to reach remote areas [3, 4].

Most airports in Indonesia are located far from residential areas, or not available in specific locations and regions. In other countries, the role of the airport has grown not only act to transport people and goods from an area to the others but also becomes business center and economic hub. This new role of the airport will attract business, commercial and industrial activities. In the longer term, the airport may change the landscape of economic activities and regional development [5, 6].

The concept of aerotropolis attempt to integrate people mobility with economic activities by taking an airport as the center. It may create a new form of areas within site from offices, hotels,
entertainment centers, and others. The concept expected propose higher mobility that exists around the airport and multiplies it through supporting infrastructure. Many airports have applied this concept, for instance, Changi Airport in Singapore built its own cinema, Beijing Capital Airport in China provide a bank facility, Hong Kong International Airport offer a large shopping center facility, Las Vegas has museum facilities, Frankfurt Airport in Germany owns hospital, Schiphol Airport in Netherland built art museum, and Stockholm Arlanda in Sweden has a multipurpose church that has been used for more than 400 marriages [7, 8].

Aerotropolis concept in Indonesia facing some obstacles such as complex bureaucracy, inadequate infrastructure, and limited funding. In Indonesia, the development of the aerotropolis concept is still in the stages of Aerospace Park. It is an industrial area focusing on the maintenance of aircraft. This condition arises due to the increasing fleet ownership from the aircraft company in Southeast Asia. The challenge for airport maintenance is high and thus providing complete facilities such as maintenance, repair, and overhaul are significant to be champion in this competition.

This research attempts to evaluate the concept of Aerotropolis by taking into account Lampung as the case study. Despite lower population and movement of aircraft, the airport has vast land availability about 9,650 square meters for development. The airport (Radin Inten II airport) location also strategically located with other Asian countries and the Middle East region. The country also has a similar airport (middle class) type; thus the result may be replicated into other airports to generate economic growth.

2. Methodology
This research combines qualitative and quantitative approaches to generate the targeted result. Firstly, desk study was used to evaluate the literature study about the aerotropolis concept and benchmark the assumption for analysis. It comprises of inflation, discount rate, weighted average cost of capital (WACC), and other financial aspects. The concept design then investigated by using life cycle cost by taking into account the initial cost, operation, and maintenance cost and revenue to generate the internal rate of return (IRR). It will confirm the capability of additional functionality to reach the expected IRR [9, 10].

When the IRR failed to meet particular value, further sharing scheme will be applied. It consists of four scenarios; initial cost sharing, operation, and maintenance cost sharing, initial cost+operation, and maintenance cost sharing and initial cost+operation and maintenance cost+revenue sharing. The scenario will govern the responsibility of public and private in the project and propose the optimum result in term of financial feasibility. This scenario will be used to formulate the institutional scheme on the project. The in-depth interview will be conducted with three experts on infrastructure policy with more than ten years of experience. The instruments use a semi-structured questionnaire and take 15 – 30 minutes to collect sufficient data to be analyzed. The result from the in-depth interview and financial analysis will support the decision to develop robust financial scenario [11].

3. Result and Discussion
3.1. Design and Development
The design and components were using previous research development and published by the research team [8]. The aerotropolis concept consists of four components such as airport terminal, industrial zone, mixed-use area and supporting infrastructure. The concept visualizes as follows.
3.2. Initial Cost

The initial cost was divided based on the components of aerotropolis. The airport is an international airport class occupying the site for about 770 Ha. The size of the terminal estimated around 62.5 Ha and the runway stretch about 3,500 m. In term of an airport terminal, the analysis considered the land acquisition, landside area, airside area, and contingency cost. The investment cost also involved the cost construction index of Lampung area (0.88) compared with the national construction cost index (0.40). The result shows that the total cost estimated about 20,524,093,076,791 rupiah or equal to US$ 1,425,284,241.

Industrial development cost considered six industries in aerotropolis ranging from cassava, corn, sugar, pineapple, palm oil, and coffee. Baseline cost of cassava is generated from related cassava industry in Malaysia and converted into Indonesian price. On the other hand, corn processing industry used the price component from Iowa State University in the United States and converted into the standard price from Bogor Agricultural Institute. The rest of the industries was using the baseline cost from companies or reports from Indonesia and consider construction cost index for the analysis. The total cost for the industrial area development about 5,365,303,968,008 rupiah or equal to US$ 372,590,553.

The mixed-use area consists of two locations; one area has land parcel about 445,786 square meters while others have 570,319 square meters. Both of them has commercials, residential, office, hotels, road access, and open space. The different is about the size of each function. The smaller size of a mixed-use area requires a 25,699,873,591,185 rupiah of investment cost, while the larger mixed-use needs a 33,305,339,412,010 rupiah. The total of both mixed-use is about 59,005,213,003,195 rupiah or equal to US$ 4,097,584,236.

Supporting infrastructure in the aerotropolis concept design is divided into four components from water processing, waste processing, geothermal power plant, road access and bus rapid transit (BRT). The cost analysis the supporting infrastructure has been considered land acquisition and cost of construction for each component. Overall, the investment cost of aerotropolis conceptual design is summarized as follows.

Figure 1. The concept of Aerotropolis in Lampung Province
Source: [8]
Table 1. Cost of Investment for Aerotropolis Conceptual Design in Lampung Province

| No | Component                  | Cost of Investment (US$) |
|----|----------------------------|--------------------------|
| 1  | Airport                    | 1,425,284,241.44         |
| 2  | Industrial development     | 372,590,553.33           |
| 3  | Mixed-use                  | 4,097,584,236.33         |
| 4  | Supporting Infrastructure  |                          |
| a  | Water processing           | 17,341,446.86            |
| b  | Waste processing           | 7,025,716.30             |
| c  | Geothermal power plant     | 178,433,778.14           |
| d  | BRT                        | 31,480,078.76            |
| e  | Road access                | 17,921,533.11            |
| TOTAL |                          | 6,147,661,584.27       |

3.3. Operation and Maintenance

Operation and maintenance (OM) cost in the study considered the functions that consist of the airport, industrial development, mixed-use and supporting infrastructure. In term of operation and maintenance cost of the airport, the estimation considered three development phase. In the first phase, the airport which operated 9,000 square meters will be estimated its OM cost up to 2025. The second phase, the airport will be developed into 416,000 square meters and OM cost will be forecasted to 2030. The last phase, the airport expanded into 625,000 square meters and the OM cost estimated to 2045.

Each industry in industrial area function has different OM cost depends on its characteristics. The coffee industry is the highest contributor to OM cost among others as about US$ 662,395,978.75. It followed by pineapple can industry that requires US$ 243,552,573.44 and cassava processing as about US$ 177,694,780.85 for operation and maintenance. Other industries generate lower OM cost below US$ 100,000,000 such as corn (US$ 84,770,444.25), sugar (US$ 7,888,446.60) and palm oil (US$ 9,081,728.85).

Each property in the mixed-use area has different OM cost depends on the operational year and the size. Office building contributes as the highest OM cost due to higher floor area ratio (FAR) compared to other types of buildings (residential, commercials, and hotels). The mixed-use area is developed into four phases; current to 2030, 2030-2035, 2035-2040 and 2040-2045. Each phase will have different size of development and construction, subsequently, affect the operation and maintenance.

Three infrastructure from five supporting infrastructures such as water treatment plant, wastewater treatment plant, and geothermal power plant is analyzed by considering the production unit. In term of the water treatment plant, 11,537 rupiahs per cubic meter is required for operation and maintenance. On the other hand, wastewater treatment plant needs a Rp 2,395 for production. Last, geothermal power plant requires Rp 508.1 billion to produce a 394,200 MWh electricity to electrify the overall industrial estate.

OM cost of BRT was analyzed by multiplying the operating cost per bus per km by taking into account a bus distance estimated around 412 km per day, the amount of bus and daily passengers capacity. In 2030, the capacity is about 61,753 passenger/day and covered by 36 unit of buses. It increases into 85,270 passenger/day in 2035 and covered by 48 buses. In 2045, the daily passengers have reached 159,313 and shall be accommodated by 91 buses. The OM cost will then increases every five years to cover estimated BRT demand.

Last, road maintenance uses a similar price in the capital city of Indonesia as about 75,000 rupiah or equal to US$ 5.21 per square meter. It then converted into the airport location in Lampung province by considered the construction cost index. The OM cost of each function is summarized in the following table.
Table 2. Operation and Maintenance Cost of Aerotropolis Conceptual Design in Lampung Province

| No | Component                  | OM Cost (US$)       |
|----|---------------------------|---------------------|
| 1  | Airport                    | 428,064,393.68      |
| 2  | Industrial development     | 1,185,383,952.74    |
| 3  | Mixed-use                  | 465,442,032.11      |
| 4  | Supporting Infrastructure  |                     |
|    | a  Water processing        | 40,648,601.16       |
|    | b  Waste processing        |                     |
|    | c  Geothermal power plant  |                     |
|    | d  BRT                     | 2,346,431.18        |
|    | e  Road access             | 2,543,021.26        |
|    | TOTAL                      | 2,124,428,378.13    |

3.4. Revenue

Each function in the aerotropolis conceptual design generates different revenues. Source of revenue from airport divided into aeronautical revenue and non-aeronautical revenue. The aeronautical revenue is generated from services or facilities related to the operation of aircraft and cargo and its supporting facilities. On the other hand, the non-aeronautics revenue is obtained from the facilities of passengers available at airports outside the aeronautical sector.

Revenues from the aeronautical sector are generated from landing and aircraft storage, air passenger service, aircraft service, aviobridge supply, counter usage and conveyor by airline, and baggage handling system. As for the revenue generated from the cargo, the sector is generated from the tariff of cargo service and cargo loading by calculating the weight of cargo. This research assumed the workload unit from similar tariff in Schipol Airport, Netherlands (9.93 Euro for passenger and 100 kg of cargo) and converted into Indonesian context. The result shows that passenger will be charge 234,514 rupiah or equal to US$ 16.29 and 2,345,140 rupiah or equal to US$ 162.86 per ton cargo.

Revenue from the non-aeronautical sector is generated from two sectors, namely the merchandise sales and commercial land leasing at the airport. The assumption uses a similar case from the Annual Report of Incheon Airport in South Korea in 2014. The merchandise sales estimated about 33,355 rupiah or equal to US$ 2.32 per pax and 15,282,322 rupiahs or US$ 1,061.27 for commercial land leasing.

Revenue from industry consist of two types; revenue from the processing industry and its supporting infrastructure. The processing industry will be considered the capacity production, required land for development, multiplier factor and commodity price. Moreover, by taking into account the inflation, the selling price for each commodity will be adjusted. The summary of revenue can be seen in Table 3.

Table 3. Revenue Component from Each Industry

| No | Component | Land area (Ha) | Multiplier factor | Capacity Production | Price (US$) |
|----|-----------|----------------|-------------------|---------------------|-------------|
| 1  | Cassava   | 190            | 95                | 684,000 ton/year    | 0.28        |
| 2  | Corn      | 44             | 11.52             | 4,360,158 m³/year   | 0.11        |
| 3  | Sugar     | 20             | 13.33             | 213,333 ton/year    | 0.87        |
| 4  | Pineapple | 18.72          | 187.10            | 673,560 ton/year    | 0.76        |
| 5  | Palm Oil  | 18.71          | 3.12              | 1,403,250 ton/year  | 0.76        |
| 6  | Coffee    | 10             | 250               | 15,000 ton/year     | 3.13        |
Supporting industry such as water treatment plant, wastewater treatment plant, and geothermal power plant also generate significant revenue for the aerotropolis development. The analysis will consider the capacity, production, land availability, needs of the area and tariff for each service. Supply of clean water in the area will be charged as about 15,046 rupiahs or US$ 1.04 per cubic meter. On the other hand, wastewater processing will be charged as about 21,065 rupiahs or US$ 1.46 per cubic meter. Last, geothermal power plant involved industrial area needs and generated the capacity for about 50 MW.

In term of mixed-use area, the analysis follows property price from each building to generate revenue. Office, commercial land and hotel use renting price, while apartment will be sold for users. Each of them has a different unit price and occupancy rate, therefore, generates different revenue. Office contributes as the highest contributor to revenue, follows by the hotel, commercial and apartment.

Bus Rapid Transit (BRT) will also produce income for the aerotropolis. It will be operated on the aerotropolis area to accommodate passenger movement from the residential or other areas into the center of economic activities. The route spans for about 39.82 km and a total of 40 bus stops. It will serve 16,178,517 passengers/year and revenue for about US$ 7,752,205.95.

![BRT Route in Aerotropolis Conceptual Design](image)

Based on the initial cost, operation and maintenance cost and revenue from the above analysis, the IRR of the aerotropolis concept is 8.80%. Despite producing a positive value, this result is argued below expected WACC of infrastructure development in Indonesia as about 11.00%. The financial scenario in the following sub-section will formulate the scheme to achieve the targeted result of IRR.

3.5. Financial Analysis

In the financial scheme, this research generates 42 sharing scenarios which divided based on project life cycle. There are three initial cost-sharing scenarios, three OM cost-sharing scenario, nine initial cost plus the OM cost-sharing scenario, and 27 initial cost + OM cost + revenue sharing scenarios. These scenarios will generate optimum IRR for the project. When analyzing the initial sharing scenario, scenario 3 produced an optimum result among others. The scenario offers government sunk cost into the project about 40% from the investment cost and the rest will be handled by the private investors. They will also be responsible for operation and maintenance as well as receiving income from carrying the services. The scenario generates 14.16% of IRR with positive NPV.

In the scenario where operation and maintenance cost is shared between government and private investors, scenario five is selected as the best contributor in term of IRR. This scheme offers private investors responsible for initial cost, but the operation and maintenance will be divided equally between parties. Revenue from this project will be claimed by the private investors. This
scenario generates an IRR of about 17.18% and a positive NPV.

This research also simulates where the sharing is not only in initial cost phase but also in the operation and maintenance phase. The analysis shows that scenario 11 proposes as the best result by taking into account equal responsibility in initial cost, OM cost and private investors gains all the revenue. IRR on this scenario generates high return compared to the previous scenario as about 26.46% with a positive NPV due to the minimum cost is borne by the private investors but gained maximum income.

Last, all phases in the life cycle interfered with sharing between the government and private sectors. Scenario 39 is selected as the best result by considering 40% of the initial cost should be handled by the government, and they will also be involved equal distribution in operation and maintenance. However, unlike other previous scenarios, in this one, the government will obtain 20% of the revenue, and the rest will belong to the private investors. The result shows that 18.77% of IRR was generated with a positive NPV. The summary of this analysis is shown in the following table.

| Scenario | Initial Cost Sharing | OM Cost Sharing | Revenue Sharing | IRR     | NPV     |
|----------|----------------------|----------------|----------------|---------|---------|
| 3        | 60%                  | x              | x              | 14.16%  | Positive|
| 5        | x                    | 50%            | x              | 17.18%  | Positive|
| 11       | 50%                  | 50%            | x              | 26.46%  | Positive|
| 39       | 60%                  | 50%            | 80%            | 18.77%  | Positive|

Based on the above analysis, each function (airport, industrial area, mixed-use, and others) in the aerotropolis are divided into selected parties responsibility. The result shows that private investors contributed 60.41% to the initial cost, 62.37% to the operation and maintenance cost and gained 78.13% of revenue. The result offers a sharing between the government and private investors in every life cycle stages without compromise the IRR and NPV. The IRR argued adequately to attract private investors with 15.81% to this project. Furthermore, in this scenario, the government is not only involved in funding the project but also has the opportunity of gaining income. This revenue might significantly contribute to helping other projects that have financial issues.

3.6. Institutional Scheme
The institution scheme follows the life cycle stage of project construction. In the development stage, planning consultant that consist of an airport consultant collaborates with industry consultant conduct the initial and planning from regional development to the investment scheme. The proposal submitted to the Ministry of Planning Agency for tendering and evaluation of its feasibility. The project will be supported by a national guarantee fund when feasibility is reached.

A special purpose vehicle formed by the government and private investors will be responsible manage the project. The government will support the initial cost in term of the airport, supporting infrastructure as well as cassava and corn processing industries. The private party will cover the initial cost of mixed-use and processing industries from sugar, pineapple can, palm oil and coffee. Each of the functions will be operated by respective parties. State-owned enterprises operate functions from the government side and private corporation for private investors side. The research produces an institutional scheme that can be seen as the following figure.
4. Conclusion

Aerotropolis propose greater connectivity and increase the economic growth of a city, local governments, and a nation. This research attempt to generate alternative conceptual design by integrating transportation, industrial development, mixed-use and supporting infrastructure. Based on the financial analysis, these integrated functions produce 8.80% of the internal rate of return (IRR). Further analysis through scenario sharing such as initial cost sharing, operation, and maintenance cost sharing, initial cost+operation and maintenance cost sharing and initial cost+operation and maintenance cost+revenue sharing have established optimum scenario both for public and private interest.

The scenario that considers 40% of initial cost and 50% operation and maintenance cost tackled by the government arise as the best alternative among others. Despite government sunk cost in each stage, the public will gain 20% of the revenue which may be used to support other infrastructure projects in the nation. This research also proposes an alternative institution scheme that may be used by the government institutions in handling such projects in Indonesia. The result of this research also can be used by the private sector as an alternative to collaborate with the government entity such as local government, SOE, and many others to develop aerotropolis concept in the country.

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