PAPUA NEW GUINEA
NATIONAL AIRPORTS CORPORATION

PAPUA NEW GUINEA
DATA COLLECTION SURVEY ON
TOKUA AIRPORT

FINAL REPORT

MARCH 2019

JAPAN INTERNATIONAL COOPERATION AGENCY

GYROS Corporation
Nippon Koei Co., Ltd.

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Summary

1. Field Survey Schedule

The first field survey was conducted from 27th October 2018 and 2nd November 2018. During the APEC period, work in Japan was carried out and the second field survey was conducted from 24rh November 2018 to 15th December 2018. During the first field survey, relevant organizations were visited and requested to cooperate the survey and data collection, survey on the existing facilities and equipment at Tokua Airport were conducted during the second field survey. List of the interviewees and survey schedule were attached in the appendix.

2. Current Conditions at Tokua Airport

Current conditions at Tokua Airport are summarized in the table below.

Facilities	Current Conditions
1) Runway, Taxiway and Apron	Alligator cracks are appeared on the whole surface of the pavements. Some aggregates are segregated so that urgent repair is necessary. According to the National Airports Corporation (NAC), repair work has been conducted, however the repair is done with the cold mix asphalt and the conditions after the repair is not good. There is a risk of FOD (Foreign Object Damage) caused by segregated aggregate.
2) Passenger Building	Since the existing passenger building was designed to handle Fokker 28 (F28) aircraft, of which seat capacity is 70, the capacity is insufficient to handle multiple arrival and departures of 100 seater Fokker 100 (F100) aircraft. Although parts of the building had been repaired by a fund from the East New Britain Government, the building has been deteriorated and rain leaking from the roof is observed. Because the security equipment is out order, hold baggage are not screened.
3) Fire Station	Although major repair work had been conducted by a fund from NAC, rain leaking form the roof is observed. The capacity of the bay and number of fire fighting vehicle is sufficient for the operation of small size jet in future.
4) Control Tower	There are cracks on the columns and beams. According to the structural study report by PNG Air Services, the life of the building is by 2023.
5) Airfield Lighting System	The control and monitoring panel in the control cabin of the control tower, switch on and off operation of the airfield lighting system are possible only from the control panel located in the electrical room on the ground floor. The conditions of lamps of the airfield lighting system are good.
6) Air Navigation and Communication Equipment	Air navigation and communication equipment is updated by a budget from PNG Air Services and support from the Government of Australia and there is no difficulty on operation. VHF Omnidirectional Range/Distance Measuring Equipment (VOR/DME) installed by Japanese Grant Aid was stop operation.
7) Utilities	Power supply to the airport is unstable. A standby generator is mainly used as main source but the conditions of the generator is not good and its capacity isn't sufficient. A well is used for the main source of water but there is only one set of the pump and well, it is possible to stop the water on repair or maintenance.
8) Cargo Facilities	There is no cargo handling facility and air cargo are handled under open air.

3. Scope of ADB CADIP

Asian Development Bank (ADB) has conducted Civil Aviation Development Investment Program (CADIP) Phase 1. The scope of the Phase 1 includes 22 airports under management of NAC. Support to the rescue and fire fighting services, rehabilitation of power supply system, security fence installation and runway rehabilitation work has been carried out at Tokua Airport. Scope of Phase 2 of CADIP is planned but details haven't been finalized.

4. Local Construction Market Conditions

There are local contractors in Rabaul/Kokopo Area and large-scale contractors are located in Port Moresby. These contractors have capability to carry out the project under a sub-contractor of the Japanese contractor.

It is difficult to obtain aggregates and security measures are required as general construction conditions in Papua New Guinea (PNG). However, there is a good quarry site in Rabaul/Kokopo Area and so that obtaining aggregate is not an issue and it is cheaper than that of other area. Mixed concrete is also available in the market but hot mixed asphalt is not popular as the asphalt pavement in PNG, it is not possible to purchase hot mixed asphalt in the market.

Since security condition in general is better than the other provinces, special security measure is not required and cost of security is cheaper than the other area in PNG.

5. Role of Tokua Airport

Priority to development of tourist sector is high in Medium Term Development Plan (MTDP) and Rabaul/Kokopo area is high priority area for tourism development. There are many tourism resources in Rabaul/Kokopo area and Tourist Promotion Authority (TPA), East New Britain Government and NAC desire to introduce international flights to Tokua Airport to promote international tourist.

There is a policy by NAC to develop, four airports, Nadzab, Tokua, Mount Hagen and Goroko Airports as regional hub. The major airlines in PNG such as Air Niugini and PNG Air use Tokua Airport as a hub airport for passengers and cargo in northern islands area. Especially, PNG Air operates a Dash 8 (DHC8) Freighter aircraft in the airport. There are transshipping cargo from Rabaul Port and Tokua Airport plays a role of cargo shipping hub for mines in northern islands area.

6. Air Traffic Demand Forecast

Results of air traffic demand forecast of international and domestic passenger and cargo are summarized in the table below.

		2017	2025	2030	2035	2040
Domestic Passengers	Annual	162,427	243,000	315,000	405,000	514,000
	Busy Day	617	870	1,120	1,450	1,840
International Passengers	Annual	---	36,900	50,700	63,200	78,900
	Busy Day	---	100	140	170	220
Daily Flights	Domestic	20.9	24	28	36	42
Weekly Flights	International	---	8	10	12	14
Domestic Cargo	Annual	No data	1,900 ton	2,500 ton	3,200 ton	4,100 ton
International Cargo	Annual	---	290 ton	400 ton	500 ton	620 ton

7. Development Policy

Development policies are summarized in the table below.

Facilities	Development Policy
Design Aircraft	Design aircraft are Boeing 737 Max 8 (B737 Max 8) and Boeing 767 (B767).
1) Runway	Runway will be extended to 2,710m for B737 Max 8 to take off at maximum take off weight and the widths will be expanded to 45m. The existing runway pavement will be structurally overlaid.
2) Taxiway and Apron	An additional connecting taxiway will be constructed and there will be two connecting taxiways. The parking space at apron will be expanded. The existing apron area will be structurally overlaid.
3) Passenger Building	A new passenger terminal building with international facilities such as immigration, quarantine and customs for international and domestic passengers will be constructed. The existing passenger building will be renovated for passengers of general aviation (GA).
4) Cargo Building	A new cargo building with cold storage facility will be constructed.
5) Fire Station	The existing fire station will be renovated.
6) Control Tower	Structural reinforcement of the existing control tower or a new control tower will be constructed.
7) Air Navigation and Communication Equipment	There is no new equipment required.
8) Utilities	Power supply system, water supply system, sewage treatment system and telephone lines will be renovated.
9) Air field lighting systems	New air field lighting systems due to the expansion of the runway, taxiways and the apron will be installed.

8. Preliminary Cost Estimate

Preliminary construction cost is approximately 118.0 billion Japanese Yen and the total project cost is estimated as 133.55 billion Japanese Yen.

9. Economic Analysis

Economic Internal Rate of Return (EIRR) was estimated as 14.5%. Because standard range of EIRR is 10% to 12%, it is reasonable to implement the Tokua Airport expansion project from a view point of national economy.

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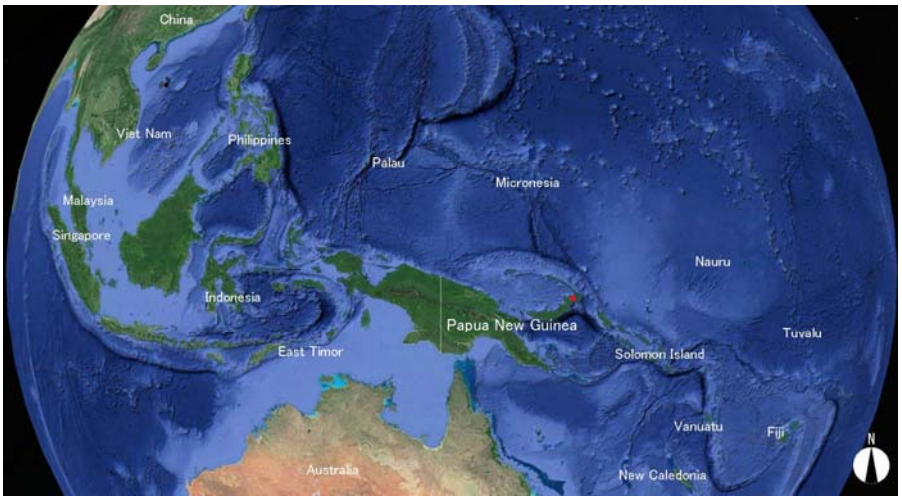
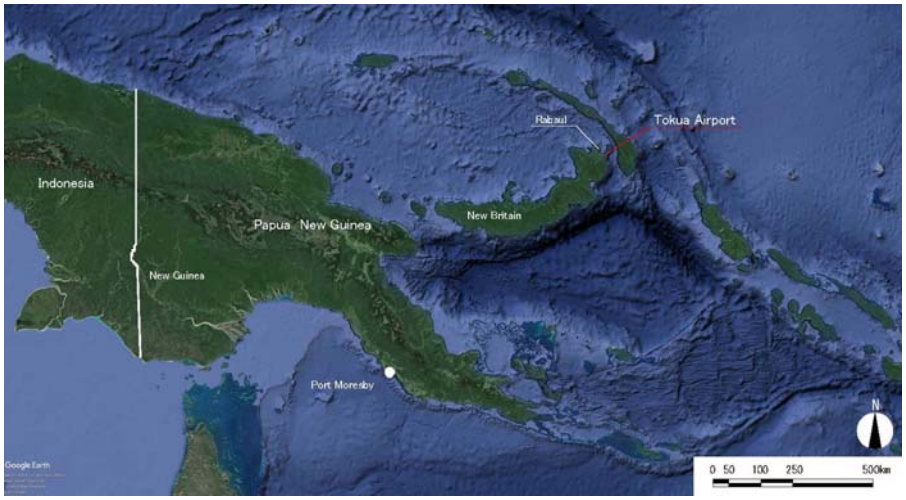




Project Location Map

Abbreviations

A320	Airbus 320
ABN	Aerodrome Beacon
ADB	Asian Development Bank
ADRM	Airport Development Reference Manual
AIC	Accident Investigation Commission
ATIS	Automatic Terminal Information Service
ATR	Air Transport Regulation Division
ATR42	ATR 42
ATR72	ATR 72
AUS AID	Australian Agency for International Development
B737	Boeing 737
B737 Max 8	Boeing 737 Max 8
B767	Boeing 767
B787	Boeing 787
CADIP	Civil Aviation Development Investment Program
CASA	Civil Aviation Safety Authority
CBR	California Bearing Ratio
CCR	Constant Current Regulator
DHC 8	Dash 8
E/N	Exchange of Notes
EIRR	Economic Internal Rate of Return
ENB	East New Britain
F100	Fokker 100
F28	Fokker 28
F70	Fokker 70
FLO	Apron Flood Light
GA	General Aviation
GDP	Gross Domestic Product
GNI	Gross National Income
GSE	Ground Service Equipment
GST	Goods & Service Tax
HDI	Human Development Index
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEPNG	Institute of Engineer in PNG
IFC	International Finance Corporation
IMF	International Monetary Fund
IPA	Investment Promotion Authority
IRC	Internal Revenue Committee
JICA	Japan International Cooperation Agency
KFW	Kreditanstalt für Wiederaufbau Bankengruppe
KVG	Kavieng Airport

MICE	Meeting, Incentive, Conference and Exhibition
MTDP	Medium Term Development Pan
MTTP	Medium Term Transport Plan
NAC	National Airports Corporation
NTS	National Transport Strategy
NWS	National Weather Service
OCG	Oriental Consultants Global
OMGWS	Outer Main Gear Wheel Span
PNG	Papua New Guinea
PNGDSP	Papua New Guinea Development Strategic Plan
PNGASL	PNG Air Service Ltd.
POM	Port Moresby International Airport
RAB	Rabaul Tokua Airport
REDL	Runway Edge Light
REIL	Runway End Identification Light
RENL	Runway End Light
RTHL	Runway Threshold Light
RWY	Runway
STEP	Special Terms for Economic Partnership
TEDL	Taxiway Edge Light
TIPS	PNG Transport Infrastructure Priorities Study
TPA	Tourist Promotion Authority
TSSP	Transport Sector Support Program
TWY	Taxiway
UNOC	United Nations Office on Drugs and Crime
VFR	Visiting friends and relatives
VIP	Very Important Person
Vision 2050	Papua New Guinea Vision 2050
VOR/DME	VHF Omnidirectional Range/Distance Measuring Equipment
WB	World Bank
WDIL	Wind Direction Light

Chapter1 Survey Background

1-1 Background

Air transport plays an important role to connect major cities in Papua New Guinea (PNG), where the steep terrain and tropical jungle hinder the road network development. Tokua Airport, which is the target of this survey, functions as the hub airport in East New Britain Province and the surrounding islands

Tokua Airport was developed under the Japanese grant aid "Emergency Development Plan of New Rabaul (Tokua) Airport" (E/N in 1996 and completed in 1998). The former Tokua Airport was an alternative airport to the former Rabaul Airport, which had been closed due to eruption of two volcanoes near Rabaul in September 1994. Tokua Airport presented issues affecting convenience and safety. It lacks an adequate passenger terminal; its runway is unpaved; and it had insufficient air traffic control facilities. Development of the airport was therefore an urgent necessity. Having already completed the JICA development study "Tokua Airport Development Plan Survey (1991-1992),” the PNG government requested grant aid from the Japanese government in order to enable this work to be implemented most quickly.

The passenger terminal building of the current Tokua Airport was built under the Japanese grant aid with the target domestic passengers of 170,000, which is equivalent to the actual number of passengers in 2015. According to the "Tokua Airport Master Plan 2009-2030", the domestic passenger traffic is expected to expand to 640,000 by 2030. Tokua Airport therefore will be significantly short of capacity in the future. There has been no large-scale renovation work carried out at the passenger terminal building for more than 20 years since it was built under the Japanese grant aid. As a result, the old airport facilities have been affecting the safe use of the airport; the concrete on the outer wall has been peeled off and the runway pavement damages have been left intact. The government of Papua New Guinea regards the tourism industry as an important growth industry in the region and is currently considering launching international flights with Australia and Japan etc., at Tokua Airport. It is, therefore, essential to expand and redevelop facilities and equipment, to widen the runway and to enhance the pavement strength to meet the international standards at Tokua Airport.

Based on the above background, the Papua New Guinea side consulted Japan in 2015 on redevelopment support of Tokua Airport and in 2016 JICA conducted a survey on the condition of the airport facilities and the redevelopment plan. The survey observed condition of aged facilities and facility operation at the airport. It also found that Papua New Guinea side expected to introduce environmentally friendly technologies of Japan and that no land issues were involved.

The survey made a comparison between detailed plans of "Tokua Airport Master Plan 2009-2030" and actual status.

The demand forecast included in the master plan is based on a simple calculation. The JICA survey team was not able to obtain highly reliable information on the future demand forecast based on recent regional development situation, development plans etc. Neither could it grasp the scale of necessary cooperation appropriate to meet the future traffic demand.

The present survey was carried out to grasp and analyze these unclear points and issues as well as to provide reference materials for considering future JICA support.

1-2 Aim of the Survey

Tokua Airport is located on the outskirts of Kokopo, where the historical connection with Japan is rather deep and development of tourism and industry is expected. The present survey will forecast the traffic demand, confirm condition of existing facilities and collect basic information to analyze appropriate scale of cooperation for Tokua Airport, thereby providing reference materials for considering future JICA support.

1-3 Target Area of Survey

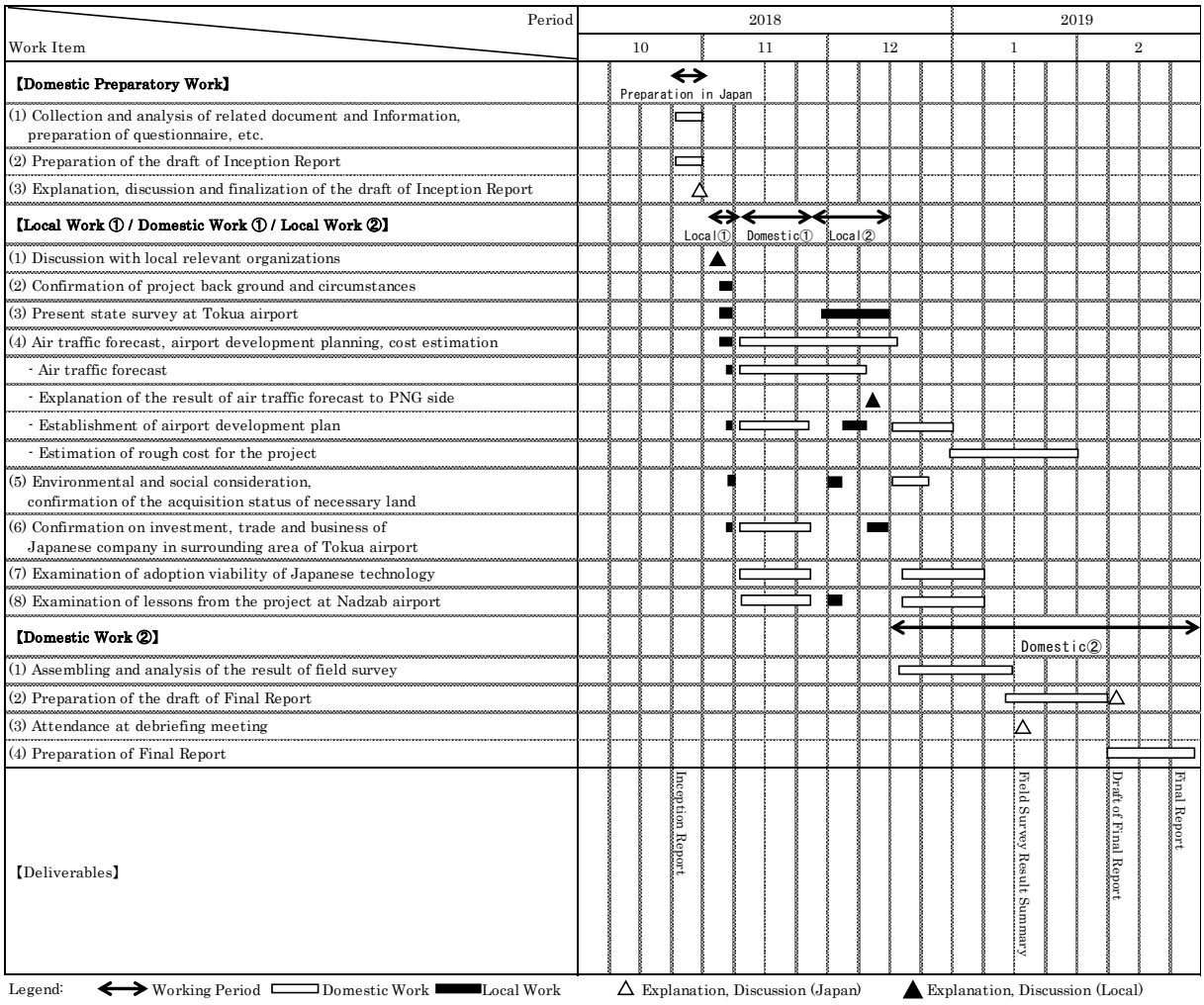
The target area of the survey is Tokua Airport, situated in approximately 15km east of Kokopo, the capital of East New Britain.

1-4 Methodology of Study

1-4-1 Work Plan

The overall work plan is summarized in Table 1.

Table 1 Work Schedule



1-4-2 Survey Team Members

Table 2 lists survey team members.

Table 2 Survey Team Members

Responsibilities	Rating	Name	Company
Project Manager/Airport Planning	2	Takao Yamaguchi	Gyros
Air Traffic Forecast	3	Wasa Morihiro	Nippon Koei
Airport Facility Equipment/ Cost Estimate	4	Satoshi Hatayama	Nippon Koei

Each consultant was dispatched to PNG at the appropriate time in accordance with the work schedule and expected work volume. They conducted the field survey in an efficient way, making most of materials and information collected in Japan. Table 3 shows man-months of each consultant in the field and in Japan.

Table 3 Personal Plan

Personnel Plan

	Responsibilities	Name	Company	Rating	2018 9	10	11	12	2019 1	2	3	Mon-Month 2018 fiscal year Local	Domestic	Total Local	Domestic
Local Work	Project Manager / Airport Planning	Takao Yamaguchi	Gyros	2		27		24 15				1.00		1.00	
	Air Traffic Forecast	Morihiro Wasa	Nippon Koei	3		27	3	8 15				0.53		0.53	
	Airport Facility Equipment / Cost Estimate	Satoshi Hatayama	Nippon Koei	4		27	3	24 15				1.00		1.00	
								Total Local Work				2.53		2.53	
Domestic Work	Project Manager / Airport Planning	Takao Yamaguchi	Gyros	2				20					1.00		1.00
	Air Traffic Forecast	Morihiro Wasa	Nippon Koei	3				18					0.90		0.90
	Airport Facility Equipment / Cost Estimate	Satoshi Hatayama	Nippon Koei	4				20					1.00		1.00
								Total Domestic Work					2.90		2.90
		Timing of Report Submission (△ indicates timing of submission)				△ Inception Report			△ Field Survey Result Summary	△ Draft of Final Report	△ Final Report				
								Total					5.43		5.43

Legend: Local Work; Domestic Work

Chapter2 Situation Surrounding Development Projects

2-1 Development Plan

2-1-1 Long-term National Development Plan[1]

Papua New Guinea Vision 2050（Vision 2050） was presented in 2010 as the long-term national development plan. It is underpinned by following seven strategic focus areas:

- Human capital development, gender, youth and people empowerment;
- Wealth creation;
- Institutional development and service delivery;
- Security and international relations;
- Environmental sustainability and climate change;
- Spiritual, cultural and community development; and
- Strategic planning, integration and control.

‘Vision 2050’maps out the future direction for the country towards 2050. It seeks to position the country to be among top 50 countries in the United Nations Human Development Index (HDI). It also seeks to shift the economy that is dominated by the mining and energy sectors as of 2010, to one that is dominated by agriculture, forestry, fisheries, eco-tourism and manufacturing, between 2010 and 2050

PNG Development Strategic Plan 2010-2030 (PNGDSP) was compiled in 2010, which is the long-term plan for twenty years. Its goal is to improve quality of life for all people in PNG and it aspires to realize the long-term vision of becoming a prosperous, middle income country by 2030. PNGDSP analyzes the situation of PNG as of 2010, set the goal as of 2030 and shows how the goal could be accomplished.

Specifically, it aims to increase Gross National Income (GNI) and Gross Domestic Product (GDP) by 8.4% per annum from 2010, thereby raising GNI and GDP by almost five times in 2010-2030.

The Development Strategic Plan 2010-2030 states that the air transport plays a vital role in the country and elaborates the sector as follows.

Given the complexity of PNG’s topography and terrain, air transport for many remote parts of PNG will continue to be the only possible means to link to the main centers of the country.

2030 targets/objectives are as follows.

[1] Department of National Planning and Monitoring ,‘Papua New Guinea Development Strategic Plan 2010-2030’

- All 22 regional airports meet safety standards of international certification standards.
- 10 regional airports be upgraded for larger jets. (Currently only Port Moresby handles large jets.)
- 50 unused airstrips be rehabilitated for operation.

With the support of Asian Development Bank (ADB), the Government of PNG is investing in upgrading 22 airports. The investment program will initially concentrate on the five airports - Port Moresby, Mt Hagen, Wewak, Hoskins and Gurney airports. It is estimated that the number of domestic travelers will almost quadruple from about 250,000 passengers in 2010 to about 950,000 in 2030. The growth of international tourism will require new international routes and appropriate airport infrastructure at key tourist destinations such as Alotau, Rabaul, Madang and Manus. International business cities like Lae also need an international airport near the city. Meanwhile, regional airlines of the Pacific island countries should be encouraged to contribute to closer regional integration. The liberalization of PNG's air space and a competitive airline market is vital for improving service on domestic flights and reducing the travelling cost.

2-1-2 Medium Term Development Plan (MTDP)[2]

The Medium Term Development Plan (MTDP) is comprised of MTDP I for 2011-2015, MTDP II for 2016-2017 and MTDP III for 2018-2022 (currently in MTTP III).

The MTDP III sets out the Government's development priorities for the next five years (2018-2022). It provides the direction for everyone with a stake in development, including departments and agencies at all levels of government, private sector, development partners and other stakeholders. The MTDP III defines the policy directions and priority areas for investment within different sectors.

The goal of MTDP III is to ensure that the future is secured through comprehensive and sustained economic growth, and 1) secure enough income from domestic tax collection, non-tax income, and export income, and increase the domestic tax collection. 2) PNG will increase national education, capacity and employment opportunities. 3) Increase the ownership and profit of PNG in the public business sector. 4) Improve the quality of service delivery in regions throughout the country. 5) Establish a safe and competitive environment that attracts overseas and domestic investments. 6) Help the province or the district to be able to levy a sustained national tax. 7) Manage the population growth to a sustainable level and recommend family planning. 8) Improve the planning process based on the rationale.

[2] Department of National Planning and Monitoring, 'Medium Term Development Plan III 2018-2022'

The MTDP III consists of two volumes. The Volume 1 focuses on the development planning framework and strategic priorities while the Volume II contains the implementation and investment plan of detailed sector strategies. The Volume I shows achievement of sector targets in MTDP I and II. The target of the air navigation sector was not achieved; the target was to have 10 additional rural airstrips in usable condition by 2015 but only 6 such airstrips were developed. The target of the tourism sector was not achieved either; the target was to increase the number of foreign visitor arrivals to 240,000 by 2017 but it was 212,456 in 2015, falling short by 27,544.

The most recent target of the air transport sector in MTDP III has not been achieved; the target was to make 10 additional rural airstrips in usable condition by 2015 but only 6 such airstrips had been developed by 2017. The target of the tourism sector was not achieved either; the target was to increase the number of foreign visitor arrivals to 240,000 by 2017 but it was 212,456 in the same year, falling short by 27,544.

2-1-3 National Transport Strategy (NTS)

National Transport Strategy (NTS) was issued by Department of Transport in July 2013, replacing the National Transport Development Plan 2006-2010. NTS is a strategic plan for the next 20-30 years based on national level planning and policy of Vision 2050, containing the medium-term transportation plan (MTTP) from 2014 to 2018. NTS declares the following vision and goals:

NTS's vision for the transport sector is "a well-integrated, competitive, safe, affordable, financially and environmentally sustainable transport system that would efficiently serve the economy and society of Papua New Guinea."

NTS sets out following 11 goals

- Restore the national transport network;
- Fully fund maintenance as far as possible from user charges;
- Deliver a safe and secure transport system for users and the public;
- Mitigate or avoid adverse social, health and environmental effects of transport;
- Develop new infrastructure to serve national and provincial priorities where economically viable and within financial and capacity constraints;
- Provide better government institutional structures to deliver transport infrastructure and services;
- Strengthen the human resource capacity of the government transport agencies;
- Develop capacity and capability of PNG national enterprises in the transport sector;
- Bring 95% of the population within easy reach of all-weather transport access;

- Provide transport access to 95% or more of developable agricultural land; and
- Provide well-planned, regulated and operated traffic networks and urban public transport systems in the major cities.

Separation of the regulator (Civil Aviation Safety Authority (CASA)) and service providers (National Airports Corporation (NAC), PNG Air Service and Air Niugini) has already been carried out. There will be no further reorganization plan in the air traffic system. MOT will continue to work on aviation policies, international aviation agreements, and permits to enter the aviation market. It will also remain responsible for formulating policies and plans across transportation modes.

For international air traffic, NTS agrees with the liberalization of the APEC Regional Aviation Services and the authorization for international charter flights from the perspective of PNG's aviation industry and airport safety. For domestic air traffic, NTS intends to introduce competition for PNG airlines while new entry to charter flights and business jets will be given only to the joint enterprise with PNG companies in the future.

The goal of financial improvement is to enable NAC to enhance its efficiency and expand revenues streams, to be able to cover maintenance & operation costs of 21 airports by 2015 and then to cover renovation projects costs up to 2030.

Airports in PNG require the government subsidy. Out of 21 airports, only five airports (Port Moresby, Nadzab, Tokua, Mount Hagen and Madan airports) generate enough revenues to cover maintenance & operation costs. ADB loan is used for the investment in airport facilities; for Tokua Airport, about 1.1 million and 70 million kina will be allocated respectively for maintenance and for facility upgrading up to 2018 to cope with F100 operation.

The overall airport development goals are as listed below.

- All airports will achieve the domestic airport security certification by 2015.
- F100 airports will be 8 by 2015, 10 by 2020 and 11 by 2025.
- Regional airports with good operational standards will be 6 by 2015, 20 by 2020, 18 by 2025 and 23 by 2030.
- Rural airstrips will be developed; 10 by 2015, 20 airports by 2020, 30 airports by 2025 and 40 airports by 2030.
- B737-400 airports will be 4 by 2015, 7 by 2020 and 10 by 2025.

The long-term airport development targets include development of Port Moresby Airport to cope with large Boeing 787 (B787)-class aircraft and upgrading Nadzab or other airport to be an alternative international airport to Port Moresby Airport.

The medium-term plan is to develop five regional airports to handle B737-800 class aircraft. Initially five airports (Mount Hagen, Wewak, Madang, Gurnee, and Hoskins airports) will be upgraded to accommodate F-100, to be followed by Wewak, Tokua and Kavieng airports. According to MTDP, 10 regional airports including Nadzab Airport will be upgraded to handle medium-range flights by 2030. Assuming ADB's Civil Aviation Development Investment Program (CADIP) will be completed by 2020, target airports will likely be Tokua, Goroka and Aropa.

Three airports (Vanimo, Buka and Momote airports) will be upgraded to accommodate F-100. Meanwhile, Goroka and Aropa airports, if not included in the medium-term plan, will be redeveloped in the future.

Seven airstrips (Chimbu, Daru, Girua, Kerema, Kiunga, Mendi and Wapenamanda) will be rehabilitated to be able to serve domestic propeller planes. Tari airport under the South Highland Regional Government might also be included in this plan.

About 85% costs of the investment for domestic airports is planned to be disbursed from the ADB CADIP, and in Project 1 of CADIP, Hoskins, Wewak, Gurnee, Goroka and Kavieng airports will be urgently rehabilitated to serve F-100 flights. This plan includes renovation of pavement, installation of security fences and procurement of fire trucks at 5 airports as well as expansion of the domestic apron and installation of instrument landing system (ILS) at Port Moresby Airport.

NTS states that NAC is responsible for airport development plans. In implementing projects for regional airports to accommodate B737-800 flights, NAC is to conduct a feasibility study to examine air traffic demand, service delivery capacity, and economic costs and benefits of the project.

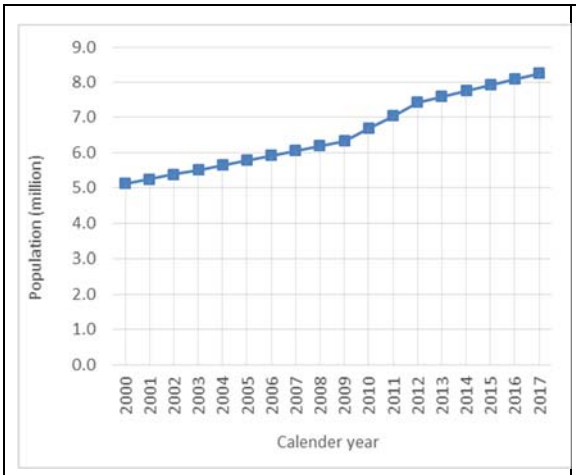
Development of Tokua Airport requires 75 million kina in 2016-2020 and it is the first priority of PNG Transport Infrastructure Priorities Study (TIPS) which was issued by Australian Agency for International Development (AUS AID) in 2012.

2-2 Economic and Social Environment

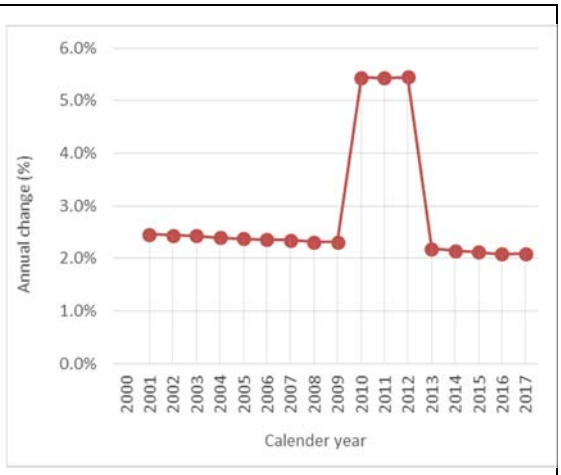
2-2-1 Demographic Statistics

In 2017, the population of Papua New Guinea (PNG) was recorded at 8.1 million, and it is estimated to be smoothly increasing thereafter (see Figure 1). The population growth rate is 3.1%.

The population of East New Britain (ENB) Province, where the Tokua Airport locates, is 328,369 according to 2011 National Population and Housing Census.



(a) Population



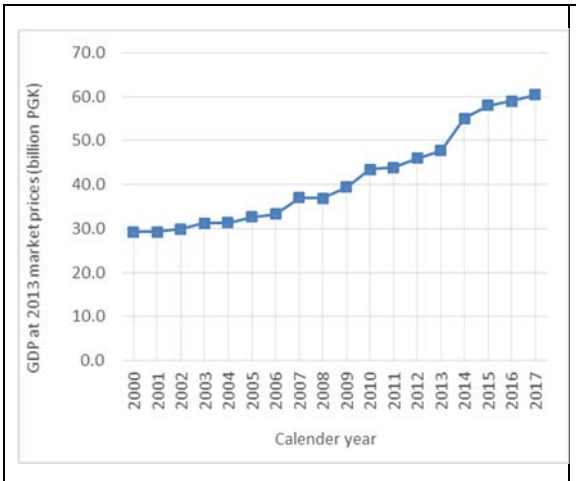
(b) Growth Rate

Source: International Monetary Fund, World Economic Outlook Database, October 2018
Note: Estimated after 2011

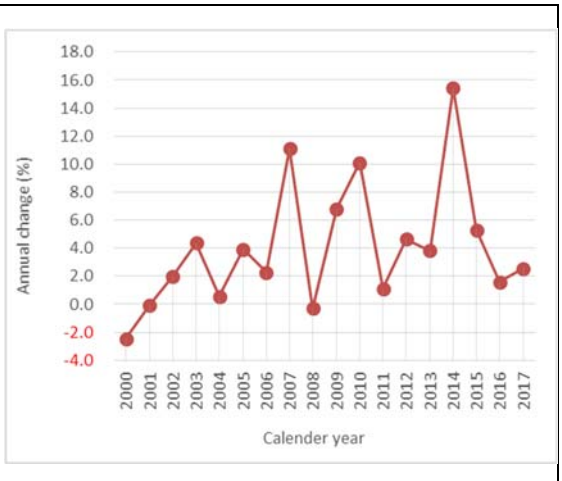
Figure 1 Statistics of Population

2-2-2 GDP Statistics

The real GDP of PNG in 2015 was recorded at PGK 58 billion at 2013 market prices (see Figure 2). The annual growth rate greatly fluctuated between -2% and + 15%. The main cause of fluctuation is supposed to be the mining and quarrying sectors.



(a) GDP



(b) Growth Rate

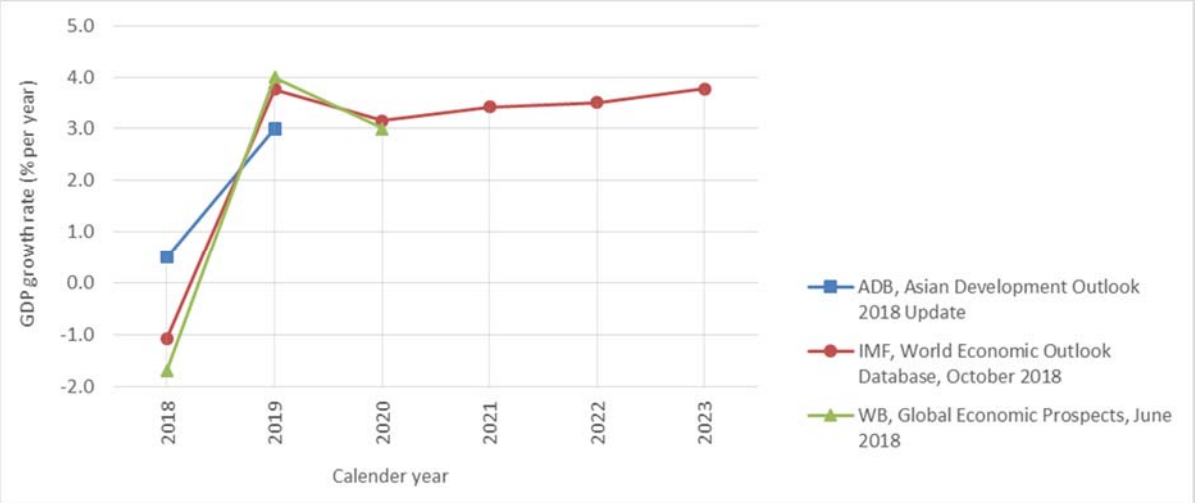
Source: International Monetary Fund, World Economic Outlook Database, October 2018
Note: Estimated after 2016

Figure 2 GDP Statistics

2-2-3 GDP Prospects

The GDP prospects of PNG were collected from ADB, the International Monetary Fund (IMF), and the World Bank (WB). The GDP in 2018 was estimated to decrease due to the earthquake in February 2018. GDP growth recovery is expected in 2019 at 3% to 4% annual growth rate (see Figure 3)

Papua New Guinea Economic Update (World Bank Group, January 2019) reported updated GDP prospects at 5.1% (2019), 3.1% (2020), and 3.4% (2021).

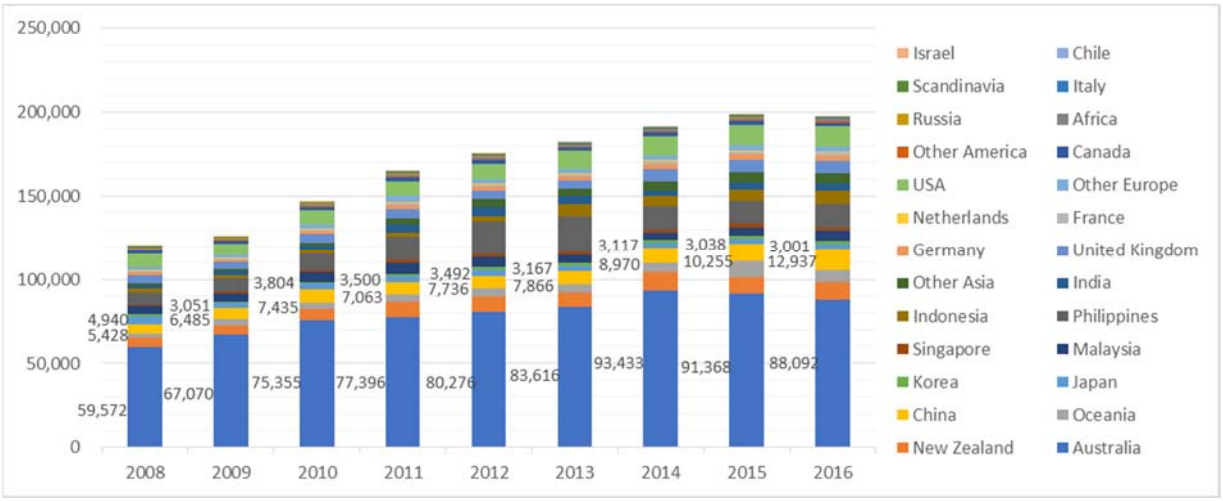


Source 1: ADB, Asian Development Outlook 2018 Update
Source 2: IMF, World Economic Outlook Database, October 2018
Source 3: WB, Global Economic Prospects, June 2018

Figure 3 GDP Prospects

2-2-4 Number of International Visitors

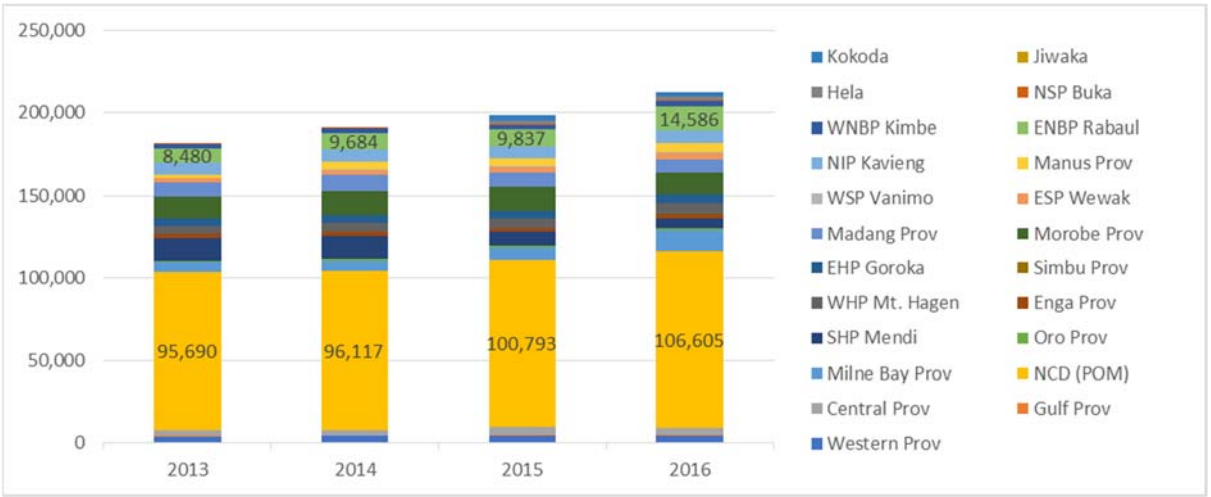
The Tourism Promotion Authority (TPA) of PNG is responsible for recording the statistics of international visitors. The number of visitors was recorded at 120,000 in 2008 and increased to 199,000 in 2015. The annual growth rate was 7.5% (see Figure 4). Considering the countries of origin, visitors from Australia accounted for 48% of the total. The number of visitors from Japan was only 2% of the total, decreasing from 5,000 visitors in 2008 to 3,000 visitors in 2015. The visitors from China accounted for 5% of the total, showing rapid growth from 5,000 visitors in 2008 to 10,000 visitors in 2015, at 10% annual growth rate.



Source: TPA, Annual Visitor Arrivals

Figure 4 Number of Visitors to PNG Sorted by Countries of Origin

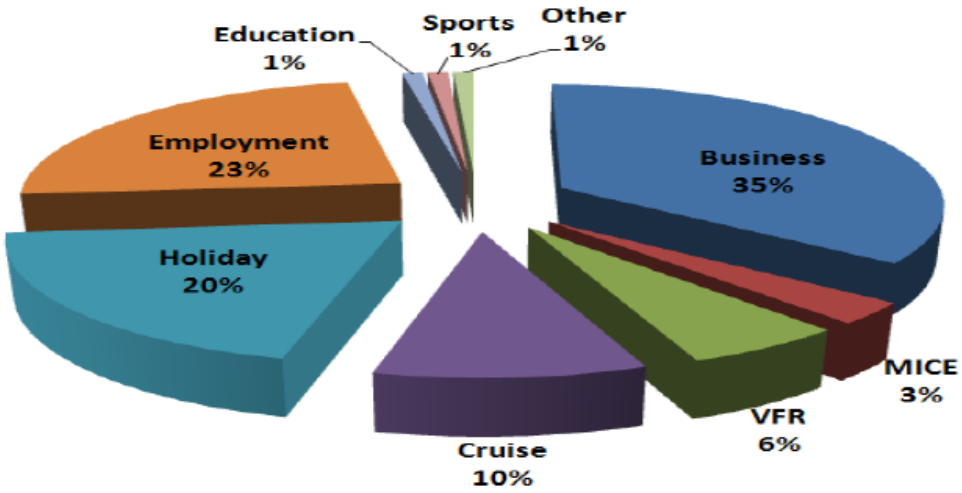
By sorting international visitors by destination, those traveling to Port Moresby accounted for 51% of the total (see Figure 5). The number of visitors to Rabaul is about 10,000, or 5% of the total.



Source: TPA, Visitor Arrivals Reports

Figure 5 Number of Visitors to PNG Sorted by Destination

In classification by purpose of visit, 35% of visitors travel to PNG for business, 23% for employment, 20% for vacation by air, and 10% for vacation by cruise (see Figure 6). Those traveling to Rabaul for vacation by cruise represented 75% of the total visitors (see Table 4).



MICE: Meeting, incentive, conference and exhibition
VFR: Visiting friends and relatives
Source: TPA, Visitor Arrivals Report 2016

Figure 6 Purpose of Visit to PNG

Table 4 Purpose of Visit to Rabaul

	Business	MCE	Vacation (air)	VFR	Vacation (Cruise)	Employment	Sports	Education	Others	Total
Visitor	725	40	1,753	321	10,985	608	12	35	107	14,586
Share	5%	0%	12%	2%	75%	4%	0%	0%	1%	100%

MCE: Meeting, conference and exhibition
VFR: Visiting friends and relatives
Source: TPA, Provinces Visited, 2016

2-3 Air Transportation Sector

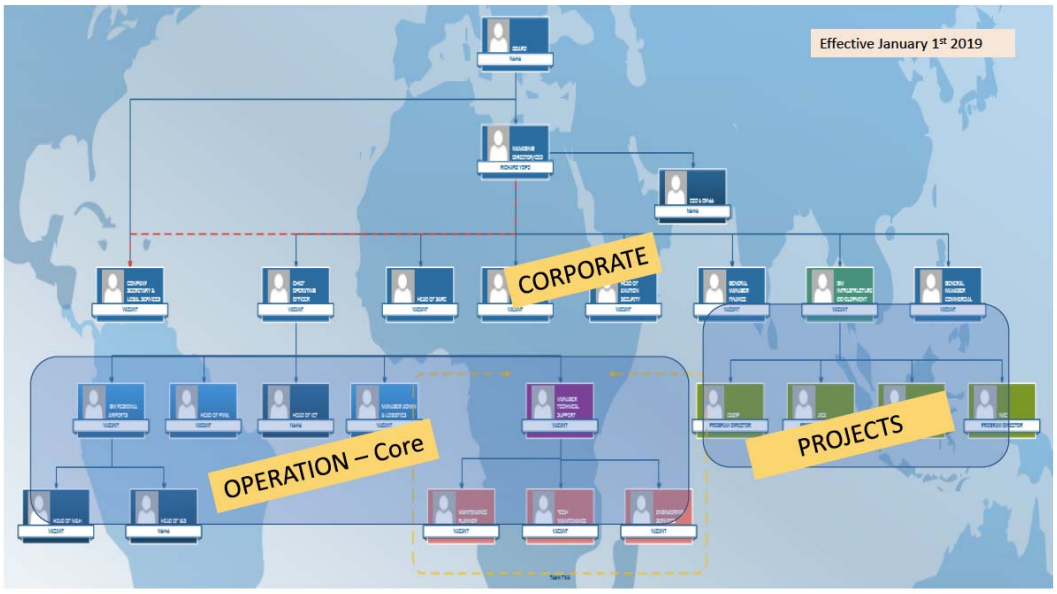
2-3-1 Organizations

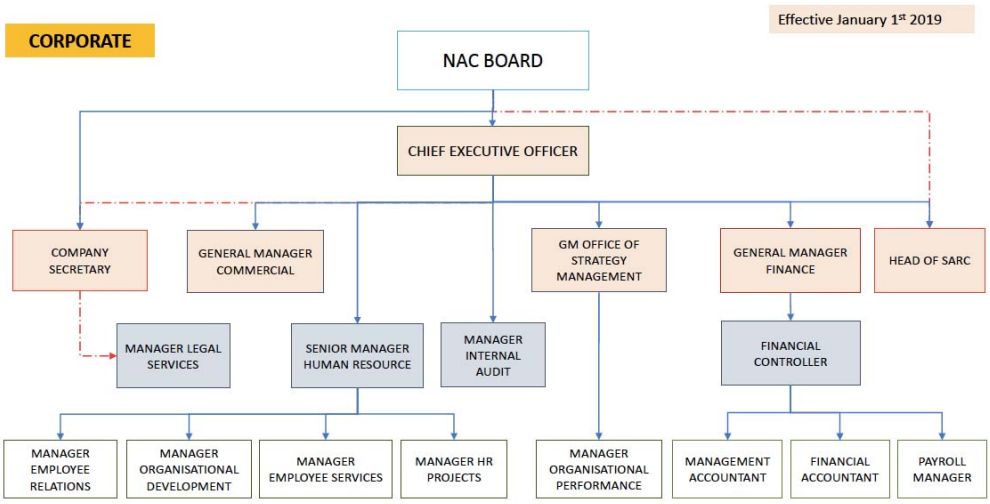
(1) National Airports Corporation Ltd.

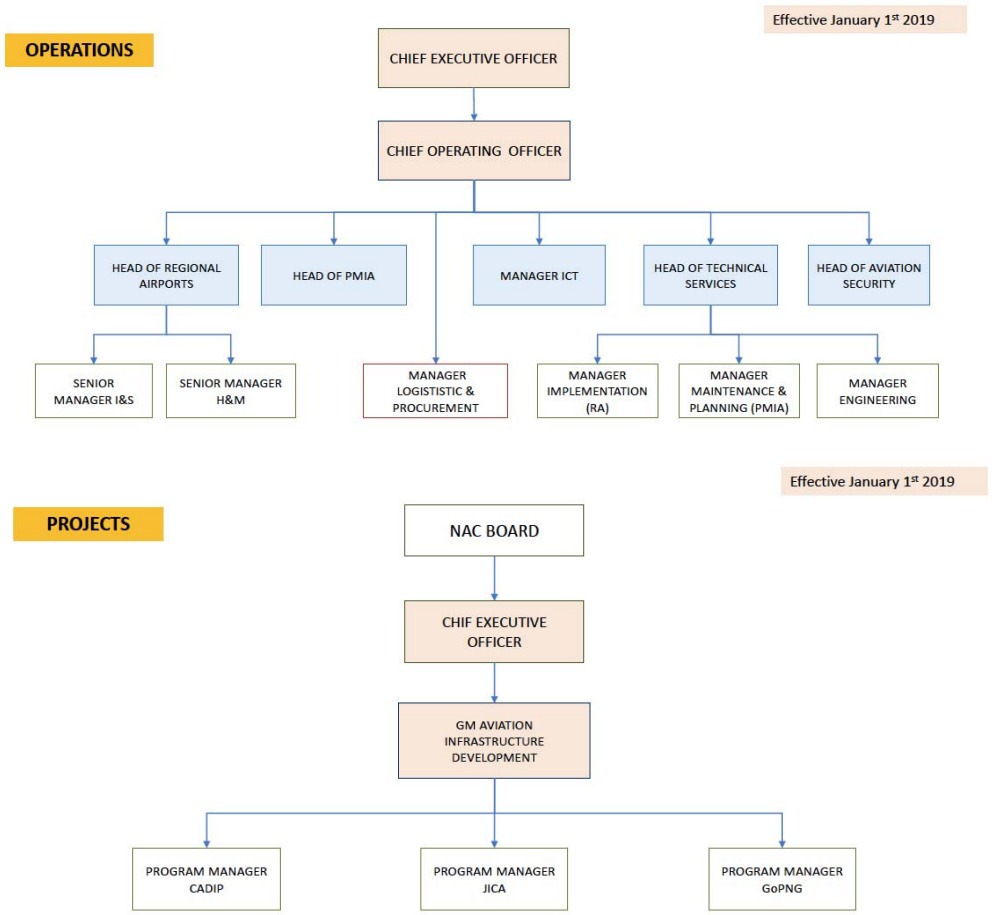
National Airports Corporation Ltd. (NAC) was incorporated in 1997 by the Company Act 1997 and was established as a state-owned company in 2010 by the Civil Aviation Amendment Act of 2010. NAC possess, operates and maintains 21 airports in the country. NAC, in coordination with DOT, is responsible for conducting study for airport development plans and implementing master plans in line with the NTS and MTTP. It is also responsible to develop and invest the projects using funds approved by the government.

NAC also sets standards on airport management and technology. It provides paid support and advice to local airports managed by local governments on airport technology, asset management and technological issues.

As shown in the figure 7, NAC's organization is divided into three departments, i.e., Corporate, Operation and Projects. The Corporate Department undertakes the company's head office function. The Operation department is responsible for airport operation and comprises the Regional Airport Section, PMIA (Port Moresby International Airport) Section, Technical Service Section and Aviation Security Section. The Project Department is divided into three, i.e., ongoing ADB CADIP, JICA projects and the government projects.







Source：NAC

Figure 7 Organization of NAC

(2) PNG Air Services Ltd.

PNG Air Services Ltd. (PNGASL) was incorporated in 1997 by the Company Act 1997 and was established as a state company by the Civil Aviation Amendment Act 2010 in 2010. PNGASL was established to conduct paid work related to air traffic control, communications and related operations within the airspace of PNG.

(3) Civil Aviation Safety Authority

Civil Aviation Safety Authority (CASA) was established by the civil Aviation Amendment Act 2010 in 2010, with the aim of improving the safety and security of civil aviation.

CASA conducts the following activities.

- To establish safety and security standards related to civil aviation, and to encourage and monitor airlines in complying with the standards;

- To set up and implement the aviation security services;
- To investigate and review commercial aircraft accidents and incidents and report them to Accident Investigation Commission (AIC);
- To register the aircraft and update the aviation information and charts;
- To encourage safety and security through provision of information, advice, and training programs, and
- To cooperate with all parties concerned with aviation safety.

CASA is responsible for the development and implementation of safety standards. It is also in the position to make the PNG government comply with the International Civil Aviation Organization (ICAO) standards as an ICAO member country.

(4) Accident Investigation Commission

Accident Investigation Commission (AIC), formed by Civil Aviation Act 2000 in 2000, assumes the investigation of air accidents on a "no fault" basis with a view to future prevention.

(5) National Weather Service

National Weather Service（NWS） is under the jurisdiction of DOT and is responsible for collection and analysis of meteorological data. NWS reports past and present weather information and forecasts short-range weather for PNG and surrounding areas. Weather information and weather forecasts are provided for general use and for aviation and shipping. NWS also gives advice on mid-range extreme weather and long-range climate change. There are NWS staff stationed at Tokua Airport to conduct meteorological observations.

(6) Air Transport Regulation Division of DOT

Air Transport Regulation Division (ATR) is one of the divisions in the Ministry of Transportation. ATR investigates and advises on aviation policies, concludes international transportation contracts, and regulates the aviation industry and market.

2-3-2 Airports

Out of the total 27 airports in the country, 21 are state/NAC airports, 3 regional airports and 3 private airports. There are 3 international airports, i.e., Port Moresby Jacksons International Airport, Daru Airport and Wewak Airport although there are no scheduled international flights at Daru Airport and Wewak Airport. Mount Hagen Airport has the largest number of international charter flights for the mine industry.

In addition to these airports, there are more than 600 airstrips with the runway length ranging from 450m to 1,700m. They are managed by the operators, but maintenance conditions are very poor.

2-3-3 Flights

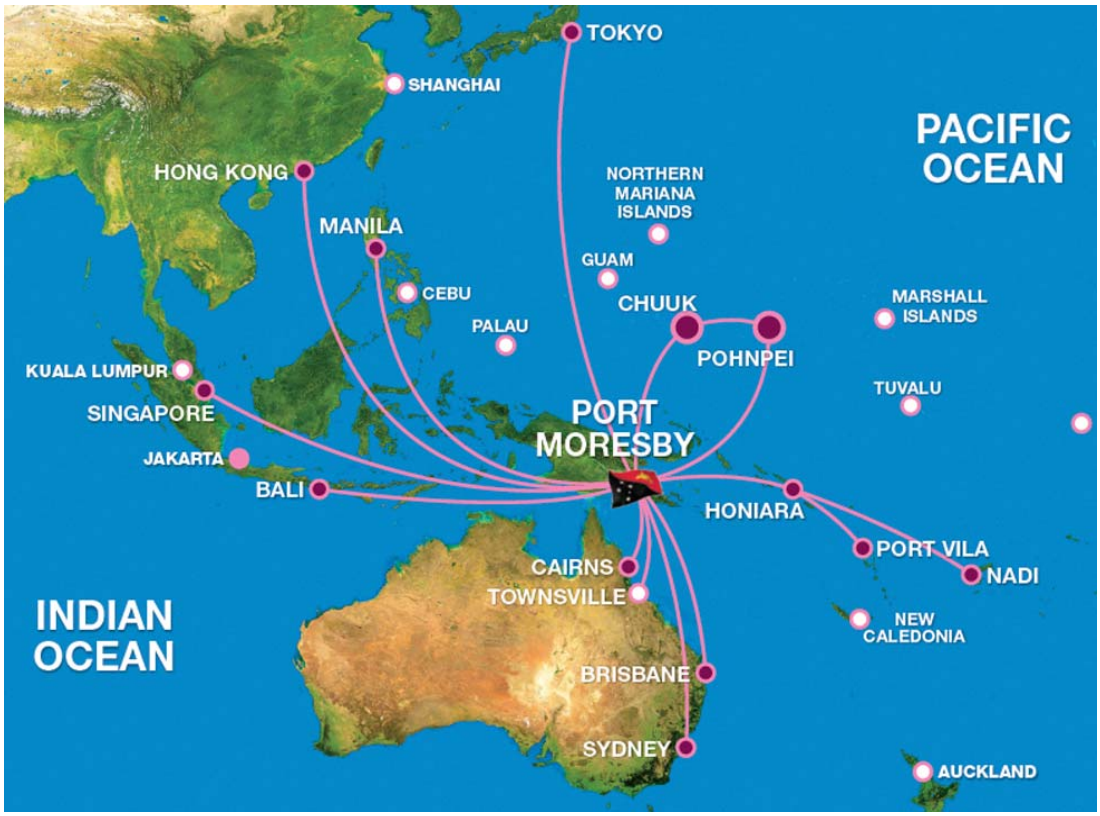
Air Niugini and PNG Air operate scheduled flights in PNG. Air Niugini was established in 1973 as a state company owned by TAA Airlines, Qantas Airlines, Ansett and PNG governments. It operates scheduled flights to international and major domestic airports. Link PNG, Air Niugini's subsidiary company, mainly operates domestic scheduled flights.

PNG Air is a commercial airline that operates scheduled domestic flights and chartered flights.

Table 5 Equipment Owned by Air Niugini

Name	Volume	Seats	Main Routes	Status
B767-300ER	2	Economy160 Business28	Hong Kong, Singapore, Brisbane	In Operation
B737-700	1	Economy104 Business12	Narita, Bauerfield, Honiara	In Operation
F100	5	Economy93 Business8	Cairns, Honiara, Nadi, Domestic Flights	In Operation
F70	4	Economy70 Business6	Chuuk, Nadi, Domestic Flights	In Operation
DH8 -Q315	4	Economy50	Domestic Flights	In Operation
DH8-Q400	1	Economy60 Business10	Domestic Flights	In Operation
ATR42-320F	1	Cargo	Domestic Cargo	In Operation

Figure 8 Domestic Air Route Map of Air Niugini

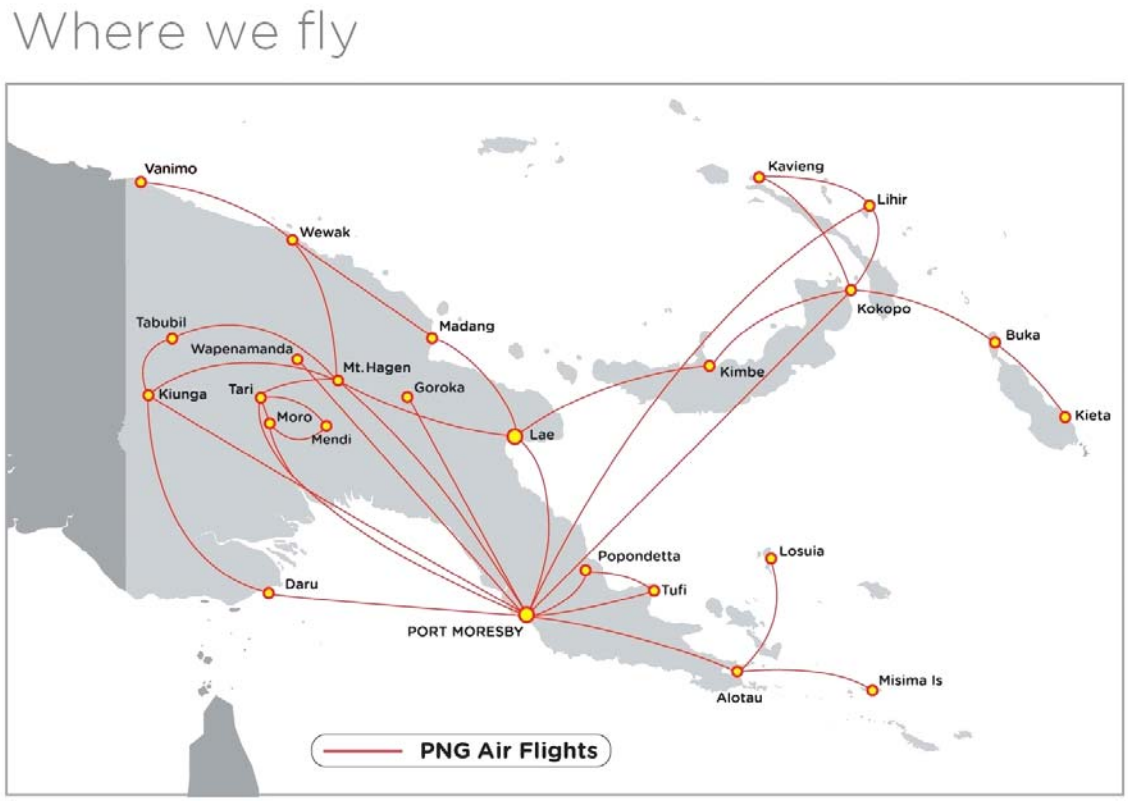


Source：Air Niugini

Figure 9 International Air Route Map of Air Niugini

Table 6 Equipment Inventory of PNG Air

Name	Volume	Seats	Main Routes	Status
ATR72-600	7	Economy 72	Domestic	In Operation
DH8-100	9	Economy 36	Domestic	In Operation
DH8-100	1	Cargo	Domestic Cargo	In Operation



Source：PNG Air

Figure 10 Domestic Air Route Map pf PNG Air

2-3-4 Statistic of Air Passenger Traffic Demand

(1) Passenger Traffic in PNG

Passenger traffic demand in PNG is 3 million passengers per year. Tokua Airport is the fourth largest airport in PNG.

Table 7 Passenger Traffic in PNG

Airport Name	Code	2014	2015	2016	2017
Tokua Airport	RAB	150,476	163,896	151,799	162,427
Lae Nadzab Airport	LAE	360,270	308,305	279,316	276,034
Mount Hagen Airport	HGU	239,362	196,362	187,349	250,794
Jacksons International Airport	POM	1,266,806	1,351,224	1,351,118	1,595,633
Other Airports		711,392	637,609	607,216	652,814
Total		2,728,306	2,657,394	2,576,796	2,937,702

Note: GA included
Source: NAC

(2) Passenger Traffic of Domestic Flight (Tokua Airport)

The four airline companies in service at Tokua Airport are Air Niugini, PNG Air[3], Travel Air[4], and Hevilift. Hevilift only operates helicopters and small aircrafts and does not utilize the passenger terminal. The passenger traffic from 2010 to 2013 of the other three companies was obtained from each airline, and data from 2014 to 2015 was obtained from the NAC.

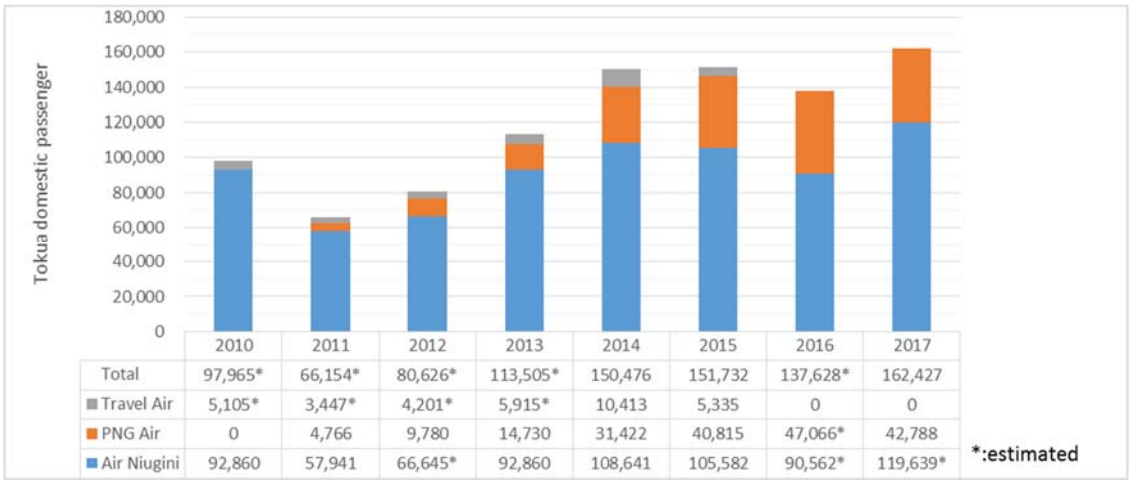
Since partial traffic data of 2012 and 2016 of Air Niugini are missing, the gap was complemented by using data from the years before and after.

There was a gap in the passenger traffic data of PNG Air in 2016, so the JICA Survey Team interpolated values using data from the years before and after. The traffic data directly obtained from PNG Air only contained arrival data; therefore, the JICA Survey Team doubled the data for adjustment.

The passenger traffic data of Travel Air from 2010 to 2013 was missing; hence, the passenger traffic share among airlines was used to fill the gap.

The recorded or estimated passenger traffic of domestic flights is shown in Figure 11. The combined total annual passenger traffic of Air Niugini, PNG Air, and Travel Air that utilizes the passenger terminal is about 100,000 to 160,000 after 2013.

[3] The brand of Airline PNG was changed to PNG Air in November 2015.
[4] Travel Air stopped the operation in PNG in 2016.



	2010	2011	2012	2013	2014	2015	2016	2017
Total	97,965*	66,154*	80,626*	113,505*	150,476	151,732	137,628*	162,427
Travel Air	5,105*	3,447*	4,201*	5,915*	10,413	5,335	0	0
PNG Air	0	4,766	9,780	14,730	31,422	40,815	47,066*	42,788
Air Niugini	92,860	57,941	66,645*	92,860	108,641	105,582	90,562*	119,639*

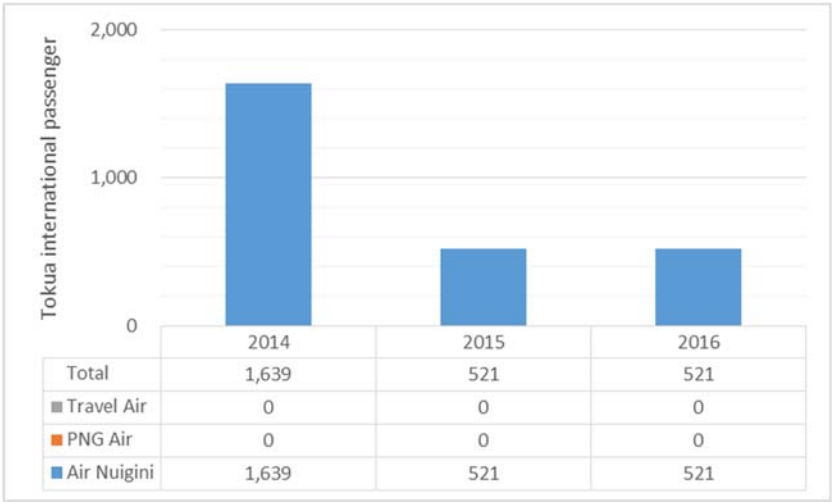
Note: GA not included
Source: Prepared by the JICA Survey Team based on the data from NAC and airlines

Figure 11 Passenger Traffic of Domestic Flights (Tokua Airport)

(3) Passenger Traffic of International Flights (Tokua Airport)

Scheduled international flights are not in service at the Tokua Airport.

Air Niugini operated several flights from Rabaul to Cairns in 2014 to 2016 (see Figure 12) due to the tourism promotion campaign of TPA.



	2014	2015	2016
Total	1,639	521	521
Travel Air	0	0	0
PNG Air	0	0	0
Air Niugini	1,639	521	521

Source: NAC

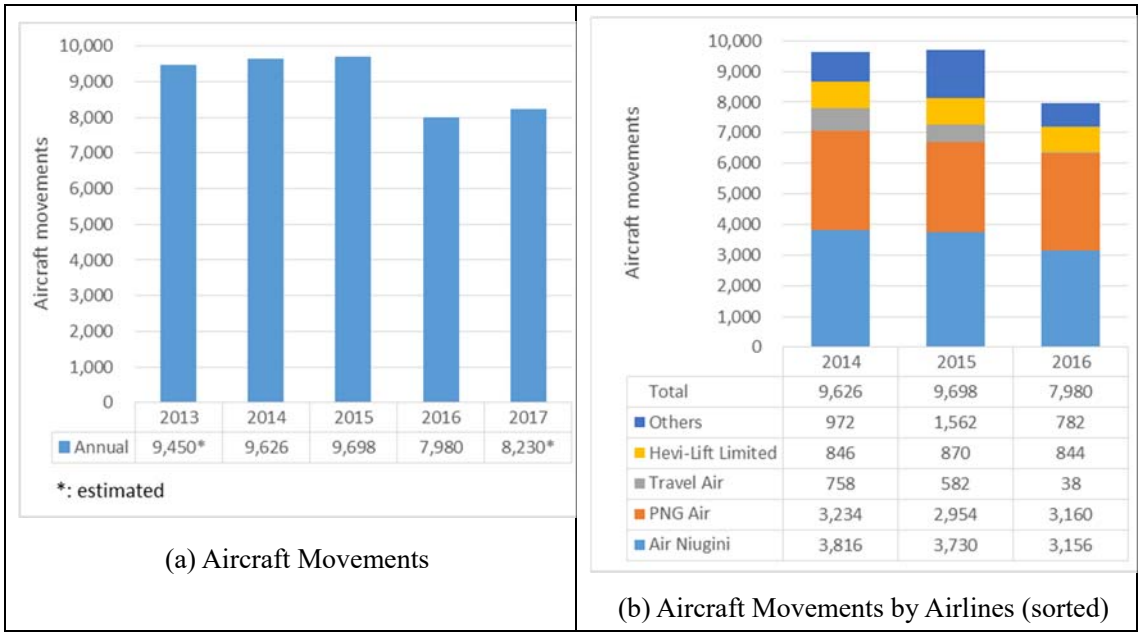
Figure 12 Passenger Traffic of International Flights (Tokua Airport)

(4) Aircraft Movements (Tokua Airport)

The JICA Survey Team analyzed the aircraft movements data from 2013 to 2017, which were provided by NAC. The departure and arrival locations were recorded based on the flight plans.

For example, the POM-KVG-RAB flight was divided and recorded as POM-KVG and POM-RAB. Therefore, the flights to RAB were sorted and doubled to count aircraft movements in RAB. Data gaps in 2013 and 2017 were interpolated.

The total annual aircraft movements, including general aviation (GA), at the Tokua Airport is around 9,000 (see Figure 13).

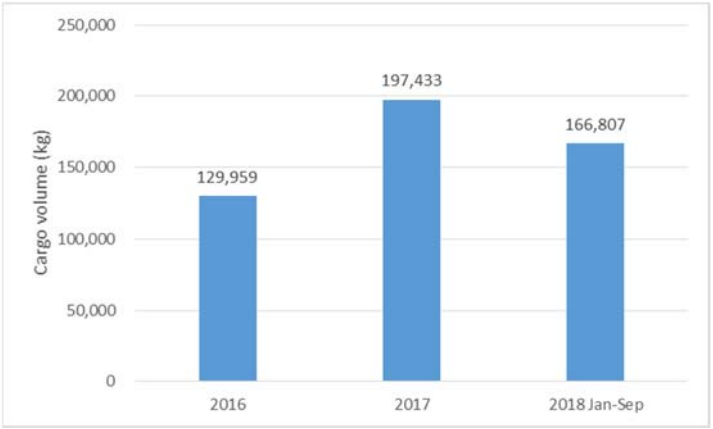


Source: NAC

Figure 13 Number of Aircraft Movements (Tokua Airport)

(5) Cargo Volume (Tokua Airport)

The volume of cargos handled by PNG Air from 2016 to 2018 is at around 150 ton per year (see Figure 14). Air Niugini handled around 41 ton per month in the POM-RAB route (average of the last ten years).



Source: PNG Air

Figure 14 Cargo Volume (Tokua Airport)

2-4 Construction Situation

2-4-1 Local Contractors

There are mainly three types of local contractors in PNG, i.e., local capital companies; subsidiaries or affiliates of Australian companies; and Chinese state companies. Local capital companies tend to be small in scale and mainly work for local governments and private sector. Relatively large projects implemented by international institutions are normally taken care of by Australian and Chinese companies. There are two types of Chinese companies. Some companies work mainly for the Chinese government development projects while others work for projects implemented by the PNG government and international organizations. The largest contractor in Kokopo is an Australian company, which has experience of working as a subcontractor for Japanese contractors. This contractor owns a concrete mill and manufactures and sells concrete products. It also locally processes steel frames and has a system to handle a large-scale construction work.

2-4-2 Construction Situation in Rabaul and Kokopo Area

Rabaul/Kokopo region is relatively safe in comparison to other cities in the country. International organizations normally take special costly safety measures in implementing projects in PNG. However, such measures will not be necessary for the Rabaul/Kokopo region.

Transportation costs in highlands and island regions are high because of undeveloped roads and distance form a port. However, thanks to Rabaul Port, it is relatively easy to transport construction materials and equipment to Rabaul/Kokopo region from abroad and from Port Moresby.

2-4-3 Local Procurement of Construction Materials and Equipment

Crushed stones are essential materials for manufacturing concrete and asphalt, but they are hard to come by in the islands and highland regions. One of the reasons for high construction unit price of the country is explainable by high transportation costs of crushed stones. However, the Rabaul/Kokopo is an exception as the Warangoi river there produces good quality crushed stones. There are two quarries in about an hour away from Tokua Airport; one is managed by a Chinese company and another by an Australian company.

Photo 1 Warangoi Quarry

Photo 2 Concrete Mill

In other countries, the heated asphalt mixture is generally used for airport pavement to endure jet planes. In PNG, however, the chip seal pavement is usually used for roads and airports. There is no contractor that owns an asphalt plant in Rabaul/Kokopo region. It is envisaged that heated asphalt mixture concrete mixture be used for Tokua Airport by importing asphalt plant from abroad.

Concrete mixture is locally available from a contractor that manufactures concrete and concrete secondary products in Kokopo.

Since there are not many large-scale construction projects in the Rabaul/Kokopo region, procuring construction equipment in the local market will likely be difficult. Construction equipment should be imported from abroad for the present project.

Chapter3 Present Condition of Tokua Airport

3-1 History of Tokua Airport

The former Rabaul Airport in Rabaul City is located in the northern end of the East New Britain Province. It was the third main airport in Papua New Guinea (PNG) handling 14.6 million passengers and 1,500 tons of cargo in 1989. The volcanoes in Rabaul erupted on September 19, 1994 which destroyed the airport and the township. The stoppage of airport functions has become a fatal problem not only for air transport and the socio-economy of East New Britain but also for the entire PNG. The Government of PNG closed airport operations permanently and decided that the Tokua Airport would be the replacement. The Tokua Airport is located 45 km southeast of Rabaul City and had long been a temporary alternative airport to Rabaul Airport when the latter was closed due to bad weather.

After the government decision mentioned above, the mobile control tower was provided by Kreditanstalt für Wiederaufbau Bankengruppe (KFW), and the power supply system and cables, fire trucks, emergency equipment, and HF transmission system were supplied by Australian Aid. On the other hand, the runway reagent rehabilitation program, which is used for compacting coral on the runway, and the emergency power generator was provided by the World Bank.
The Government of PNG asked for a grant aid from the Government of Japan for the immediate implementation of the development of the Tokua Airport, which is based on the JICA report "The Study on the Tokua Airport Development Project, 1991~1992".
In response to the request in January 1995 from the Government of PNG, the Government of Japan regarded it as appropriate for grant aid and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA Survey Team was sent to PNG in July 1995 to conduct the survey study. Based on the survey study, the Government of PNG and the Government of Japan exchanged a note in February 1996. After the detailed design stage, tender assistance and construction of the new airport commenced. The new airport was finally opened in March 1998.

During the construction of the runway, the existing runway was operational for F28 aircrafts and had undergone simple maintenance only, such as leveling and compacting of the runway surface. The runway length was reduced for small aircraft operations. A temporary passenger terminal was operated with basic services such as departure and arrival procedures for passengers. The existing apron was arranged to accommodate two F28 aircrafts.

Photo 3 Runway Surface only Coral compacted（August 1995）

Photo 4 Parking of F28 at Apron

Photo 5 Passenger Waiting Aircraft in front of Temporary Passenger Terminal Building

Photo 6 Panoramic View of Terminal Area from Landside（August 1995）

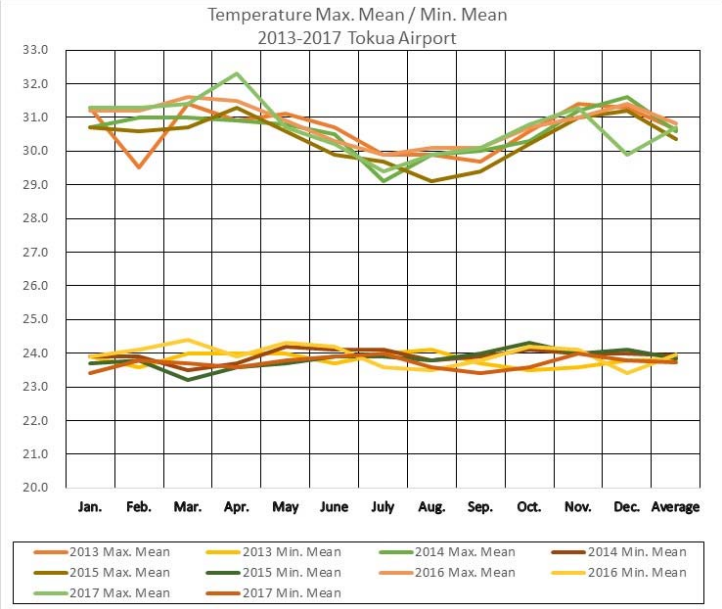
Source: JICA Survey Team

3-2 Natural Condition

3-2-1 Weather Condition

The Tokua Airport is located 152° 22.8' E, 4° 20.4' S and lies right on the equator, in the tropical rainforest climate, within the hot and humid zone. The meteorological data observed during the past five years at the airfield of the Tokua Airport showed that the minimum mean temperature was around 23 to 24 degrees, the maximum mean temperature in November to May was around 31 to 32 degrees, and the maximum mean temperature in June to October was around 29 to 31 degrees, as shown in Figure 15.

The annual rainfall during the past five years was recorded at over 2,400 mm; however, the rainfall in October to November was comparatively less than in other seasons, and there was no difference between the dry and rainy seasons. The maximum monthly rainfall recorded in January 2015 was 490 mm.



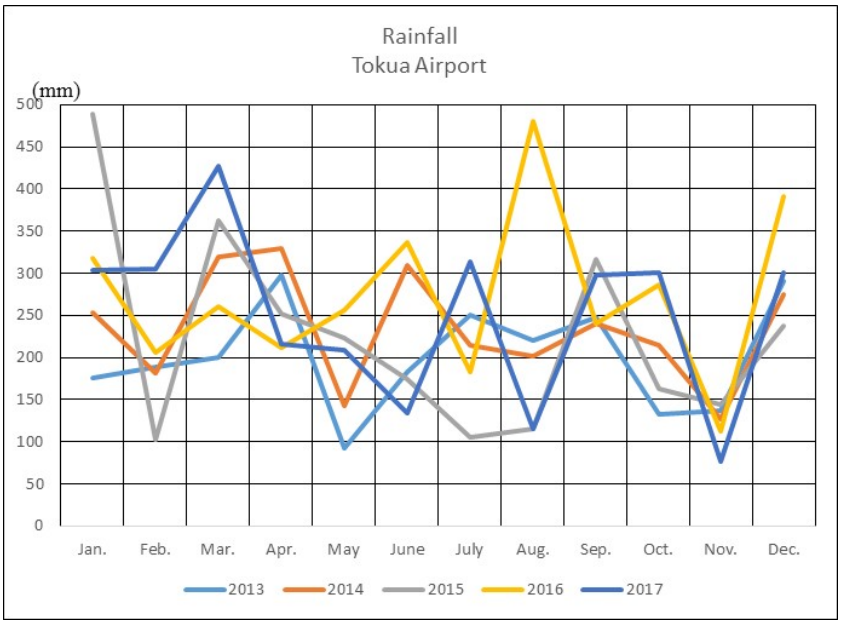
Source: Observatory at Tokua Airport

Figure 15 Temperature Max. Mean and Min. Mean (2013 - 2017)

Table 8 Monthly Rainfall at Tokua Airport

	2013	2014	2015	2016	2017
Jan.	176	254	489	318	304
Feb.	188	182	103	206	305
Mar.	200	319	363	261	427
Apr.	298	329	252	212	216
May	93	142	223	256	209
June	183	310	175	336	134
July	251	215	106	183	314
Aug.	221	201	115	481	116
Sep.	247	240	317	241	298
Oct.	133	215	163	286	301
Nov.	137	127	144	112	77
Dec.	291	275	238	391	301
Total	2418	2809	2688	3283	3002

Source: Observatory at Tokua Airport (Unit: mm)



Source: Observatory at Tokua Airport

Figure 16 Monthly Rainfall at Tokua Airport (2013 - 2017)

3-2-2 Earthquake

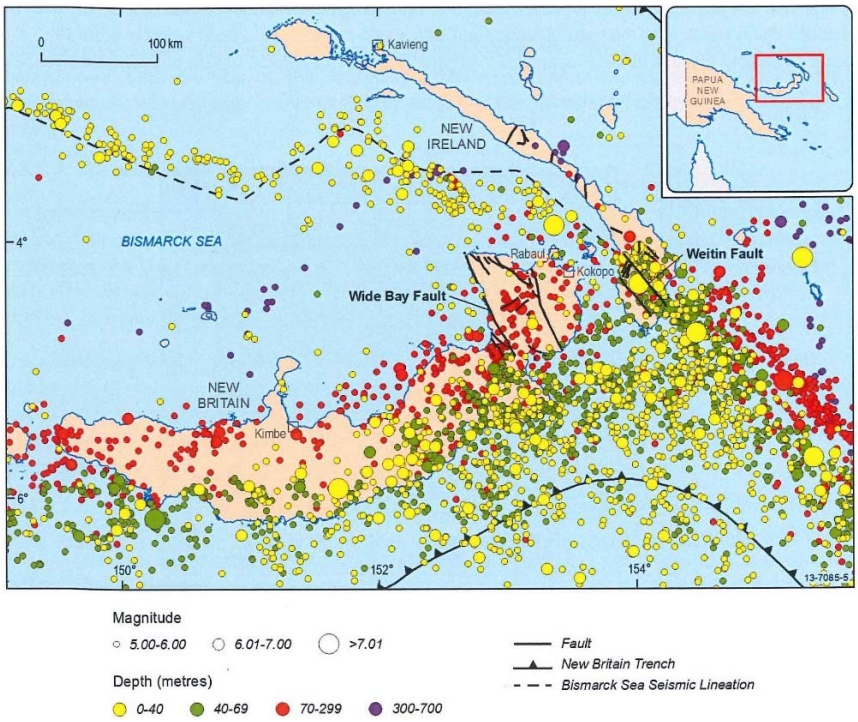
New Britain Island, the largest island in the Bismarck Archipelago of PNG, is in one of the most seismically active regions in the world, and based on the records analyzed by the National Oceanic and Atmospheric Administration (NOAA), relatively big earthquakes of over magnitude 6.0 were observed 50 times in the past 60 years as shown in Table 9. In addition, earthquakes of over magnitude 7.0 were observed 30 times after the completion of the Tokua Airport project in 1998. Furthermore, earthquakes of magnitude 7.8 to 8.0 in November 2000 had affected the structure of the control tower at the Tokua Airport, and many hairline cracks on the beams and pillars were discovered after the earthquake.

Based on the report "Integrating Hazard and Exposure for East New Britain 2013" issued by the Department of Mineral Policy and Geohazards Management, PNG shows that many earthquakes with magnitude over 5.0 were observed around the east side of New Britain Island and New Ireland, as shown in Figure 16.

Table 9 Seismicity for the Past 50 Year around East New Britain Province

Year	Month	Day	Time	Earthquake Location Name	Latitude (South)	Longitude (East)	Depth (km)	Magni -tude
1960	6	11	15:14	Solomon Sea	9.400	152.300	33	6.6
1964	11	17	08:15	New Britain	5.700	150.700	46	7.6
1967	8	13	22:15	Bismarck Sea	4.400	152.500	30	6.4
1968	2	12	5:44	New Ireland	5.500	153.200	74	7.8
1968	10	23	21:04	North Coast, Wewak, Dagua	3.400	143.300	21	7.5
1969	8	2	04:30	Bismarck Sea	6.600	146.900	17	5.4
1970	10	31	17:53	Madang	4.907	145.471	8	7.3
1971	7	14	06:11	New Ireland, Bougainville	5.500	153.900	47	7.9
1971	7	26	01:23	Bismarck Sea, Rabaul	4.900	153.200	48	7.9
1971	9	25	04:36	Bismarck Sea	6.500	146.600	115	7.0
1975	7	20	14:37	Bismarck Sea, Bougainville	6.590	155.054	49	7.9
1975	7	20	19:54	Solomon Islands, Buin, Boku	7.104	155.152	44	7.7
1977	8	28	20:10	Admiralty Islands	1.081	146.230	33	5.5
1979	6	25	05:29	East Mt. Hagen	4.980	145.577	189	6.2
1983	3	18	09:05	New Ireland	4.883	153.581	89	7.6
1983	12	22	01:02	Ulawun, Rabaul	5.392	151.868	26	6.4
1984	3	27	20:06	Karkar	4.647	145.805	28	6.6
1985	5	10	15:35	New Britain, Bialla, Piona	5.599	151.045	27	7.1
1985	7	3	04:36	New Britain Rabaul	4.439	152.828	46	7.2
1986	6	24	03:11	-	4.448	143.943	102	7.1
1987	2	8	18:35	Huon Peninsula, Umboi Island	6.088	147.689	55	7.6
1987	10	12	13:57	Solomon Sea	7.288	154.371	25	6.8
1987	10	16	20:48	New Britain, Kandrian Kimbte	6.266	149.060	48	7.7
1988	7	5	20:32	New Britain, Kandrian Arawe	5.964	148.780	53	6.8
1988	9	6	00:42	Kaiapit (Landslide Generated)	6.060	146.230	0	4.3
1989	3	10	14:14	New Britain Rabaul	4.346	152,797	53	5.4
1990	12	30	19:14	New Britain	5.097	150.967	179	7.5
1993	10	13	02:06	Eastern, Upper Markham Valley	5.889	146.020	25	6.9
1995	8	16	10:27	New Britain, Rabaul Kokopo	5.799	154.178	30	7.7
1998	7	17	08:49	Sissano	2.943	142.582	25	7.0
2000	11	16	04:54	New Ireland, Duke of York	4.001	152.327	17	8.0
2000	11	16	07:42	New Ireland, New Britain	5.233	153.102	30	7.8
2000	11	17	21:01	New Britain	5.496	151.781	33	7.8
2002	1	10	11:14	Aitape	3.212	142.427	11	6.7
2002	9	8	18:44	Kairiru Island, Muschu Island, Wewak	3.260	142.940	13	7.6
2005	9	9	07:26	New Ireland	4.539	153.474	90	7.7
2014	4	11	07:07	Bougainville Island	6.586	155.049	61	7.1
2014	4	19	13:29	Solomon Sea	6.755	155.024	43	7.5
2015	3	29	23:48	-	4.729	152.562	41	7.5
2015	5	5	01:44	-	5.462	151.875	55	7.5
2016	12	17	10:51	New Ireland, New Britain	4.509	153.450	103	7.9
2017	1	22	04:30	Bougainville Island	6.214	155.122	136	7.9
2018	2	25	17:44	South Highlands, Hela, Indonesia	6.068	142.768	23	7.5
2018	2	28	02:45	South Highlands	6.182	142.492	16	6.1
2018	3	4	19:56	South Highlands	6.307	142.620	10	6.0
2018	3	6	14:13	South Highlands, Hela	6.294	142.607	10	6.7
2018	4	7	05:48	South Highlands, Hela	5.841	142.490	10	6.3

Source: National Oceanic and Atmospheric Administration: NOAA



Source：Integrating Hazard and Exposure for East New Britain 2013, Geoscience Australian

Figure 17 Seismicity Location, Magnitude and Depth around East New Britain Province

3-2-3 Volcanic Eruption

There are many active volcanoes in the northern part of New Britain Province. Three active volcanoes, namely, Tavurvur, Vulcan, and Rabaul, located northwest of the Tokua Airport are significant for the Rabaul, Kokopo, and Tokua areas. Eruption of these volcanoes in 1937 and 1994 caused extensive damage to the former Rabaul City which was buried under volcanic ash.

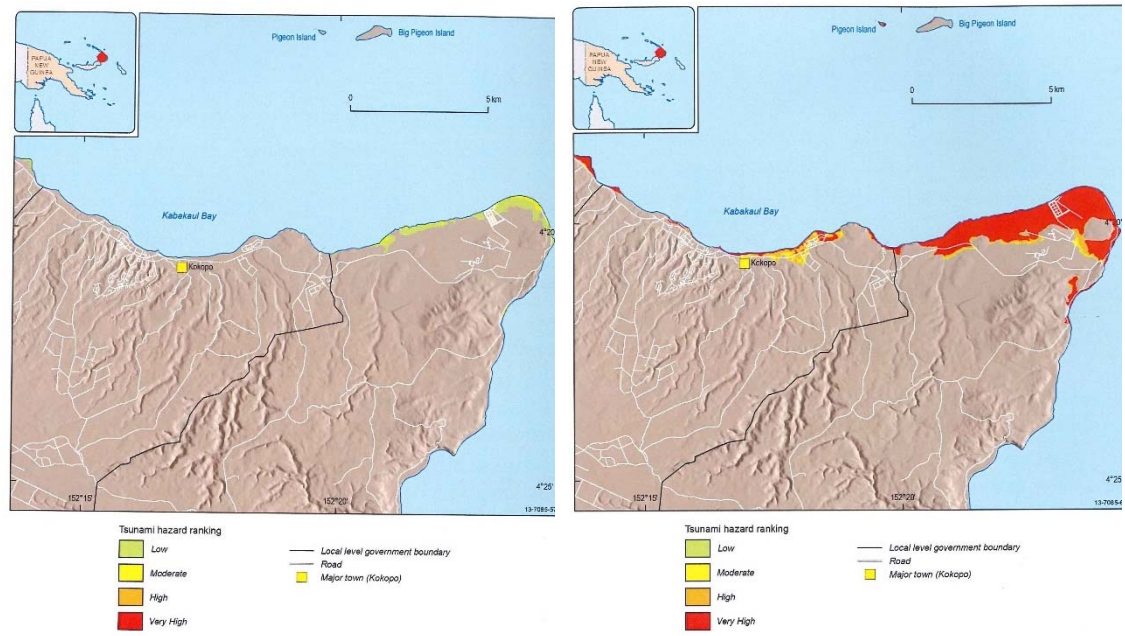
The influence of volcanic ash caused by three big volcanoes is dependent on the wind direction. In case of the northwest wind from April to September, volcanic ash will reach Tokua Airport; however, there is no effect in case of the southeast wind from October to March. The damage caused by the falling ashes affected crops, houses, roads, as well as the health of residents. Because of the recent falling ash in 2006, 2008, and 2009, the Tokua Airport was closed after the eruption; however, the thickness of falling ash was only 1 mm on the airfield, runway, taxiway, and apron.

3-2-4 Tsunami

Historically, tsunami inundation has affected East New Britain Province several times. A tsunami occurred in July 1971 which was caused by a 7.9-magnitude earthquake at Rabaul Sea and

reached Rabaul City. However, there was no casualty and damage to the Tokua Airport caused by the eruption in 1994, and the 7.9-magnitude earthquake in 1995 greatly affected Rabaul City.

Tsunami inundation for Kokopo generated by an 8.0-magnitude and 8.8-magnitude earthquake was anticipated, as shown in Figure 18. A small inundation area was predicted as a result of the 8.0-magnitude earthquake; however, in the case of the 8.8-magnitude earthquake, the inundation area with a 2-m flow depth will be covered, which is within the Tokua Airport area. It is probable that an 8.8-magnitude earthquake occurs once in a hundred years.



Appendix Figure B 2 *Anticipated tsunami inundation for Kokopo from an event generated by a magnitude 8.0 earthquake on the New Britain Trench. The level of hazard is presented as flow depth: Low (0-0.5 m) shown in green, Moderate (0.5-1 m) shown in yellow, High (1-2 m) shown in orange, Very High (>2 m) shown in red.*

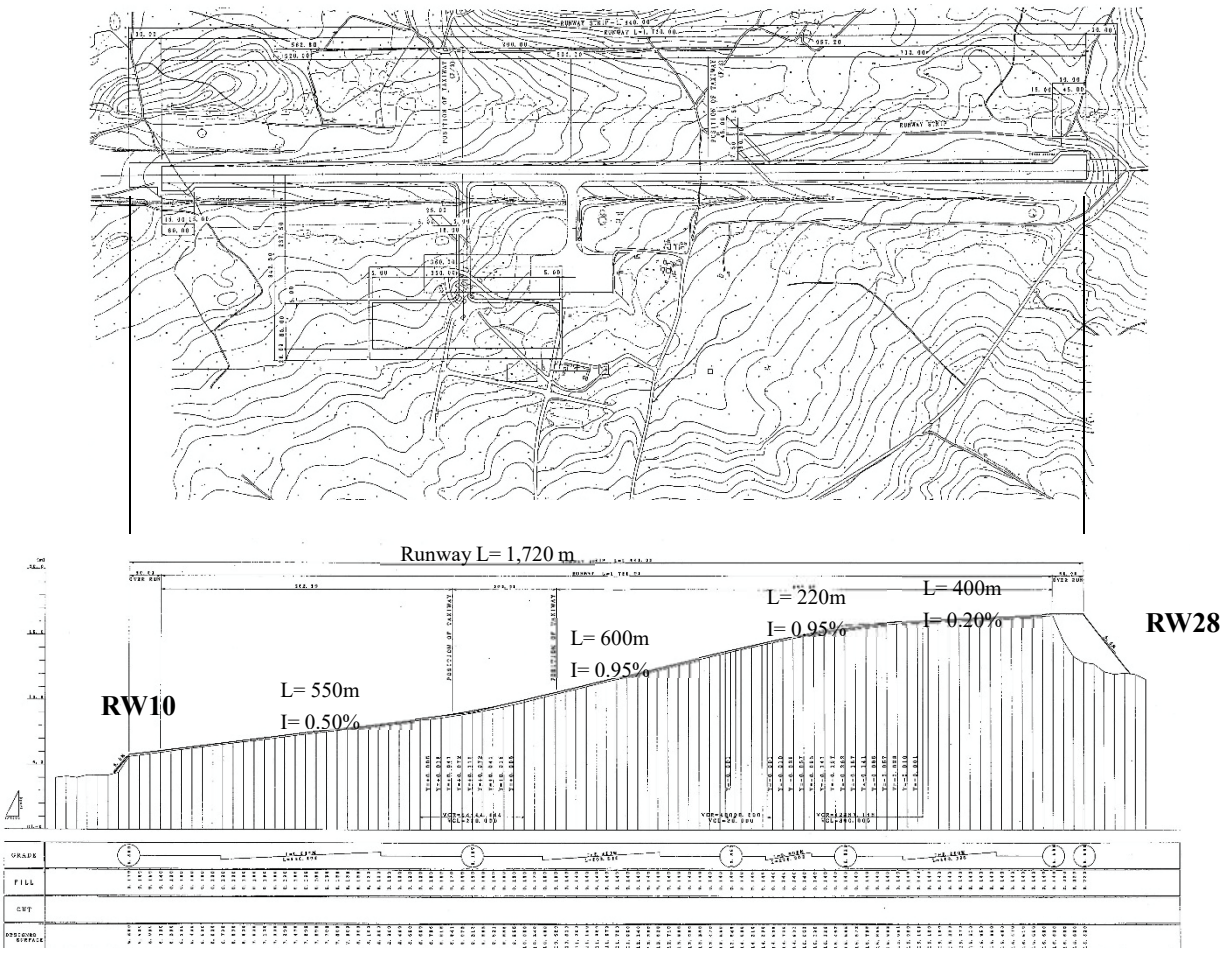
Appendix Figure B 6 *Anticipated tsunami inundation for Kokopo from an event generated by a magnitude 8.8 earthquake on the New Britain Trench. The level of hazard is presented as flow depth: Low (0-0.5 m) shown in green, Moderate (0.5-1 m) shown in yellow, High (1-2 m) shown in orange, Very High (>2 m) shown in red.*

Source: Integrating Hazard and Exposure for East New Britain 2013, Geoscience Australian

Figure 18 Anticipated Tsunami Inundation for Kokopo Generated by a Magnitude 8.6 (Left) and a Magnitude 8.8 (Right) Earthquake

3-2-5 Topography and Geology

The highest altitude of the runway is the threshold point of the east side (RW28) and gradually falls to the opposite threshold point of the west side (RW10). There are small hills located on the north side and south side of the runway. The runway profile of the Tokua Airport has a relatively steep slope of about 0.95%, which is below the maximum slope of 1.0% based on the ICAO standards.



Source: JICA Survey Team

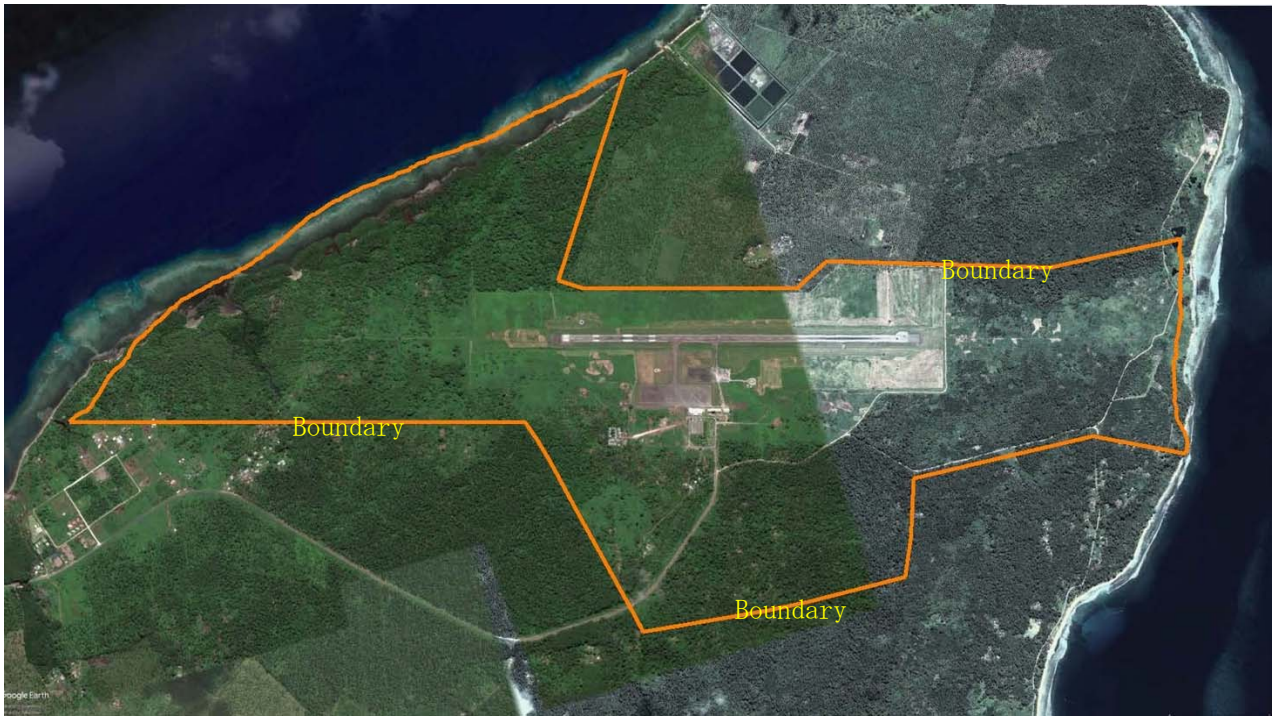
Figure 19 Runway Longitudinal Section

According to previous boring tests at the airport area in 1991, the existing airstrip is located on firm or very firm silty/clayey deposit and dense sandy deposit of volcanic origin. The field California Bearing Ratio (CBR) ranged between 6% and 14%. The N-value ranged between 30 and 50 on a depth of around 10 m from the surface; however, the N-value fell to around 10 under that layer, so it is a considerable foundation type of the building. It is expected that groundwater level exists lower than an elevation of 4 m during the dry season, so in case of runway expansion on the west side, it is required to fill over the elevation of 6 m because the existing elevation on the west side of the runway is around 4 to 5 m. On the other hand, in case of a runway expansion on the east side, it is required to fill a depth of over 5 m because of the longitudinal slope changes and the sight distance from the aircraft.

3-3 Land Use around the Airport

3-3-1 Airport Boundary

NAC has land rights over the Tokua Airport area surrounded by the boundary lines as shown in Figure 1. The boundary covers both the shoreline of the east side and the west side in order to avoid the influence of obstacles for aircrafts landing and approaching and the influence of aircraft noise, and in order to expand to a long runway in future.



Source: NAC

Figure 20 Tokua Airport Boundary

3-3-2 Land use around Airport

There is no industrial activity around the airport and well-kept natural environment, except north of the airport where coconut plantation and cacao plantation spread out.

3-4 Condition of Exist Airport Facilities

Twenty years after the opening of the new Tokua Airport in 1998, NAC did not make significant improvements for almost all facilities, except for a part of the terminal building, navigation system, or power supply system, and are always kept good condition, so the facilities discussed below are basically the same as in 1998.

3-4-1 Airside Facilities

There are many alligator cracks, which is presumed cased by structural damage, on the surface of the runway, the taxiway, the apron and the Ground Service Equipment (GSE) road and the pavement conduction is deteriorated severely. There are partial repairs, however, the repair was temporary work and the repair condition is bad. As aggregates has started segregated, it is necessary to repair the pavement urgently to secure safe aircraft operations. The present conditions of the airside facilities are summarized in the table 10.

Table 10 Present Condition of Runway, Landing Strip, Taxiway, Apron, GSE facility

Facilities	Scale	Area (m^2)	Construction Item	Existing Condition
1.1 Runway	Length: 1,720 m Width: 30 m	53,175	Asphalt Pavement Surface 4cm, Binder 4cm Leveling 4cm	Many cracks on surface and surface layer comes off at touch down point
1.2 Overrun	Length: 60 m Width: 30 m	3,600	Asphalt pavement and Bituminous surfacing (chip seal)	Many cracks on surface and surface layer comes off
1.3 Shoulder	Width: 7.5 m	27,356	Bituminous surfacing (chip seal)	Bituminous fell out and changed only aggregate
1.4 Runway Marking		1 lot	Runway centerline, runway side strip, fixed distance, touchdown zone, designation, runway threshold, runway middle, overrun	Many cracks on marking & unclear color
1.5 Landing Strip	Length: 1,840m Width: 150 m			Well maintained grass cutting
2.1 Taxiway	Length: 222.5 m Width: 15 m	4,111	Asphalt pavement	Many cracks on surface, surface layer come off
2.2 Shoulder	Width: 7.5 m	2,614	Bituminous surfacing (chip seal)	Bituminous fell out and changed to aggregate
2.3 Taxiway Marking		1 lot	Taxiway centerline, taxiway side strip, taxiway holding position	Many cracks on marking and unclear color
3.1 Apron	Length: 85 m Width: 350 m	29,750	Asphalt pavement F28: 3 spots, DH6: 2 spots, GA: 8 spots, Helicopter: 4spot	Many cracks on surface and layer come off
3.2 Shoulder	Width: 5 m	2,275	Bituminous surfacing (chip seal)	Bituminous fell out and changed to aggregate
3.3 Apron Marking		1 lot	Obligation of PNG government and airlines	Many cracks on marking and unclear color
3.4 GSE road	Length: 360 m Width: 20 m	7,200	Bituminous surfacing (chip seal)	Bituminous fell out and changed to aggregate

Photo 7 Repair of Runway Pavement (1)

Photo 8 Repair of Runway Pavement (2)

Photo 9 Condition of Runway Pavement (1)

Photo 10 Condition of Runway Pavement (2)

3-4-2 Passenger Terminal Building

The passenger terminal building was designed for 70 seater aircraft, Fokker 28 (F28) and the current passenger handling capacity is not sufficient to accommodate multi flights of 100 seater aircraft such as Fokker 100 (F100). The passenger terminal building had rehabilitated by the budget of ENB Government. Re-paint, replace of lumps and installation of the air conditions were carried out and the maintenance condition is good. But deterioration of the roof and outside walls are severe and there are water leaks in some places. The existing conditions of the passenger terminal building is shown in the table 11.

Table 11 Present Condition of Passenger Terminal Facility

Facilities	Scale	Area (m^2)	Construction Item	Existing Condition
Passenger Terminal	Length: 56 m Width: 22.5 m	1,300		
Check-in Counter		35.00	Check-in space for four airlines	Using
Check-in Lobby		105.00	Check-in space for four 4 airlines	Using
Departure Lobby		210.00	Waiting space for passengers	Using, leaking, change ceiling with air-con
Arrival Lobby		60.00	Waiting space for passengers	Using, leaking, change ceiling with air-con
Restaurant		69.80	Snack and kiosk	Using
Baggage Storage		26.30	Holding baggage space	Using
Airline office		140.30	Office for four airlines	Using/ Air Niugini, PNG Air, PNG Cargo
Information Counter		19.50	Reservation hotel, taxi and rental car	Using
Toilet (1)		10.20	For VIP, airline, and management staff	Using
Kitchen		6.00	For airline and management staff	Using
Toilet (2)		10.20	For VIP, airline, and management staff	Using
VIP room		37.50	Waiting for VIP	Using
Administration Office		52.20	7 management staff for airport	Using
Police Office		12.30	Police room for airport	Using
Holding Lounge		232.50	Waiting space for passengers	Using, leaking, change ceiling with air-con
Toilet (3)		14.00	For passenger	Using
Toilet (4)		14.00	For passenger	Using
Toilet (5)		14.00	For passenger	Using
Toilet (6)		14.00	For passenger	Using
Baggage Claim		180.00	For passenger	Using
Corridor/Others		37.70		Using
Baggage Handling (Arr.)		-		Using as both passenger and cargo
Baggage Handling (Dep.)		-		Using
Pedestrian Way				Using

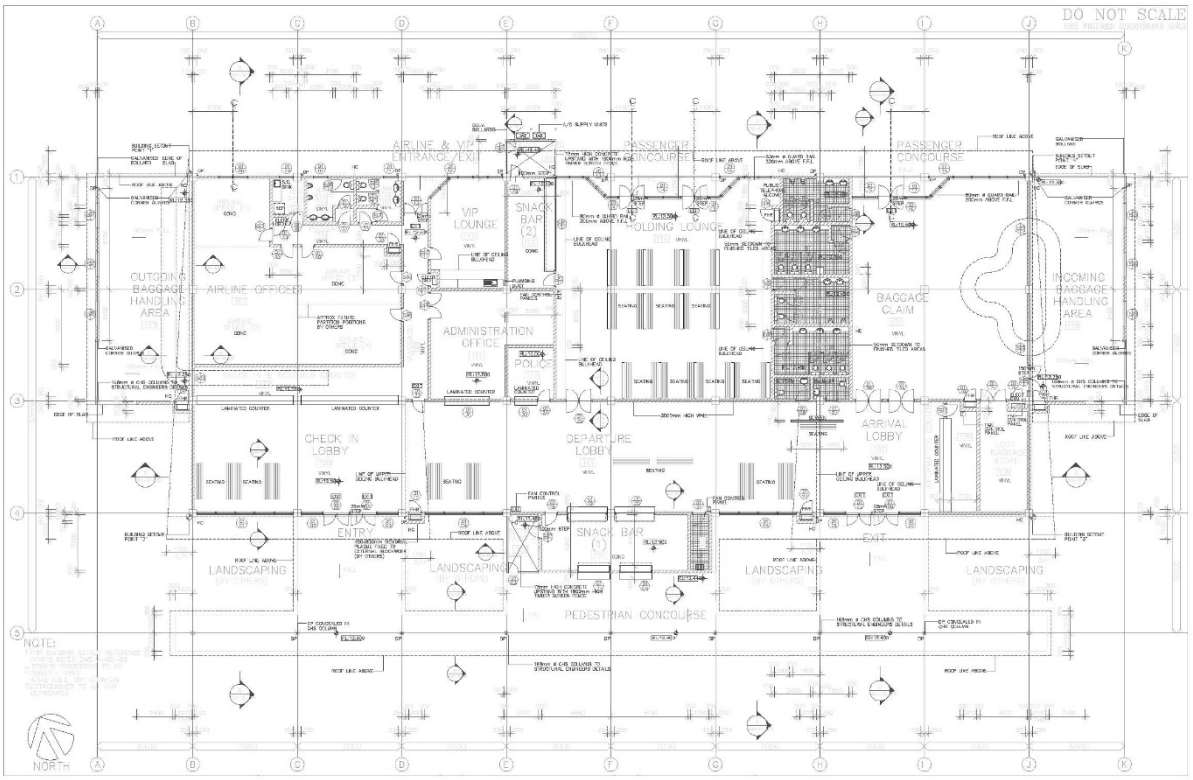


Figure 21 Passenger Terminal Building Plan

Photo 11 Exterior of Passenger Terminal

Photo 12 Interior of Passenger Terminal

3-4-3 Cargo Handling Facility

There is no cargo handling facility in Tokua Airport. Cargo handling is carried out at western side of the passenger terminal building.

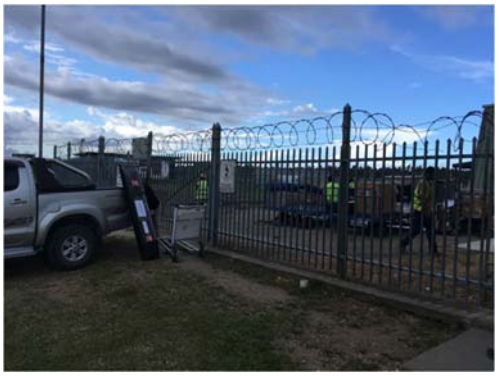


Photo 13 Cargo Handling (1)

Photo 14 Cargo Handling（2）

3-4-4 Control Tower and Administration Office

There are cracks on the columns and the beams in the control tower and administration office. According to a structural analysis report[5] from the Australian Consultant, which was contracted by PNG Air Services, the life of the building was estimated as 5 years and structural reinforcement or re-construction was recommended.

Table 12 Present Condition of Control Tower and Administration Office

Facilities	Scale	Area (m^2)	Construction Item	Existing Condition
Administrative office and Control Tower	Length 65m Width10.5m	780		
1F Meeting Room		63.00	For meeting 50 persons	Using, leaking
Manager Room		27.00	For meeting	Using, leaking
Assistant Manager & Guest Room		20.30	For meeting	Using, leaking
Staff Room		72.00	Office work space (10 persons)	Using, goods storage
Rest Room		20.00	Rest and night stay	Using
Toilet (M)		12.00	For staff	Using
Kitchen		5.00	For staff	Using
Toilet (F)		7.50	For staff	Using
AFTN and Meteorological Room		71.50	For meteorological data and flight planning space	Using only for meteorological staff and goods storage
Maintenance Room		45.00	For repairing equipment space	Using
Power room		204.80	Low voltage transformer and power board space	Using
D.E.G. Room		47.3	Emergency diesel engine generator	No use, engine failure

[5] Tokua Airport Control Tower Structural Desktop Assessment Report by Cardno in August 2018

Staircase, Corridor		34.60		Using
2F Equipment Room		25.00	For repairing equipment	Using
Staircase		12.50		Using
3F Equipment Room		25.00	Related flight communication equipment space	Using
Staircase		12.50		Using
4F Rest Room		25.00	Rest area for controller	Using
Staircase		12.50		Using
5F Control Cabin		37.80	Flight control space (3 persons)	Using, remarkable leaking, steel fence rusted

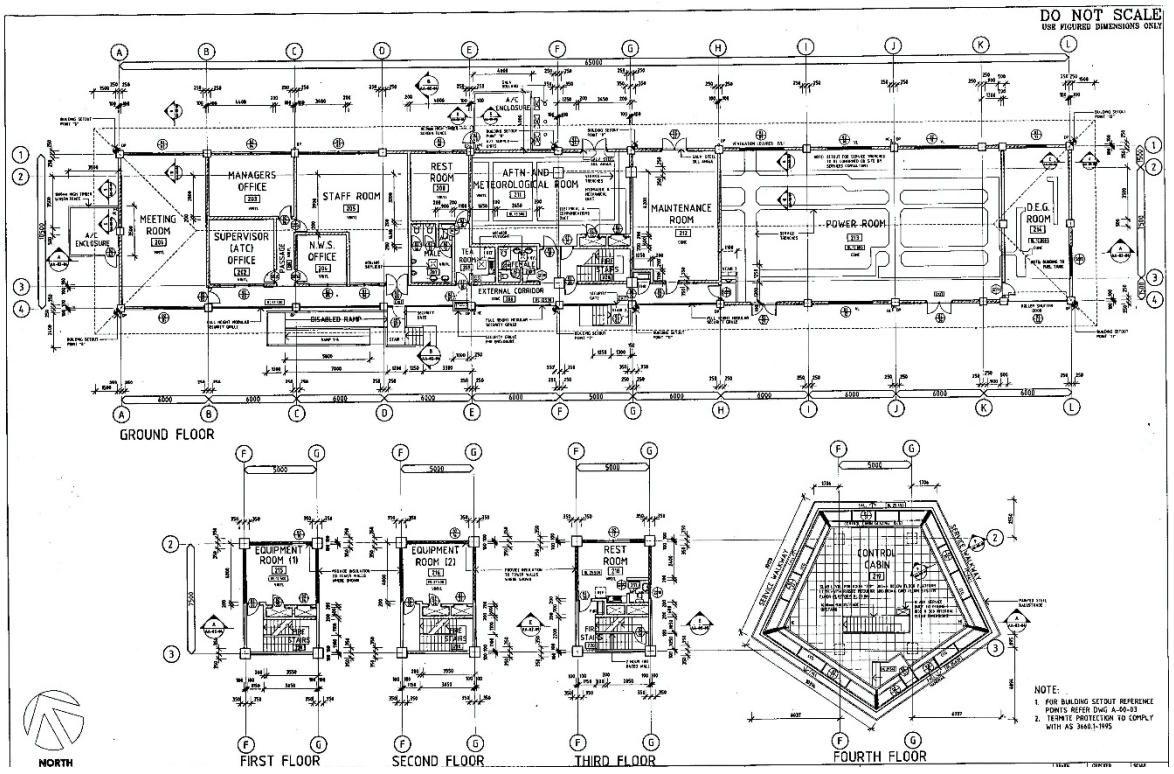


Figure 22 Control Tower and Administration Office Plan

Photo 15 Control Tower and Administration Office

Photo 16 Rusted Steel fence

Photo 17 Remarkable Leaking in Control Cabin

Photo 18 Cracks on pillar and Beam

3-4-5 C.F.R Workshop Building

The entrance of the C.F.R Workshop Building was lower than the height of the fire fighting vehicles procured by CADIP in 2015. The entrance of was renovated to accommodate 2 larges size fire fighting vehicles together with renovation of the roofs.

Table 13 Present Condition of C.F.R Workshop Building

Facilities	Scale	Area (m^2)	Construction Item	Exist Condition
C.F.R Workshop	Length 24 m Width16.8 m	462		
1F Garage Maintenance Bay		237.80	Garage for a fire engine and equipment repairing space	Using beams improved
Office		19.20	General administration space	Using
Workshop		53.60	Equipment repairing space	Using
Tool storage		44.10	Rescue goods、Tool box	Using
Battery Charger Room		11.30	Related battery charging space	Using

Toilet・Shower Room		9.60	For staffs	Using
Locker Room		7.70	For staffs	Using
Kitchen		9.60	For staffs	Using
Staircase		10.30		Using
2F Watching Room		19.20	Watching runway condition	Using
Lecture and Training Room		29.50	For staffs	Using
Staircase		10.30		Using

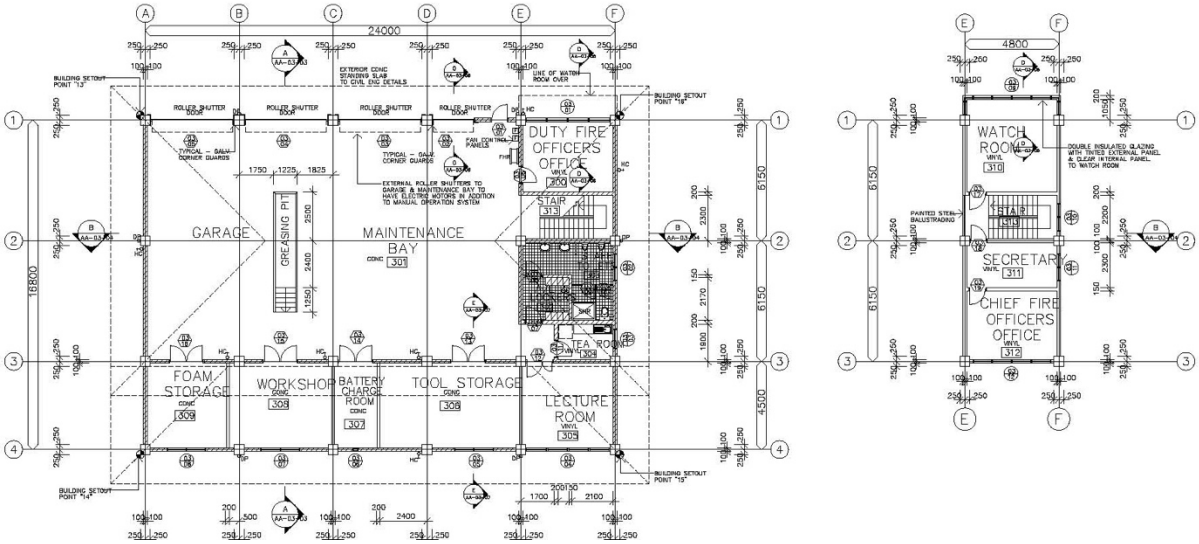


Figure 23 C.F.R Workshop Plan

Photo 19 Exterior of Airside

Photo 20 Interior Wall & Ceiling

3-4-6 Navigation Aids

There are VHF Omnidirectional Range/Distance Measuring Equipment (VOR/DME), which was installed by the Japanese Grant Aid, at top of the hill at the eastern side of the airport. The VOR/DME had stop operation since 2017 and it is not maintained PNG Air Services planned to move to the new satellite base air navigation system from the conventional air navigation system.

Because there are VOR/DMEs in Kavieng and Nadzab near Tokua Airport. It was decided not to use the VOR/DME at Tokua Airport.

Table 14 Present Condition of Navigation Aids

Facilities	Scale	Quantity	Construction Item	Existing Condition
Navigation (1) VOR/DME		1 lot	VOR: 111.95-117.97Hz, 100W DME: 962-1212MHz Power Supply / UPS	Stop radio waves No maintenance
(2) Communication Console	1) Tower 2) AFTN	1 lot 1 lot	3 consoles for aerodrome, ground and coordinator 3 consoles for AFTN	Using
(3) ATC Tape Recorder		1 lot	Magnetic Head 10ch	No use
(4) VHF Transmitter and Receiver	1) TWR	1 lot	Communications between ATC and Pilots, 120.9 MHz	Using
	2) Transmitter and Receiver	1 lot	Emergency communication from aircraft, 121.5MHz	Using
	3) Power Supply	1 lot	Power supply / UPS	Using
(5) HF AFS SSB		1 lot	Buck-up system for PTC 2.8MHz～22MHz	Using
(6) VHF FM	Fixed Walkie-Talkie	2 lot 5 lot	Communications between ATC, fire trucks, and other car 145-150 MHz	Using
Meteorology				
(1) Surface Weather Observatory System	Computer Processing	1 lot	Wind speed and direction, temperature, barometer	No use System renewal
(2) Auto Weather Station	Analog Read	1 lot	Temperature, hygrometer, Rainfall Gauge	Using
(3) Weather Satellite	GMC Receive	1 lot	Parabola antenna, WX satellite receiver, image printer	Using

Photo 21 Stop Radio Waves of VOR/DME

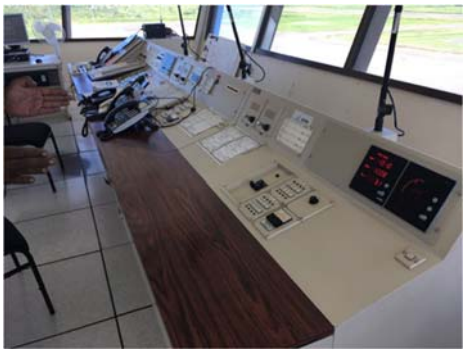


Photo 22 AFTN Console

3-4-7 Airfield Lightings System

The control and monitoring panel in the control cabin in the control tower, it is not possible to switch on and off the airfield lighting system from the control cabin. The control and monitoring panel in the electrical rooms on the ground floor is used to control the airfield lighting system. The conditions of the lamps are good and maintained without operational problem.

Table 15 Present Condition of Airfield Lightings System

Facilities	Scale	Quantity	Construction Item	Existing Condition
Lightings		1 lot		
(1) Runway Edge (REDL)	High Intensity	54 set 24 set 6 set	Above-surface type, 150W Buried type, 185W Turning pad portion / above surface type, 45W (both RW)	Using
(2) Runway Threshold (RENL/RTHL)	High Intensity	4 set 12 set	Above-surface type, 200W Buried type, 200W	Using
(3) Taxiway Edge (TEDL)		26 set	Above-surface type, 45W	Using
(4) Runway End Indicator (REIL)		4 set	2 Flashings x 2	Using
(5) Wind Direction Indicator (WDIL)		2 set	Both sides RWY28/10 ends	Using
(6) Aerodrome Beacon (ABN)		2 set	On ATC Tower top, 1000W	Using
(7) Apron Flood Light (FLO)		2 set	On Terminal Bldg. roof , 1000W x 2	Using
(8) Lights Control Panel / Power Supply	1) Lights Control	1 lot	Console in ATC room 5F Console in Power room 1F	No use Using
	2) Power Supply	1 lot	CCR 30KVA x 2、5KVA x 2、3.5KVA x 2	Using
(9) Light Gun		1 set	In ATC room, 100W	Using
Power Supply				
(1) Commercial Power Receiving Station		1 set	Convert 22KV to 11KV and 450V	Using
(2) Generator System		1 set	Provide fuel tank capable to run 48hrs, 415V 3 ϕ , 350KVA、	No use, Engine failure
(3) Aerodrome Power Line		1 set	11K and 415KV underground	Using

Photo 23 Failed Lights Control Panel in ATC

Photo 24 Lights Control Panel in power room 1F

3-4-8 Other Airport Facilities

Water is supplied from a well at the western side of the apron and a pump is used to provide water to the terminal area. Since there are only one set of well and pump, there is no backup during maintenance and out of service time. Sewage treatment system is located at the western side of the terminal area. There was a backup generator, which was installed by the Japanese Grant Aid but the generator was broken when there was long power cut in the airport because it was used continuously about a month. A movable simply backup generator is used to supply power during black out, the capacity of the generator is not sufficient to supply all facilities in the terminal area. Condition of the exhaust emission is bad and it makes wall of the building dirty.

Table 16 Present Condition of Other Airport Facilities

Facilities	Scale	Quantity	Construction Item	Exist Condition
Water Supply System		1 lot	Pump up type of well	Using, No maintenance
Waste Water Treatment System		1 lot	Infiltrate type	Using, No maintenance
Mobile Generator		1 set	ADB Aids	Using Inadequate power not to cover main area Wall of administration office changed to black by exhaust gas
Parking		1 lot	Bituminous surfacing (chip seal)	Bituminous fell out & changed to aggregate

Photo 25 Generator Renewal

3-5 Public Transport and Airport Access

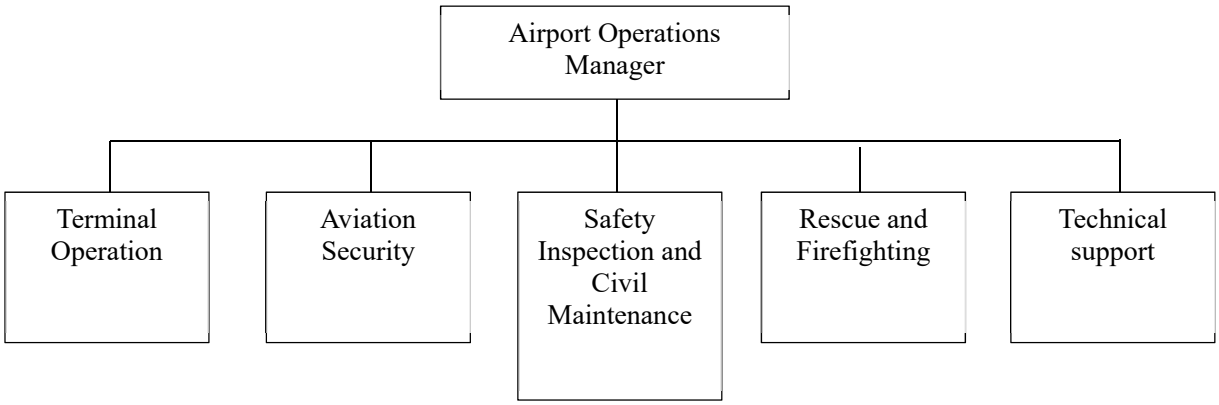
The distance between the Tokua Airport and the nearest town of Kokopo is 14 km connected by one main road with 7-m width. The road was paved with bituminous surfacing (chip seal); however, many potholes were observed on the road, and the provincial government conducts repair continuously. Almost all air passengers use a shuttle bus provided by hotels or a private car owned by passengers, although local residents usually use public bus.

Source：Bing Maps

Figure 24 Access Road between Kokopo and Tokua Airport

3-6 Tokua Airport Organization

Organization structure for operation and maintenance is shown in the figure 25.



Source: NAC Tokua Airport

Figure 25 Organization Chart of Tokua Airport

3-7 Current Development Plan of Tokua Airport

3-7-1 Renovation by ENB Government

The passenger building of Tokua Airport has been renovated on the governmental budget of ENB since 2017. The renovation includes recoating of the interior, renovation of the electric facilities, the check-in counter and repairing of baggage carousel. The budget for this renovation is 1.3 million kina.

3-7-2 Tokua Airport Master Plan 2009-2030

"Tokua Airport Master Plan 2009-2030" was developed as a part of long-term development plan of Nadzab Airport, Mount Hagen Airport and Tokua Airport by Civil Aviation Authority (CAA) in 2009 when National Airports Strategic Management Plan was formulated. CCA is in charge of the management of those airports. Tokua Airport Master Plan was developed by the method of planning dynamic and strategic future situation of the airport, though master plans are normally developed referring facility scale calculated based on demand forecast. This method was applied because of three reasons. As demand forecast can reflect only limited information, the number of annual passengers counted by demand forecast tend to become inconsistent with the actual number. Facility scale calculated from the number of passengers at the peak time has limited consistency with the number of annual passengers calculated from demand forecast. Dynamic and strategic plan is flexible enough to reflect fundamental socio-economical changes which can happen in the future. Consequently this master plan is considered as more flexible than the conventional ones and allows long-term and maximum utilization of the infrastructures in the airport.

This masterplan formulates short and long term development concepts which satisfy demands for airport and commercial sector development, and requirements for environment. In addition to planning activities, it also includes specification of risks and opportunities, development of airport development plan targeting areas around the airport, priority clarification of the proposed development plans and dictation of bird hazard on the flight pass and other kinds of hazards.

Demand forecast is prepared for five types of scenarios. The number of expected annual passengers of 2013 has big gaps among each scenario. For example, the smallest forecast prospects 338.4 thousands passengers and the largest one prospects 1.1288 million passengers. In this master plan facility scale was calculated based on the scenario which expects 638 thousands of annual passengers in 2030.

According to the classified priorities of the airport development plans, extension of runway to 45 meter width and passenger building is prioritized and to be completed by 2020. Other plans are followed, such as extension of runway to 2,350 meter length by 2030, extension of passenger building accepting 500 thousands of passengers including international flights, and construction of new parallel induction path.

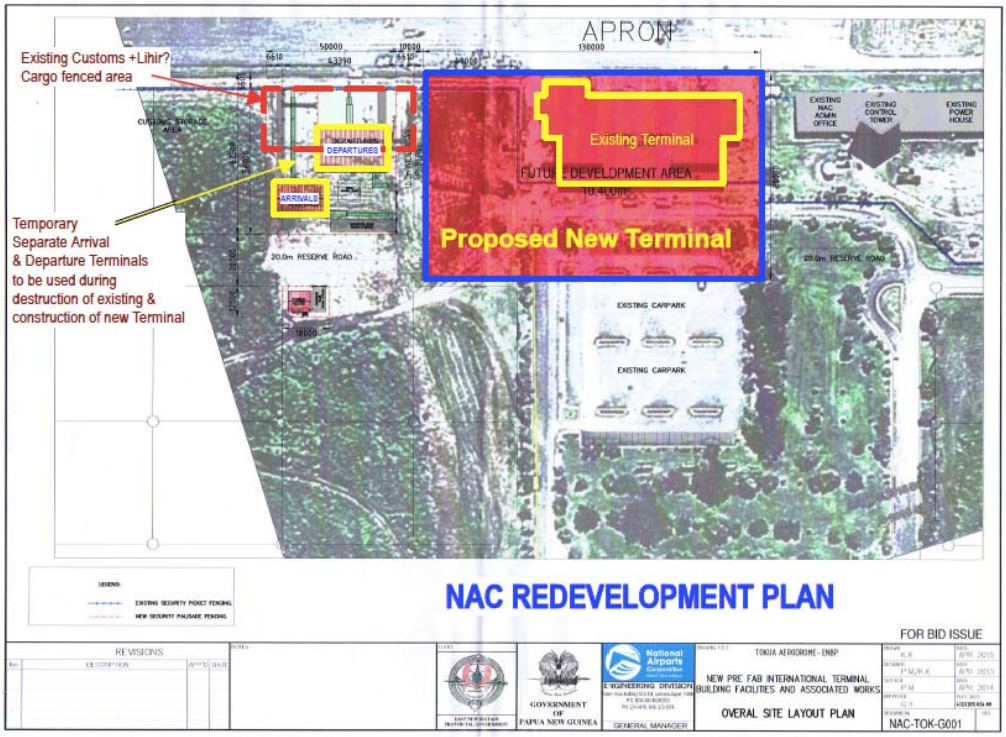
In the terminal area development, areas around existing passenger building are planned to be targeted.

Source: Airport Master Plan 2009-2030

Figure 26 Tokua Airport Master Plan 2030

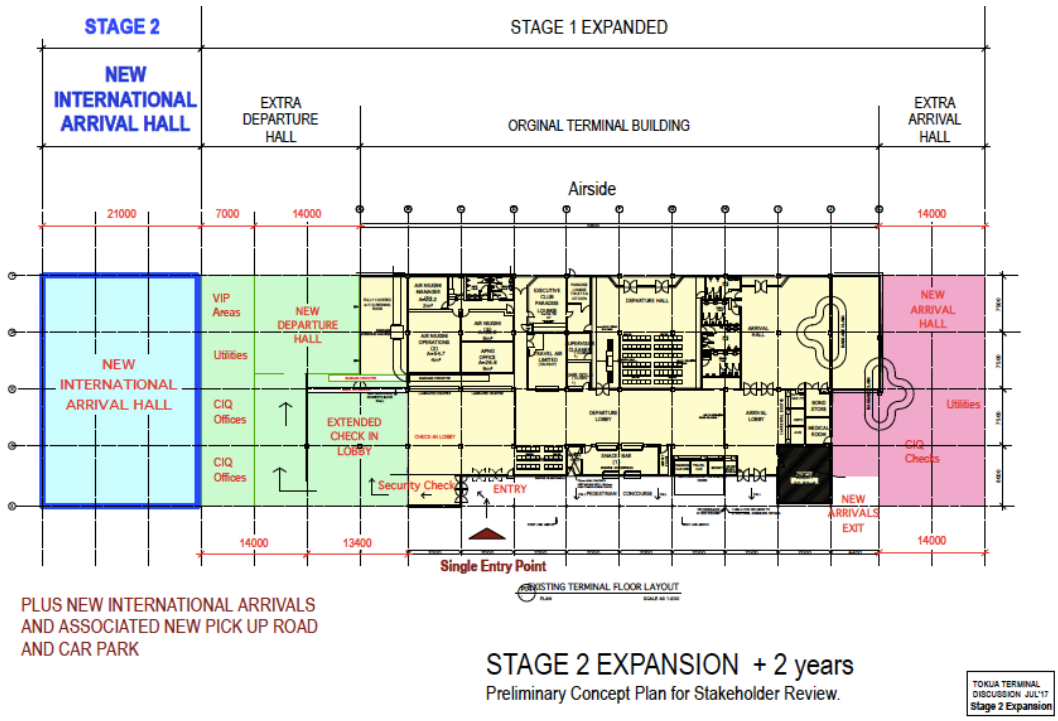
3-7-3 Expansion Plan by NAC

NAC formulated an expansion plan of the current terminal area by the local consultant in July 2017. NAC has planned to construct temporally passenger building in the western part of the existing terminal area, and construct new terminal building after removal of the old one. NAC has planned 50 million kina for the budget. This is the plan to expand existing building. The first stage of the plan includes extension of current passenger building at the eastern side for arrival area and western side for departure area. At the second stage, internal arrival area located at the west is planned to be expanded. The plan also includes extension of the second floor for passengers' café at the center, NAC office at east and offices of airlines at west. 3.5 million kina is quoted for implementation of the plan.



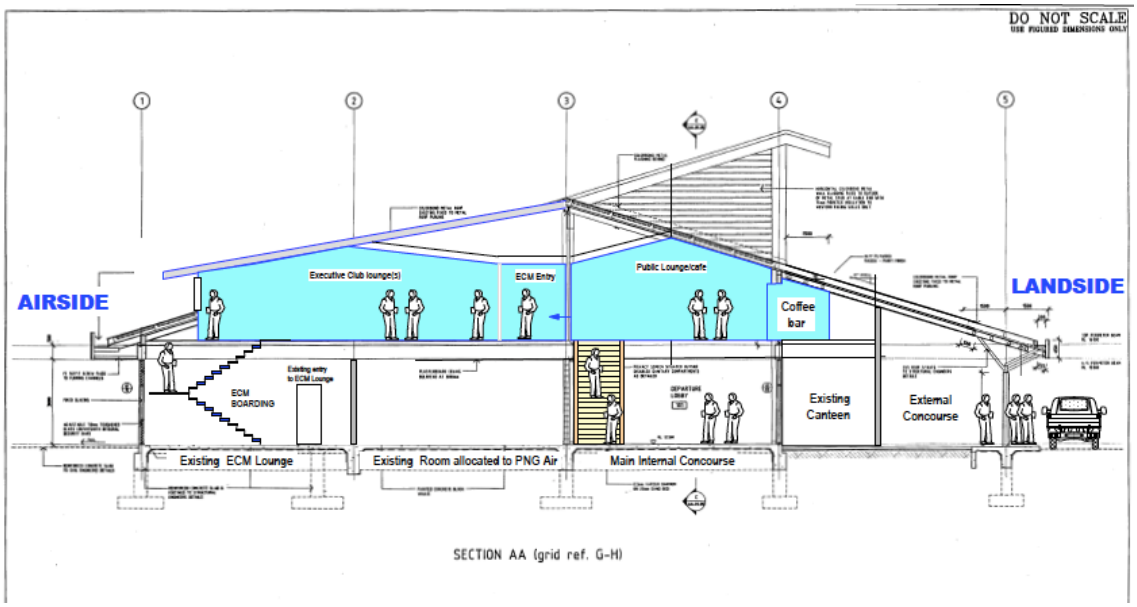
Source: NAC

Figure 27 Floor plan of Tokua Airport Development by NAC



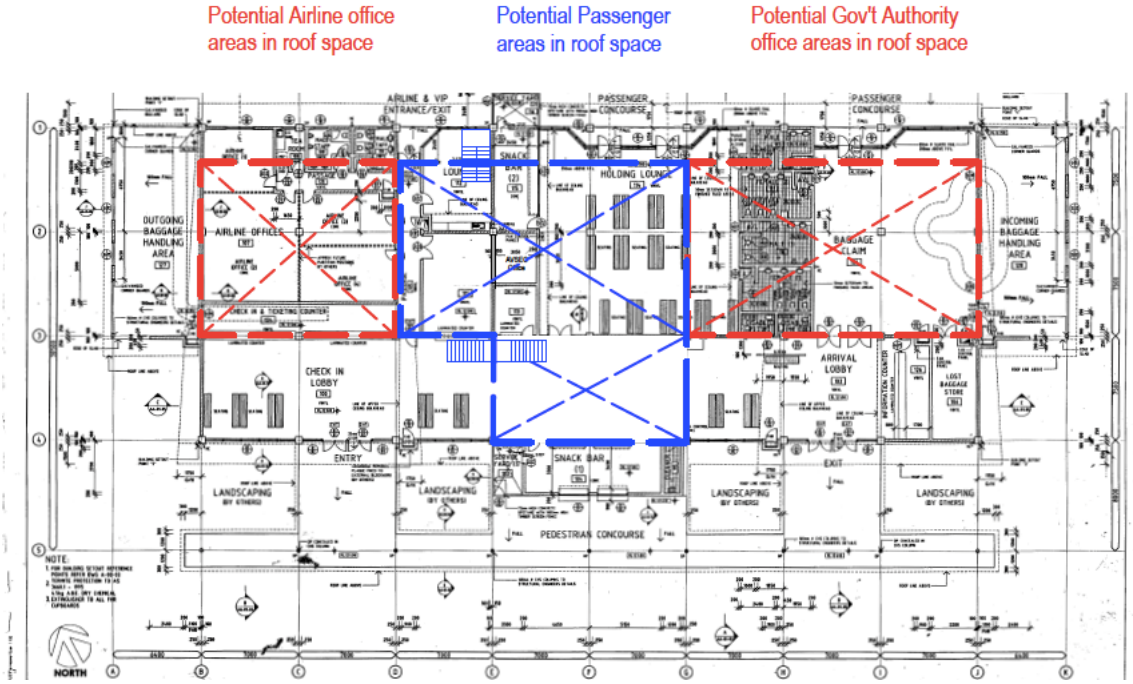
Source: Tokua Terminal Discussion July 2017

Figure 28 Extension Plan of Current Building (Ground Floor)



Source: Tokua Terminal Discussion July 2017

Figure 29 Extension Plan of Current Building (Cross Section)



Source: Tokua Terminal Discussion July 2017

Figure 30 Extension Plan of Current Building (First Floor))

Chapter4 Support from Other Donors

4-1 Support from ADB

4-1-1 Outline of CADIP

In PNG ADB provides support to twenty two major airports through CADIP which renovate airport facilities in order to satisfy safety standards decided by ICAO and upgrade the facilities to the international level. The Phase 1 of CADIP has been implemented and the Phase 2 is under consideration.

The Phase 1 of CADIP is divided into three Tranches. Total budget of Phase 1 is 478 million US dollar. This budget is allocated 113 million US dollar for Tranche 130 million US dollar for Tranche 2 and 248 million US dollar for Tranche 3. Scopes of each Tranche are listed in Table 17.

Table 17 Scope of CADIP Phase 1

Airport	Tranche 1	Tranche 2	Tranche 3
Port Moresby Airport	Expansion of domestic Apron, ILS		
Mount Hagen Airport	New Terminal Building	Procurement of Fire Truck	Pavement Rehabilitation
Hoskins Airport	Pavement Renovation, Fence, PAPI, Extension of Terminal Building		
Kavieng Airport	Fence		Extension of Runway
Gurney Airport	Fence		Extension of Runway
Wewak Airport	Fence		Extension of Runway
Goroka Airport	Fence	Pavement Rehabilitation, Extension of Runway, Procurement of Fire Truck, New Passenger Building	
Vanimo Airport		Pavement Rehabilitation, Fence	Extension of Runway
Popondetta Airport (Girua)		Pavement Rehabilitation, Fence, New Terminal Building	
Chimbu Airport		Pavement Renovation, Fence	
Tari Airport		Fence	Fence
Buka Airport		Fence	
Momote Airport		Fence	Pavement Rehabilitation
Tokua Airport		Fence, Procurement of Fire Truck, Generator for Emergency	
Nadzab Airport		Procurement of Fire Truck Generator for Emergency	

Madang Airport		Procurement of Fire Truck	Pavement Rehabilitation
Mendi Airport			Pavement Rehabilitation
Kiunga Airport			Fence
Kerema Airport			Fence

*Although Kieta Airport, Wapenamanda Airport and Daru Airport are not included in the scope of CADIP Phase 1, runway rehabilitation work at these airports is planned in following phase of CADIP.

New Passenger Buildings were constructed in Mount Hagen Airport and Goroka Airport. The contractors were Chinese state-owned enterprises and expended 40 million kina for Mount Hagen Airport and 95 million kina for Goroka Airport.

Source: NAC

Photo 26 Passenger Building of Mount Hagen Airport

Source: NAC

Figure 31 Passenger Building Perspective of Goroka Airport

Development of Tokua Airport is included in the CADIP Phase 1 Tranch 2. Outlines of the Phase 2 has been under discussion and not decided yet.

4-1-2 Development of Kokua Airport

Development of Tokua Airport through ADB CADIP Phase 1 is separated into three packages. First package includes supply of large-sized fire trunks and firefighting equipment targeting Tokua Airport and another one (Nadzab Airport). The activities in the package has already completed. Second package includes renovation of power facilities and the third package includes renovation of field fence and runway. The contract of both packages was completed in November 2018 when this filed survey was conducted. Construction of field fence and runway has been started partly. Repairing of power facilities, however, has not been started yet as the kick off meeting is not curried out.

Scope of the development is listed in the table 18.

Table 18 Development of Kokua Airport by ADB CADIP

	Contents	Progress
Support to Fire control and Salvage	Procurement of Two Large-Sized Fire Trunks Mock-up of Training F100 Plane	Completed in 2015
Renovation of Power Facilities	Development of Generator and Power Station Renovation of Navigation Lighting System Development of Facilities for Firefighting	Contracted, but Construction not Started
Renovation of Field Fence and Runway	Construction of Field Fence Renovation of Runway Pavement Construction of Field Engineers' Office and Workshop Construction of Airport Market and Pubic Toilet	Contracted, but Construction not Started

4-1-3 Repairing of Power Facilities

(1) Development of Generator and Power Station

Repairing power facilities in Tokua Airport is included in the same package of repairing power facilities in Nadzab Airport. Tender documents directed that capacity of generator in Tokua Airport is to be about 300 KVA and arranged of dual machines. However the details depend on consideration of the contractor and have not been decided yet. Power station is planned to be constructed in the free space which is located at the opposite side of current control tower building and at the south side across the road. The station will have space for three generators, power distribution panel and Constant Current Regulator (CCR) for air field lighting. The station will have roof of steel-frame and wall of masonry.

(2) Renovation of Navigation Lighting System

Renovation of the navigation lighting system includes replacement of all the existing CCR and arrangement of control panel. Control panel with touch screen will be replaced of the existing panels which is out of order in the control tower. Lighted wind direction indicator will also be arranged at the north-eastern side of the apron. Control panels are planned to be installed in the control tower and power station.

Generates, CCR, power distribution panels are planned to be arranged in the newly constructed power station after removal of the used ones. After removal of the used ones the rooms will be utilized for some purpose though it has not been decided.

(3) Development of Firefighting Facilities

Firefighting facilities are planned to be established for fire fighters by utilizing mock-up of airplane at the western side of the current terminal building. As the mock-up has already procured with fire trucks since 2015, only development of the pavement and drainage is included in the scope of this project.

4-1-4 Construction of Field Fence and Runway

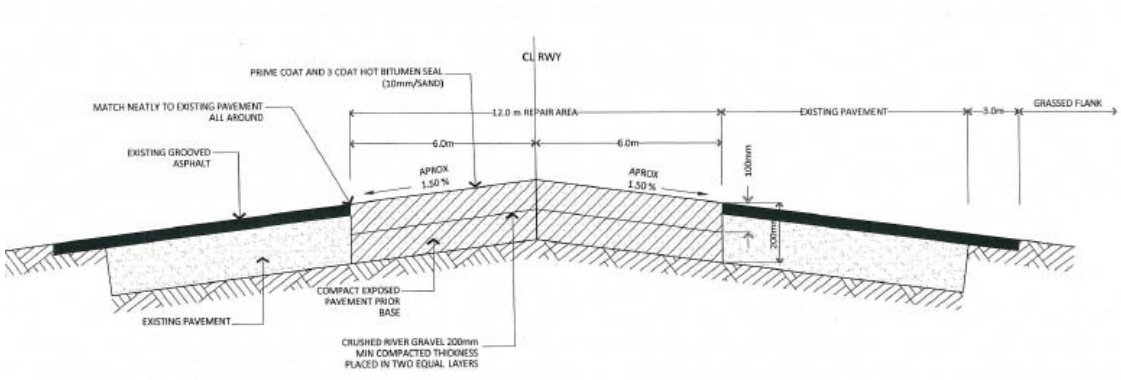
(1) Construction of Field Fence

Filed fences will be replaced of all the existing ones but extended part of runway threshold 10 (eastern are of the airport). Regarding the extended part of runway termination 10 new fences will be constructed at 200 meter west from the existing runway.

(2) Rehabilitation of Runway Pavement

Runway pavement is planned to be renovated. Renovated area will be 1520 meter length and 12 meter width and cover all the area of the pavement 100 meter inside from the termination. The pavement will be structured of pebble tamped 200 millimeters and three layers of tip seal on the pebble.

Pavement structure is specified in the figure 32.



Source: NAC

Figure 32 Renovation Plan of Runway Pavement of Tokua Airport

(3) Construction of Residential Houses for Airport Staff

As residential houses for the security officers are planned to be constructed in the south side of existing car parking. The each house will be 19.8 meter width and 22.8 meter depth, and high floor typed single story building of 80 meter wide. The houses are built of wood.

(4) Construction of Field Engineers' Office and Workshop

Construction of Filed engineers' office includes construction of car parking and roads at the east side of the parking of fire engine, and office and warehouse at the east corner of the area. The office will be have carport with roof for four vehicles and 11.4 meter width and 2.85 meter depth. Offices will have an individual room, a big room, kitchen and toilet. The office will be lightweight steel skeleton building.

Workshop will be 24 meter width and 12 meter depth and have parking space for three big sized vehicles, toilet and kitchen.

(5) Construction of Airport Market and Public Toilet

Construction of airport market includes preparation of market space and public toilet at the opposite side of existing carpark in the east. The market will be 35 meter width and 44.25 meter depth. The area will be specified with a fence. Steel roof is also planned to be established in the sized of 20 meter width and 8 meter depth. Public toilet will constructed of bricks in the north east side.

4-2 Support from the World Bank

The World Bank provide support mainly to the road and agriculture sector in PNG. Apart from these sectors it also provide support to health, youth employment, energy and PPP. It does not target Tokua Airport directly. However, it support the area through tourism promotion project in Rabaul and Kokopo area. The tourism promotion project is targeting areas around Kokopo and Alotau for five years (2017-2023), and allocated 20 million USD (about 20 billion yen). Main target is Tourist Promotion Authority. Some small scale infrastructure is planned to be provided such as market facilities and breakwater near pier of cruise ships, and provision of water to cruise ships.

After termination of support from the World Bank the tourism promotion project will be handed over to International Finance Corporation (IFC) which deal with private loan department.

4-3 Support from Australian Government

Australian government support transport sector based on Transport Sector Support Program (TSSP) in PNG. Programs targeting airport sector are listed in the table 19.

Table 19 Sector Program for Airport Sector by Australian Government

Program	Implementing Agency	Outline	Budget	Term
PAMAS	PNG Air Services	Installment of New Airport Traffic Control System and ADS-B Facilities in 7 Locations	12.2 million kina	No information
Agency Support Arrangement	PNG Air Services	Capacity Development of PNG Air Services, Expansion of Coverage Area of VHF Communication System	63 million kina	From July 2013 to July 2018
Agency Support Arrangement)	CASA	Capacity Development of CAS	96 million kina	From May 2015 to November 2019
Agency Support Arrangement	AIC	Capacity Development of AIC	12 million kina	From December 2014 to November 2019

Tokua Airport receive support from PAMAS for maintenance of Automatic Terminal Information Service (ATIS) has been implemented. Blind flight system has also been installed through airport security system utilizing satellite.

4-4 Support from Chinese Government

Chinese Government announced a plan of road maintenance from Rabaul Port to Tokua Airport. Sewage Treatment Plant was constructed in an area from Kokopo and Tokua Airport. However, it was not utilized because of the environmental concerns at the timing of this field survey.

Chapter5 Air Traffic Demand Forecast

The subject of this chapter is to forecast the growth of domestic and international aircraft movements, passenger traffic, and air cargo volume.

5-1 Target Year

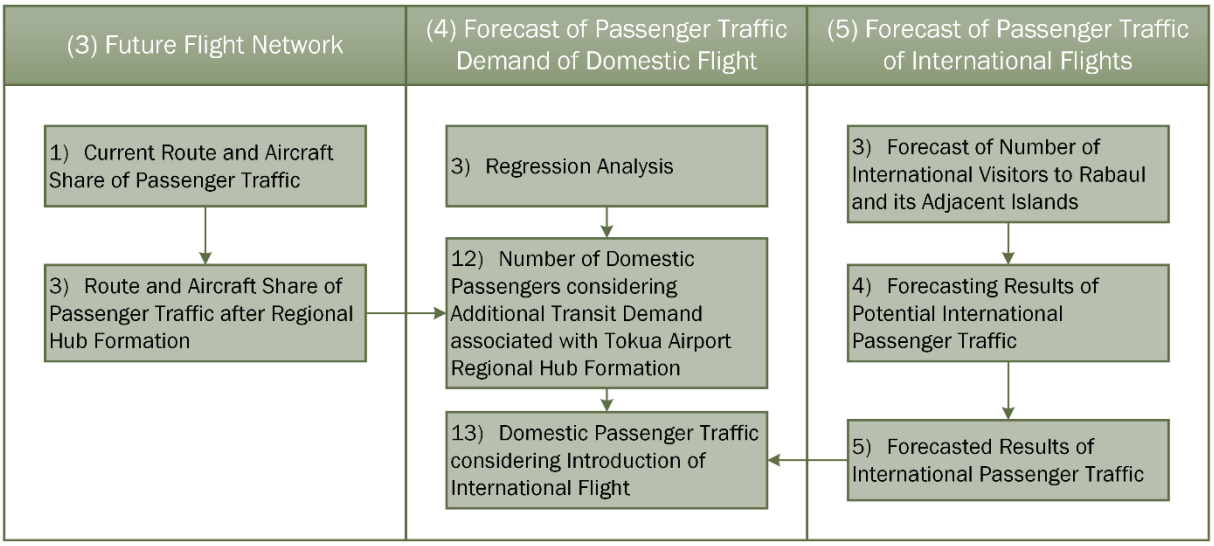
It is assumed that preparatory survey, detailed design, construction bidding, and construction work will be finished by 2024 and that the operation of new facilities will start in 2025.

The capacity of civil work facilities, such as the runway, corresponds to the demand in 2030, and the capacity of terminal building corresponds to the demand in 2035. The JICA Survey Team set the target year considering the requests from NAC, which are "The target of pavement works can be five year after the construction completion, because the further expansion works by NAC are easy." and "The target year of Passenger Terminal Building should be for 10 years due to difficulty of expansion by NAC."

The additional target year of 2040 was considered for the Phase 2 project to meet further demand increase. The Phase 2 project is not studied in this survey, and the funding source is not decided.

5-2 Study Work Flow of Forecast of Passenger Traffic Demand

The passenger traffic demand was forecasted following to the workflow shown in Figure 33.



Source: JICA Survey Team

Figure 33 Study Work Flow of Forecast of Passenger Traffic Demand

5-3 Future Flight Network

5-3-1 Current Route and Aircraft Share of Passenger Traffic

Passenger data sorted by route and aircraft could not be obtained. Instead, it was deduced using the route and aircraft share of seats in the weekly flight schedule. A peak day passenger number was allocated to each route and aircraft as shown in the following formula. For example, it was assumed that PX202 POM-HKN-RAB allocated 33% seats each to POM-HKN, POM-RAB, and HKN-RAB. As a result, RAB had 67% (= 33% + 33%) passenger share on PX202.

Route and aircraft share of number of seats = Route and aircraft share of passenger traffic

Number of passengers in each route and aircraft
= Peak day passenger number × Route and aircraft share of passenger traffic

The route and the aircraft shares of Air Niugini and of PNG Air are shown in Table 20 and Table21 respectively.

Table 20 Route and Aircraft Share of Passenger Traffic (Air Niugini, 2018)

Code	Route	Aircraft	Aircraft Movements / Week	Seats / Aircraft Movements	Seats / Week	Share
PX202	POM-HKN-RAB	F100	1 time	67seats	67 seats	2.6%
PX203	RAB-HKN-POM	F100	1 time	67 seats	67 seats	2.6%
PX204	POM-RAB	F100	3 times	101 seats	303 seats	11.8%
PX207	RAB-POM	F70	3 times	76 seats	228 seats	8.8%
PX208	POM-LAE-HKN-RAB	F70	3 times	38 seats	114 seats	4.4%
PX209	RAB-HKN-LAE-POM	F100	3 times	51 seats	152 seats	5.9%
PX252	POM-RAB-BUA	F100	6 times	34 seats	202 seats	7.8%
PX253	BUA-RAB-POM	F100	6 times	34 seats	202 seats	7.8%
PX274	POM-RAB-KVG	F100	14 times	34 seats	471 seats	18.3%
PX275	KVG-RAB-POM	F100	14 times	34 seats	471 seats	18.3%
PX817	LNV-RAB	DH8-315	3 times	50 seats	150 seats	5.8%
PX818	RAB-LNV	DH8-315	3 times	50 seats	150 seats	5.8%
Total			60 times		2,578 seats	100.0%

Source: JICA Survey Team

Table 21 Route and Aircraft Share of Passenger Traffic (PNG Air, 2018)

Code	Route	Aircraft	Aircraft Movements / Week	Seats / Aircraft Movements	Seats / Week	Share
CG8704	POM-RAB	AT7	1 time	72 seats	72 seats	2.7%
CG1704	POM-RAB	DH8	2 times	36 seats	72 seats	2.7%
CG8705	RAB-POM	AT7	1 time	72 seats	72 seats	2.7%
CG8720	POM-LAE-HKN-RAB	AT7	7 times	36 seats	252 seats	9.5%
CG8721	RAB-HKN-LAE-POM	AT7	7 times	36 seats	252 seats	9.5%
CG8724	POM-RAB-BUA	AT7	2 times	24 seats	48 seats	1.8%
CG1744	RAB-BUA	DH8	2 times	36 seats	72 seats	2.7%
CG8725	BUA-RAB	AT7	2 times	72 seats	144 seats	5.5%
CG1725 CG1745	BUA-RAB	DH8	3 times	36 seats	108 seats	4.1%
CG8746	RAB-BUA-KIE	AT7	1 time	48 seats	48 seats	1.8%
CG1746	RAB-BUA-KIE	DH8	1 time	24 seats	24 seats	0.9%
CG8747	KIE-BUA-RAB	AT7	1 time	48 seats	48 seats	1.8%
CG1747	KIE-BUA-RAB	DH8	1 time	24 seats	24 seats	0.9%
CG8736	POM-RAB-KVG	AT7	2 times	24 seats	48 seats	1.8%
CG8737	KVG-RAB-POM	AT7	2 times	24 seats	48 seats	1.8%
CG8910 CG8912	POM-RAB-LNV	AT7	10 times	24 seats	240 seats	9.1%
CG8911 CG8913	LNV-RAB-POM	AT7	10 times	24 seats	240 seats	9.1%
CG1913	LNV-RAB-POM	DH8	2 times	12 seats	24 seats	0.9%
CG8915	LNV-RAB	AT7	3 times	72 seats	216 seats	8.2%
CG1915	LNV-RAB	DH8	1 time	36 seats	36 seats	1.4%
CG8916 CG8920	RAB-LNV	AT7	2 times	72 seats	144 seats	5.5%
CG1914 CG1916	RAB-LNV	DH8	2 times	36 seats	72 seats	2.7%
CG8924	LNV-KVG-RAB	AT7	3 times	48 seats	144 seats	5.5%
CG8925	RAB-KNG-LNV	AT7	4 times	48 seats	192 seats	7.3%
Total			72 times		2,640 seats	100.0%

Source: JICA Survey Team

5-3-2 Route and Fleet Plan

NAC plans to upgrade the Tokua Airport from a domestic airport to a regional hub in PNG. Besides, F100, which Air Niugini operates mainly on domestic flights, is scheduled to retire in 2025, and Air Niugini has already ordered B737-max8 as a substitute model. Four units are to be delivered by 2021. B737-max8 is planned to be in service in Port Moresby (POM), Gurney (GUR), Nadzab (LAE), Tokua (RAB), and Mt. Hagen (HGU).

Considering the above background, the JICA Survey Team hypothesized the following conditions about the future flight network and fleet plan.

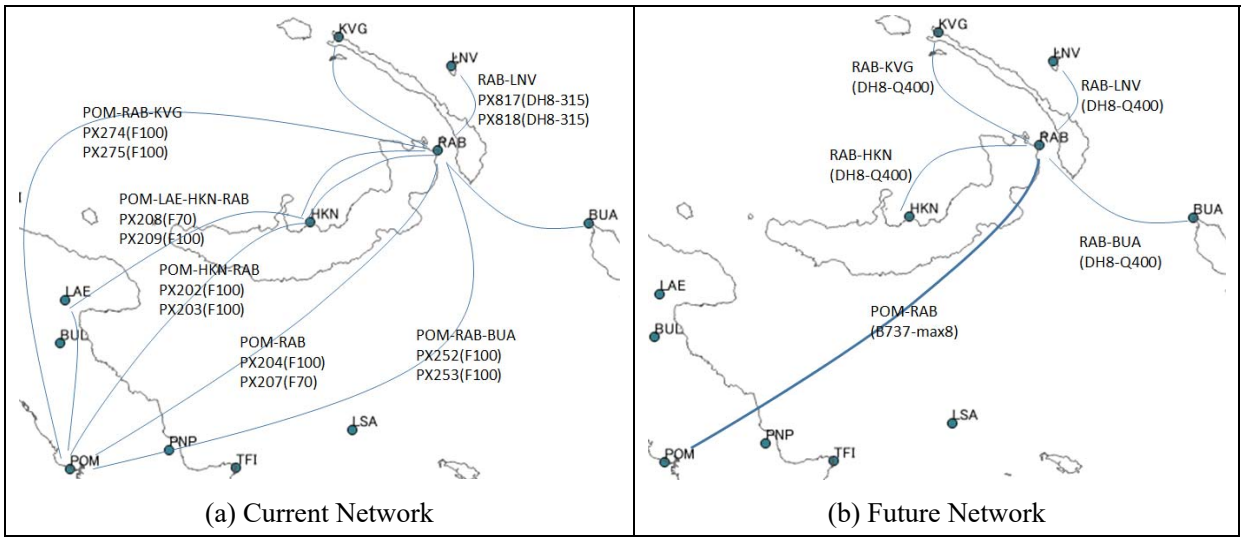
[Air Niugini]

- B737-max8 will be launched on POM-RAB line in 2025 upon the completion of the Tokua Airport Expansion Project. Dash 8 (DHC8)-Q400 will be operated on all the other routes.
- As the B737-max8 starts its service, the flight network will be changed to a hub-and-spoke type (Figure 34).

- POM-RAB-BUA line and POM-RAB-KVG line will be divided into POM-RAB line, RAB-BUA line, and RAB-KVG line. As a result, passengers currently staying on board at RAB will have to transfer aircrafts at RAB.
- POM-LAE-HKN-RAB line will be divided into POM-LAE line, LAE-HKN line, POM-RAB line, and RAB-HKN line. As a result, passengers between LAE and RAB will fly via POM.

[PNG Air]

- The route and fleet composition will not be changed.



Source: JICA Survey Team

Figure 34 Flight Network (Air Niugini)

5-3-3 Route and Aircraft Share of Passenger Traffic after Tokua Airport Regional Hub Formation

The JICA Survey Team examined the passenger share by each route and aircraft type in the future flight network (Figure 34) as shown in Table 22. As a result of the Tokua Airport becoming a hub, the incremental transit demand was estimated at 26.1% of the total number of current passengers.

For estimation of the incremental transit demand, the JICA Survey Team assumed the condition of POM-RAB-BUA (PX252, PX253) and POM-RAB-KVG (PX274, PX275) as listed below:

- Non-O/D passenger of RAB, ex. passenger from POM to KVG, remains on board at RAB. His ticked data is recorded as POM-KVG, so he is not counted as passenger traffic at RAB.

- Ordinal transit passenger of RAB, ex. passenger from POM to LNV, descends from PX204 POM-RAB and boards connecting flight of PX817 RAB-LNV. His ticket data is recorded as POM-RAB and RAB-LNV, so he is counted as passenger traffic at RAB.

Table 22 Route and Aircraft Share of Passenger Traffic
(Air Niugini, After Tokua Airport Regional Hub Formation)

Present (2018)				Future		
Code	Route	Equipment	Share	Route	Equipment	Share
PX202	POM-HKN-RAB	F100	2.6%	HKN-RAB *1	DH8-Q400	3.0%
PX203	RAB-HKN-POM	F100	2.6%	RAB-HKN *2	DH8-Q400	3.0%
PX204	POM-RAB	F100	11.8%	POM-RAB	B737-max8	28.1%
PX207	RAB-POM	F70	8.8%	RAB-POM	B737-max8	28.1%
PX208	POM-LAE-HKN-RAB	F70	4.4%			
PX209	RAB-HKN-LAE-POM	F100	5.9%			
PX252	POM-RAB-BUA	F100	7.8%	RAB-BUA *3	DH8-Q400	7.8%
PX253	BUA-RAB-POM	F100	7.8%	BUA-RAB *4	DH8-Q400	7.8%
PX274	POM-RAB-KVG	F100	18.3%	RAB-KVG *5	DH8-Q400	18.3%
PX275	KVG-RAB-POM	F100	18.3%	KVG-RAB *6	DH8-Q400	18.3%
PX817	LNV-RAB	DH8-315	5.8%	LNV-RAB	DH8-Q400	5.8%
PX818	RAB-LNV	DH8-315	5.8%	RAB-LNV	DH8-Q400	5.8%
合計			100.0%			126.1%

*1: Includes HKN-RAB passengers of PX208
*2: Includes RAB-HKN passengers of PX209
*3: Includes POM-BUA passengers of PX252
*4: Includes BUA-POM passengers of PX253
*5: Includes POM-KVG passengers of PX274
*6: Includes KVG-POM passengers of PX275
Source: JICA Survey Team

5-4 Forecast of Passenger Traffic Demand of Domestic Flight

5-4-1 Forecast Method

Air demand fluctuates in conjunction with socioeconomic activities. The JICA Survey Team assumed and verified a correlation between the real GDP and the domestic passenger number, excluding the influence of inflation. Regression analysis of real GDP and number of domestic passengers was carried out, and the number of domestic passengers was estimated from the forecasted value of real GDP. In addition, the JICA Survey Team examined the number of passengers by route, and the incremental transit demand due to Tokua Airport's regional hub formation was added to regression analysis outputs

5-4-2 Real GDP Statistics and Forecast

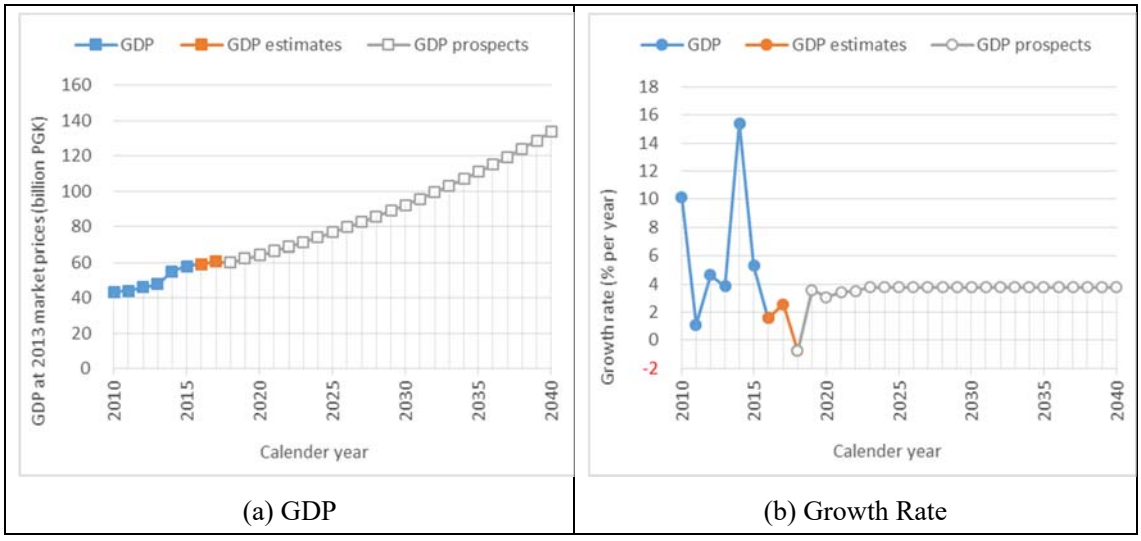
As mentioned in Chapter 3, statistics of real GDP were collected from the IMF. Forecasted values were collected from ADB, IMF, and WB (Table 23). Since the forecasted value collected was up to 2023, it was assumed that the growth rate in 2023 will continue after 2024. The average value

indicated in Table 23 was utilized in the GDP forecast for passenger traffic forecast. Figure 35 shows the time series of real GDP statistics and forecasted values.

Table 23 GDP Growth Rate Forecast

	2018	2019	2020	2021	2022	2023	After 2024
ADB	0.5	3.0	N/A	N/A	N/A	N/A	N/A
IMF	-1.1	3.8	3.2	3.4	3.5	3.8	N/A
WB	-1.7	4.0	3.0	N/A	N/A	N/A	N/A
Average	-0.8	3.6	3.1	3.4	3.5	3.8	3.8

N/A: No data
Source 1: ADB, Asian Development Outlook 2018 Update
Source 2: IMF, World Economic Outlook Database, October 2018
Source 3: WB, Global Economic Prospects, June 2018



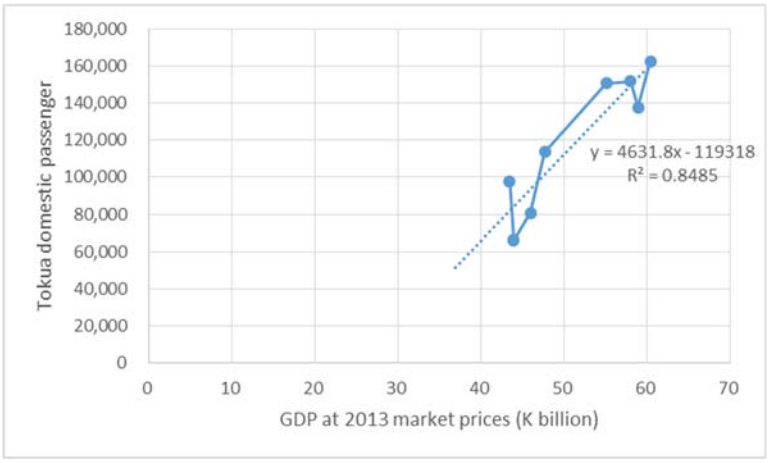
(a) GDP (b) Growth Rate

Source: JICA Survey Team

Figure 35 Real GDP Statistics and Forecasts

5-4-3 Regression Analysis

Regression analysis was carried out using the linear regression formula for real GDP and annual domestic passenger. The coefficient of determination (R^2) is 0.85, so correlation can be confirmed (Figure 36). The significance test (T-test) for the correlation coefficient was performed, and the T-value obtained was 5.80. In the Manual on Air Traffic Forecasting (ICAO, 2006), a T-value of 2 or more is adopted as a standard, and the current test result clears the criterion.



Source: JICA Survey Team

Figure 36 Scatter Plot of Real GDP and Annual Domestic Passenger

5-4-4 Forecast Result of Domestic Passenger Traffic

The regression equation was used to forecast domestic flight passenger traffic, and the results are shown in Table 24. The actual annual traffic in 2017 was 162,000 persons. The annual passenger traffic is projected to be 380,000 people in 2030 and 500,000 people in 2040.

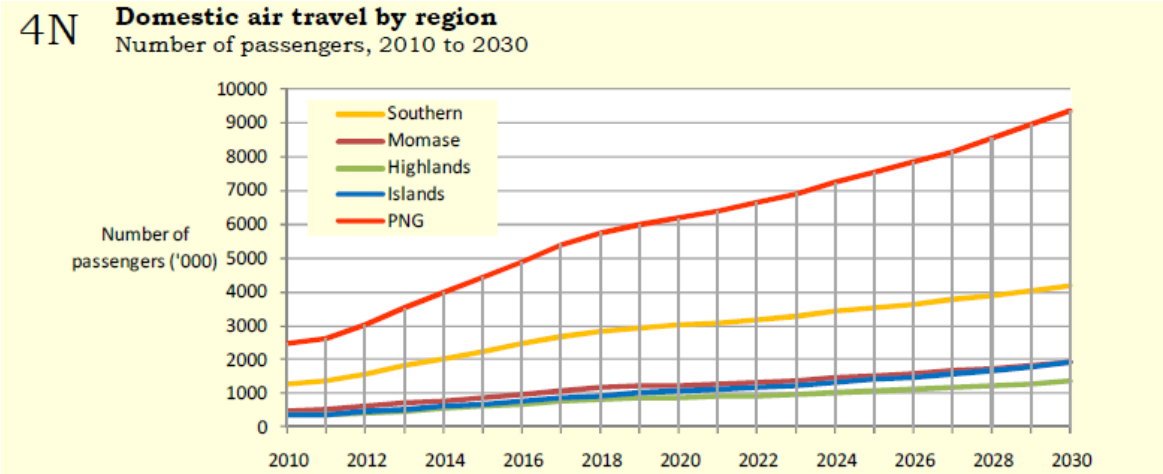
Table 24 Forecast Result of Domestic Passenger Traffic (Regression Analysis)

	2017 (Actual)	2025 (Forecast)	2030 (Forecast)	2035 (Forecast)	2040 (Forecast)
Annual	162,427	235,000	308,000	394,000	500,000

Source: JICA Survey Team

5-4-5 Comparison with Forecast of Papua New Guinea Development Strategic Plan 2010-2030

In the Papua New Guinea Development Strategic Plan 2010-2030 (DSP 2030), demand forecasts for domestic passengers by region were conducted. Air travel demand in the Island Region to which Tokua Airport belongs is about 1 million people per year in 2017 and about 2 million people per year in 2030 (Figure 37). Assuming that the growth rate of passenger traffic is the same for Tokua Airport and the entire Island Region, the demand for Tokua Airport in 2017 is about 160,000 people per year, and in 2030 is about 320,000 people per year, which is almost the same as the forecasted value in this survey.

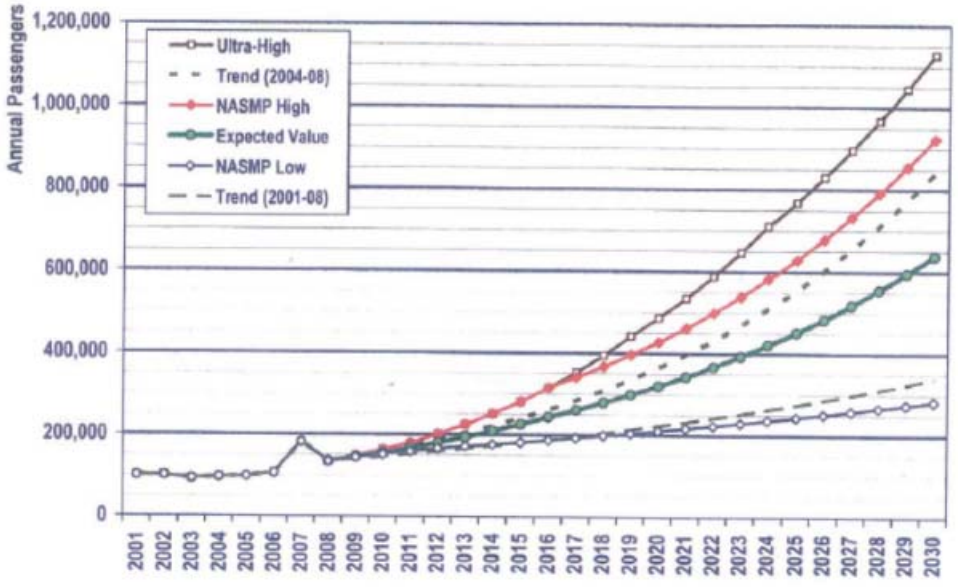


Source: DSP 2030

Figure 37 Forecast of Domestic Passenger Number (DSP 2030)

5-4-6 Comparison with Forecast of Tokua Airport Master Plan 2009-2030

The Tokua Airport Master Plan 2009-2030 (Tokua Airport M/P 2030) forecasted a 2.5-fold increase which corresponded to about 260,000 people per year in 2017 and about 640,000 people per year in 2030 (Figure 38). Given that the actual number of air passengers in 2017 was about 160,000 people per year, the JICA Survey Team evaluated that it was an excessive prediction.



Source: Tokua Airport M/P 2030

Figure 38 Forecast of Domestic Passenger Number (Tokua Airport M/P 2030)

5-4-7 Analysis of Elasticity

GDP elasticity, specifically the analysis of GDP growth rate and traffic growth rate of domestic passenger, was confirmed (Table 25). In Japan, the GDP elasticity was about 3 during the bubble economy period from 1985 to 1995. In comparison, the forecast result of the GDP elasticity for this research is about 1.5. This numerical value is reasonable and not excessive. Also, a reduction in the numerical value of GDP elasticity accompanying the increase in demand for commercial air services seems to be a reasonable assumption.

Table 25 Analytical Results for GDP Elasticity

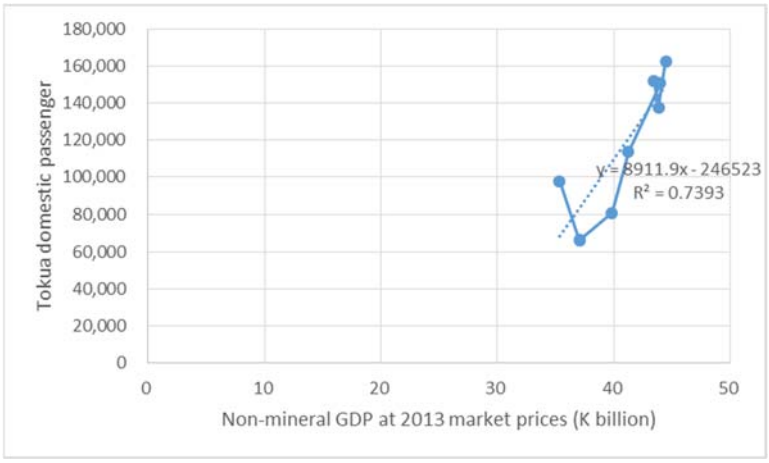
Analytical Period	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040
Annual average growth rate of GDP	6.1%	2.0%	3.6%	3.8%	3.8%	3.8%
Annual average growth rate of domestic passenger traffic	12.7%	3.6%	5.8%	5.5%	5.1%	4.8%
GDP elasticity	2.1	1.8	1.6	1.5	1.4	1.3

Source: JICA Survey Team

5-4-8 Correlation to Other Indicators

The domestic flight passenger demand was forecasted using regression analysis in the foregoing clause. Correlation was confirmed between the passenger traffic demand for domestic flights and other indicators besides GDP.

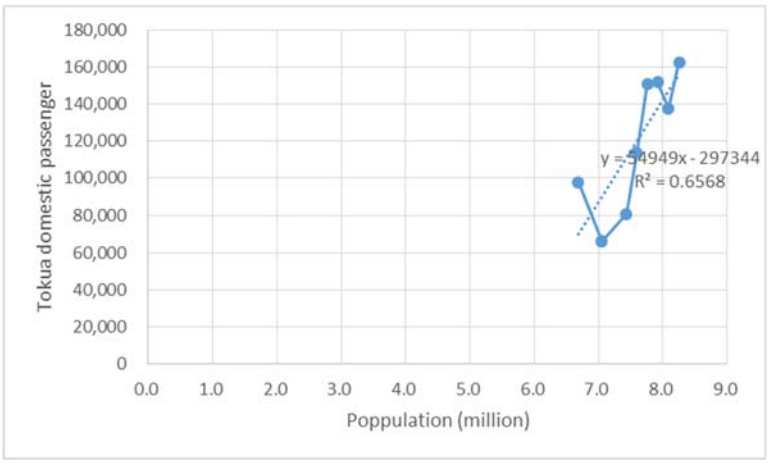
Correlation was confirmed between GDP, excluding the resource sector, and passenger demand for domestic flights since the resource sector has a great impact on the GDP of PNG. The GDP of the resource sector was estimated using mining and quarrying data from 2010 to 2014 in the Key Indicators for Asia and the Pacific 2018 (ADB). For estimation of non-resource sector GDP, the JICA Survey Team subtracted the resource sector GDP from the total GDP. From 2015 to 2017, the JICA Survey Team estimated the non-resource sector GDP by using the non-resource sector growth rate shown in the IMF Country Report No. 17/411. The R^2 values of domestic passenger and non-resource sector GDP (Figure 39) are lower than the GDP's R^2 value (Figure 36), and the non-resource sector GDP is not an appropriate indicator for forecasting.



Source: JICA Survey Team

Figure 39 Scatter Plot of Non-mineral GDP and Domestic Passenger Number

The same study on the population was conducted. As for population, data from 2010 to 2017 shown in the IMF, World Economic Outlook Database, October 2018 was utilized. The R^2 value of population and domestic passenger number (Figure 40) is lower than GDP's R^2 value (Figure 36). Population is not an appropriate as explanatory variable for passenger traffic.



Source: JICA Survey Team

Figure 40 Scatter Plot of Population and Domestic Passenger Number

5-4-9 Peak Day Passenger Traffic of Domestic Routes

The peak day coefficient and the peak day passenger number were calculated using the following formula: Calculation results are shown in Table 26 and Table 27.

Peak day coefficient = Daily average passenger number in peak month / Annual number of passengers

Peak day passenger number = Annual number of passengers × Peak day coefficient

Table 26 Peak Day Coefficient (Passenger Traffic)

2014	2015	2016	Average
1/272	1/284	1/285	1/280

Source: JICA Survey Team

Table 27 Peak Day Passenger Traffic

2025	2030	2035	2040
840 people	1,100 people	1,410 people	1,780 people

Source: JICA Survey Team

5-4-10 Peak Day Passenger Traffic by Airline Companies

The current and the forecasted values of peak day passenger traffic by airline company were calculated using the following equation. The airline share of passenger traffic is based on data from 2014 to 2016. Calculation results are shown in Table 28.

Peak day passenger traffic (by airline, current)

= Annual passenger traffic (by airlines, current) × Peak day coefficient

Peak day passenger traffic (by airline, forecast)

= Peak day passenger traffic (forecast) × Airline share

Table 28 Peak Day Passenger Traffic by Airline

Airline	Share 2014-2016	2014 - 2016	2025	2030	2035	2040
Air Niugini	71.9%	363	604	789	1,012	1,281
PNG Air	28.1%	142	237	309	396	501

Unit: people

Source: JICA Survey Team

5-4-11 Peak Day Domestic Passenger Traffic by Route and Equipment

The current and the forecasted values of peak day passenger traffic by route and aircraft type were calculated using the following equation. Calculation results are shown in Table 29, Table 30, and Table 31.

Peak day passenger traffic (by route and aircraft)

= Peak day passenger traffic (by airline) × Share by route and aircraft type

Table 29 Peak Day Passenger Number (by Route and Aircraft Type, Air Niugini, Current)

Code	Route	Aircraft	Share 2018	Passenger number 2014-2016
PX202	POM-HKN-RAB	F100	2.6%	9
PX203	RAB-HKN-POM	F100	2.6%	9
PX204	POM-RAB	F100	11.8%	43
PX207	RAB-POM	F70	8.8%	32
PX208	POM-LAE-HKN-RAB	F70	4.4%	16
PX209	RAB-HKN-LAE-POM	F100	5.9%	21
PX252	POM-RAB-BUA	F100	7.8%	28
PX253	BUA-RAB-POM	F100	7.8%	28
PX274	POM-RAB-KVG	F100	18.3%	66
PX275	KVG-RAB-POM	F100	18.3%	66
PX817	LNV-RAB	DH8-315	5.8%	21
PX818	RAB-LNV	DH8-315	5.8%	21
Total			100.0%	363

Unit: people

Source: JICA Survey Team

Table 30 Peak Day Passenger Number (by Route and Aircraft Type, Air Niugini, Future)

Route	Aircraft	Share	2025	2030	2035	2040
HKN-RAB	DH8-Q400	3.0%	18	24	31	39
RAB-HKN	DH8-Q400	3.0%	18	24	31	39
POM-RAB	B737-max8	28.1%	170	222	284	360
RAB-POM	B737-max8	28.1%	170	222	284	360
RAB-BUA	DH8-Q400	7.8%	47	62	79	100
BUA-RAB	DH8-Q400	7.8%	47	62	79	100
RAB-KVG	DH8-Q400	18.3%	110	144	185	234
KVG-RAB	DH8-Q400	18.3%	110	144	185	234
LNV-RAB	DH8-Q400	5.8%	35	46	59	75
RAB-LNV	DH8-Q400	5.8%	35	46	59	75
Total		126.1%	762	996	1,277	1,615

Unit: people

Source: JICA Survey Team

Table 31 Peak Day Passenger Number
(by Route and Aircraft Type, PNG Air, Current and Future)

Code	Route	Aircraft	Share 2018	Passenger number 2014-2016	2025	2030	2035	2040
CG8704	POM-RAB	AT7	2.7%	4	6	8	11	14
CG1704	POM-RAB	DH8	2.7%	4	6	8	11	14
CG8705	RAB-POM	AT7	2.7%	4	6	8	11	14
CG8720	POM-LAE-HKN-RAB	AT7	9.5%	14	23	29	38	48
CG8721	RAB-HKN-LAE-POM	AT7	9.5%	14	23	29	38	48
CG8724	POM-RAB-BUA	AT7	1.8%	3	4	6	7	9
CG1744	RAB-BUA	DH8	2.7%	4	6	8	11	14
CG8725	BUA-RAB	AT7	5.5%	8	13	17	22	27
CG1725 CG1745	BUA-RAB	DH8	4.1%	6	10	13	16	21
CG8746	RAB-BUA-KIE	AT7	1.8%	3	4	6	7	9
CG1746	RAB-BUA-KIE	DH8	0.9%	1	2	3	4	5
CG8747	KIE-BUA-RAB	AT7	1.8%	3	4	6	7	9
CG1747	KIE-BUA-RAB	DH8	0.9%	1	2	3	4	5
CG8736	POM-RAB-KVG	AT7	1.8%	3	4	6	7	9
CG8737	KVG-RAB-POM	AT7	1.8%	3	4	6	7	9
CG8910 CG8912	POM-RAB-LNV	AT7	9.1%	13	22	28	36	46
CG8911 CG8913	LNV-RAB-POM	AT7	9.1%	13	22	28	36	46
CG1913	LNV-RAB-POM	DH8	0.9%	1	2	3	4	5
CG8915	LNV-RAB	AT7	8.2%	12	19	25	32	41
CG1915	LNV-RAB	DH8	1.4%	2	3	4	5	7
CG8916 CG8920	RAB-LNV	AT7	5.5%	8	13	17	22	27
CG1914 CG1916	RAB-LNV	DH8	2.7%	4	6	8	11	14
CG8924	LNV-KVG-RAB	AT7	5.5%	8	13	17	22	27
CG8925	RAB-KNG-LNV	AT7	7.3%	10	17	22	29	36
Total			100.0%	142	237	309	396	501

Unit: people
Source: JICA Survey Team

5-4-12 Number of Domestic Passengers considering Additional Transit Demand associated with Tokua Airport Regional Hub Formation

Calculation results of the additional transit demand associated with the hub formation of Tokua Airport are shown in Table 22 and Table 30. The annual passenger traffic was calculated as follows and the results are shown in Table 32. Passenger traffic increase 26.1% due to the hub formation.

Annual number of passengers (considering hub formation)
= Peak day number of passengers (considering hub formation) / Peak day coefficient

Table 32 Forecast Result of Domestic Passenger Traffic
(Considering Regional Hub Formation)

		2025	2030	2035	2040
Annual	Total (a)	280,000	365,000	468,000	593,000
	Regression Analysis (b)	235,000	308,000	394,000	500,000
	Incremental Transit Passenger (c)=(a)-(b)	45,000	57,000	74,000	93,000
Peak Day	Total	1,000	1,310	1,670	2,120
	Air Niugini	760	1,000	1,280	1,620
	PNG Air	240	310	400	500

Unit: people
Source: JICA Survey Team

5-4-13 Domestic Passenger Traffic considering Introduction of International Scheduled Flight

International flights are not in service at the Tokua Airport. For this reason, international visitors arrive at Tokua Airport via Port Moresby and are classified as domestic passengers. International visitors traveling to Rabaul are potential international passengers at Tokua Airport when international flights are in service. In connection with this, the forecasted number of international passengers is shown in Table 58. Since these passengers were considered to shift from domestic to international, the number of international passengers was deducted from Table 32. The final forecasted domestic flight passenger number is shown in Table 33.

Table 33 Domestic Passenger Traffic Forecast (Considering Shift to International Flights)

		2025	2030	2035	2040
Annual	Domestic passenger (a)=(b)-(c)	243,000	315,000	405,000	514,000
	Domestic Passenger considering Hub Formation (b)	279,588	365,295	468,438	592,564
	Shift to international passenger (c)	36,890	50,701	63,154	78,901
Peak Day	Total	870	1,120	1,450	1,840
	Air Niugini	630	820	1,050	1,330
	PNG Air	240	310	400	500
Peak Hour		154	190	227	277

Unit: people
Source: JICA Survey Team

5-4-14 Forecast Result of Peak Hour Domestic Passenger Traffic

Peak hour ratio was calculated using the empirical formula in Japan.

Peak hour rate (domestic flight) = 1.51 / Daily aircraft movements + 0.1151

Tokua Airport's conformity to the above formula was confirmed based on the data from 2014 to 2016 and the current flight schedule.

From the data (as presented in Table 36 below), the number of aircraft movements at peak hour was calculated to be 3.9 times.

Peak hour ratio = 1.51 / 20.9 + 0.1151 = 0.187

Peak hour aircraft movements

= Peak day aircraft movements × Peak hour ratio

= 20.9 × 0.187 = 3.9

On the other hand, checking from the current flight schedule, the peak aircraft movements occur at 6:00-7:00 and 12:00-13:00, and the average number of movements at 6:00-7:00 is 3.6 times (Table 34). The two values were roughly the same, and the JICA Survey Team concluded that the empirical formula in Japan could be applied to Tokua Airport.

Table 34 Number of Aircraft Movements at Peak Hour (2018 Flight Schedule)

Time	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total	Average
6:00-7:00	4	5	4	4	4	2	2	25	3.6
12:00-13:00	0	6	2	5	0	3	1	17	2.4

Source 1: Air Niugini, Flight Schedule, 28 October 2018 to 30 March 2019
Source 2: PNG Air, Flight Schedule, 2 July 2018

Peak hour domestic passenger traffic was calculated using the following formula. Calculation results are shown in Table 35.

Peak hour passenger traffic = Peak day passenger traffic × Peak hour ratio

Table 35 Peak Hour Domestic Passenger Traffic

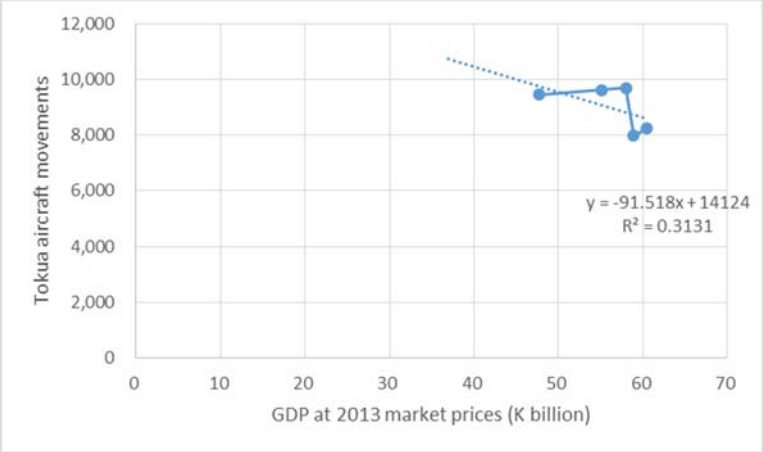
	2025	2030	2035	2040
Peak hour ratio	0.178	0.169	0.157	0.151
Peak hour passenger traffic (people)	154	190	227	277

Source: JICA Survey Team

5-5 Forecast of Aircraft Movements of Domestic Flights

5-5-1 Forecast Method

The obtained data on aircraft movements was only for five years, and this was found insufficient for statistical analysis. Even by checking the relation between real GDP and aircraft movements on a scatter plot (Figure 41), there was no correlation found between them.
Therefore, the aircraft movements were estimated from passenger traffic by route and equipment with the assumption of the fleet plan of airlines.



Source: JICA Survey Team

Figure 41 Scatter Plot of Real GDP and Aircraft Movements

5-5-2 Current Peak Day Aircraft Movements of Domestic Flight

Based on data from 2014 to 2016, the peak day coefficient (Table 36) was calculated using the following equation.

Peak day coefficient

= Daily average aircraft movements of peak month / Aircraft movements per year

= 1/328

Table 36 Peak Day Coefficient (Aircraft Movements per Year, Air Niugini + PNG Air)

	2014	2015	2016	Average
Aircraft movements per year	7,050	7,278	6,316	6,881
Peak day (daily average aircraft movements of peak month)	22	21	20	20.9
Peak day coefficient	1/322	1/340	1/323	1/328

Source: JICA Survey Team

The number of aircraft movements of peak day was calculated using the data from 2014 to 2016 (Table 37). Also, the JICA Survey Team confirmed the aircraft movements in the 2018 flight schedule (Table 38). The JICA Survey Team confirmed the number of aircraft movements of peak day by aircraft type from the 2018 flight schedule (Table 39).

Table 37 Aircraft Movements of Peak Day (by Airline, Records from 2014 to 2016)

Airline	Calculation Method	Aircraft Movements
Air Niugini	Aircraft movements per year × Peak day coefficient	10.9
PNG Air	Aircraft movements per year × Peak day coefficient	10.1
Air Niugini + PNG Air	Daily average aircraft movements of peak month	20.9
GA	Daily average aircraft movements of peak month	6.2

Source: JICA Survey Team

Table 38 Aircraft Movements of Peak Day (by Airline, 2018 Flight Schedule)

Airline	Aircraft Movements							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Average
Air Niugini	8	10	8	10	8	9	7	9
PNG Air	10	11	16	12	13	5	5	10
Air Niugini + PNG Air	18	21	24	22	21	14	12	19

Source: Air Niugini, PNG Air

Table 39 Number of Aircraft Movements of Peak Day (by Aircraft Type, 2018 Flight Schedule)

Airline	Equipment	Aircraft Movements per Week	Daily Average Aircraft Movements
Air Niugini	F100	48	7
	F70	6	1
	DH8-315	6	1
PNG Air	DHC 8-100	14	2
	ATR 72-600	58	8

Source: Air Niugini, PNG Air

5-5-3 Forecast Result of Domestic Flight Peak Demand (by Route and Aircraft Type)

The number of aircraft movements was calculated by dividing the number of passengers on each route and aircraft type by the number of passengers per flight (see from Table 40 to Table 49).

Number of passengers per flight = Number of seats × Load factor

Aircraft movements of peak day (by route and aircraft type)

= Passenger number of peak day (by route and aircraft type) / Number of passengers per flight

Calculations were made not only for the forecast, but also for the current situation. The current boarding rate was estimated by trial and error so that the total aircraft movements was the same as the value indicated in Table 37.

For the forecast, the following assumptions were set.

[Air Niugini]

- The load factor is 70%.

[PNG Air]

- The number of aircraft movements of peak day will be maintained at the same level as the current level.
- Scheduled flights will be increased when load factor reaches 70%.

[GA]

- The number of aircraft movements will be maintained at the same level as the current level.

Table 40 Aircraft Movements of Peak Day (by Route and Aircraft Type, Air Niugini, Current)

Code	Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
PX202	POM-HKN-RAB	F100	67	77%	52	0.2	
PX203	RAB-HKN-POM	F100	67	77%	52	0.2	
PX204	POM-RAB	F100	101	77%	78	0.5	
PX207	RAB-POM	F70	76	77%	59	0.5	
PX208	POM-LAE-HKN-RAB	F70	38	77%	29	0.5	
PX209	RAB-HKN-LAE-POM	F100	51	77%	39	0.5	
PX252	POM-RAB-BUA	F100	34	77%	26	1.1	
PX253	BUA-RAB-POM	F100	34	77%	26	1.1	
PX274	POM-RAB-KVG	F100	34	77%	26	2.5	
PX275	KVG-RAB-POM	F100	34	77%	26	2.5	
PX817	LNV-RAB	DH8-315	50	77%	39	0.5	
PX818	RAB-LNV	DH8-315	50	77%	39	0.5	
Subtotal		F100				8.7	10 times
		F70				1.1	2 times
		DH8-315				1.1	2 times
Total						10.9	14 times

Source: JICA Survey Team

Table 41 Forecast of Aircraft Movements of Peak Day
(by Route and Aircraft Type, Air Niugini, 2025)

Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
HKN-RAB	DH8-Q400	70	70%	49	0.3	
RAB-HKN	DH8-Q400	70	70%	49	0.3	
POM-RAB	B737-max8	152	70%	106	1.3	
RAB-POM	B737-max8	152	70%	106	1.3	
RAB-BUA	DH8-Q400	70	70%	49	0.8	
BUA-RAB	DH8-Q400	70	70%	49	0.8	
RAB-KVG	DH8-Q400	70	70%	49	1.9	
KVG-RAB	DH8-Q400	70	70%	49	1.9	
LNV-RAB	DH8-Q400	70	70%	49	0.6	
RAB-LNV	DH8-Q400	70	70%	49	0.6	
Subtotal	DH8-Q400				7.1	8 times
	B737-max8				2.6	4 times
Total					9.8	12 times

Source: JICA Survey Team

Table 42 Forecast of Aircraft Movements of Peak Day
(by Route and Aircraft Type, Air Niugini, 2030)

Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
HKN-RAB	DH8-Q400	70	70%	49	0.4	
RAB-HKN	DH8-Q400	70	70%	49	0.4	
POM-RAB	B737-max8	152	70%	106	1.7	
RAB-POM	B737-max8	152	70%	106	1.7	
RAB-BUA	DH8-Q400	70	70%	49	1.0	
BUA-RAB	DH8-Q400	70	70%	49	1.0	
RAB-KVG	DH8-Q400	70	70%	49	2.4	
KVG-RAB	DH8-Q400	70	70%	49	2.4	
LNV-RAB	DH8-Q400	70	70%	49	0.8	
RAB-LNV	DH8-Q400	70	70%	49	0.8	
Subtotal	DH8-Q400				9.2	10 times
	B737-max8				3.4	4 times
Total					12.6	14 times

Source: JICA Survey Team

Table 43 Forecast of Aircraft Movements of Peak Day
(by Route and Aircraft Type, Air Niugini, 2035)

Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
HKN-RAB	DH8-Q400	70	70%	49	0.5	
RAB-HKN	DH8-Q400	70	70%	49	0.5	
POM-RAB	B737-max8	152	70%	106	2.2	
RAB-POM	B737-max8	152	70%	106	2.2	
RAB-BUA	DH8-Q400	70	70%	49	1.3	
BUA-RAB	DH8-Q400	70	70%	49	1.3	
RAB-KVG	DH8-Q400	70	70%	49	3.1	
KVG-RAB	DH8-Q400	70	70%	49	3.1	
LNV-RAB	DH8-Q400	70	70%	49	1.0	
RAB-LNV	DH8-Q400	70	70%	49	1.0	
Subtotal	DH8-Q400				11.9	12 times
	B737-max8				4.4	6 times
Total					16.3	18 times

Source: JICA Survey Team

Table 44 Forecast of Aircraft Movements of Peak Day
(by Route and Aircraft Type, Air Niugini, 2040)

Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
HKN-RAB	DH8-Q400	70	70%	49	0.7	
RAB-HKN	DH8-Q400	70	70%	49	0.7	
POM-RAB	B737-max8	152	70%	106	2.8	
RAB-POM	B737-max8	152	70%	106	2.8	
RAB-BUA	DH8-Q400	70	70%	49	1.7	
BUA-RAB	DH8-Q400	70	70%	49	1.7	
RAB-KVG	DH8-Q400	70	70%	49	3.9	
KVG-RAB	DH8-Q400	70	70%	49	3.9	
LNV-RAB	DH8-Q400	70	70%	49	1.3	
RAB-LNV	DH8-Q400	70	70%	49	1.3	
Subtotal	DH8-Q400				15.1	16 times
	B737-max8				5.6	6 times
Total					20.7	22 times

Source: JICA Survey Team

Table 45.Number of Aircraft Movements of Peak Day
(by Route and Aircraft Type, PNG Air, Current)

Code	Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
CG8704	POM-RAB	AT7	72	38%	28	0.1	
CG1704	POM-RAB	DH8	36	38%	14	0.3	
CG8705	RAB-POM	AT7	72	38%	28	0.1	
CG8720	POM-LAE-HKN-RAB	AT7	36	38%	14	1.0	
CG8721	RAB-HKN-LAE-POM	AT7	36	38%	14	1.0	
CG8724	POM-RAB-BUA	AT7	24	38%	9	0.3	
CG1744	RAB-BUA	DH8	36	38%	14	0.3	
CG8725	BUA-RAB	AT7	72	38%	28	0.3	
CG1725 CG1745	BUA-RAB	DH8	36	38%	14	0.4	
CG8746	RAB-BUA-KIE	AT7	48	38%	18	0.1	
CG1746	RAB-BUA-KIE	DH8	24	38%	9	0.1	
CG8747	KIE-BUA-RAB	AT7	48	38%	18	0.1	
CG1747	KIE-BUA-RAB	DH8	24	38%	9	0.1	
CG8736	POM-RAB-KVG	AT7	24	38%	9	0.3	
CG8737	KVG-RAB-POM	AT7	24	38%	9	0.3	
CG8910 CG8912	POM-RAB-LNV	AT7	24	38%	9	1.4	
CG8911 CG8913	LNV-RAB-POM	AT7	24	38%	9	1.4	
CG1913	LNV-RAB-POM	DH8	12	38%	5	0.3	
CG8915	LNV-RAB	AT7	72	38%	28	0.4	
CG1915	LNV-RAB	DH8	36	38%	14	0.1	
CG8916 CG8920	RAB-LNV	AT7	72	38%	28	0.3	
CG1914 CG1916	RAB-LNV	DH8	36	38%	14	0.3	
CG8924	LNV-KVG-RAB	AT7	48	38%	18	0.4	
CG8925	RAB-KNG-LNV	AT7	48	38%	18	0.6	
Subtotal		DH8				2.0	2 times
		AT7				8.1	10 times
Total						10.1	12 times

Source: JICA Survey Team

Table 46 Forecasted Number of Aircraft Movements of Peak Day
(by Route and Aircraft Type, PNG Air, 2025)

Code	Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
CG8704	POM-RAB	AT7	72	64%	46	0.1	
CG1704	POM-RAB	DH8	36	64%	23	0.3	
CG8705	RAB-POM	AT7	72	64%	46	0.1	
CG8720	POM-LAE-HKN-RAB	AT7	36	64%	23	1.0	
CG8721	RAB-HKN-LAE-POM	AT7	36	64%	23	1.0	
CG8724	POM-RAB-BUA	AT7	24	64%	15	0.3	
CG1744	RAB-BUA	DH8	36	64%	23	0.3	
CG8725	BUA-RAB	AT7	72	64%	46	0.3	
CG1725 CG1745	BUA-RAB	DH8	36	64%	23	0.4	
CG8746	RAB-BUA-KIE	AT7	48	64%	31	0.1	
CG1746	RAB-BUA-KIE	DH8	24	64%	15	0.1	
CG8747	KIE-BUA-RAB	AT7	48	64%	31	0.1	
CG1747	KIE-BUA-RAB	DH8	24	64%	15	0.1	
CG8736	POM-RAB-KVG	AT7	24	64%	15	0.3	
CG8737	KVG-RAB-POM	AT7	24	64%	15	0.3	
CG8910 CG8912	POM-RAB-LNV	AT7	24	64%	15	1.4	
CG8911 CG8913	LNV-RAB-POM	AT7	24	64%	15	1.4	
CG1913	LNV-RAB-POM	DH8	12	64%	8	0.3	
CG8915	LNV-RAB	AT7	72	64%	46	0.4	
CG1915	LNV-RAB	DH8	36	64%	23	0.1	
CG8916 CG8920	RAB-LNV	AT7	72	64%	46	0.3	
CG1914 CG1916	RAB-LNV	DH8	36	64%	23	0.3	
CG8924	LNV-KVG-RAB	AT7	48	64%	31	0.4	
CG8925	RAB-KNG-LNV	AT7	48	64%	31	0.6	
Subtotal		DH8				2.0	2 times
		AT7				8.1	10 times
Total						10.1	12 times

Source: JICA Survey Team

Table 47 Forecasted Number of Aircraft Movements of Peak Day
(by Route and Aircraft Type, PNG Air, 2030)

Code	Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
CG8704	POM-RAB	AT7	72	70%	50	0.2	
CG1704	POM-RAB	DH8	36	70%	25	0.3	
CG8705	RAB-POM	AT7	72	70%	50	0.2	
CG8720	POM-LAE-HKN-RAB	AT7	36	70%	25	1.2	
CG8721	RAB-HKN-LAE-POM	AT7	36	70%	25	1.2	
CG8724	POM-RAB-BUA	AT7	24	70%	17	0.3	
CG1744	RAB-BUA	DH8	36	70%	25	0.3	
CG8725	BUA-RAB	AT7	72	70%	50	0.3	
CG1725 CG1745	BUA-RAB	DH8	36	70%	25	0.5	
CG8746	RAB-BUA-KIE	AT7	48	70%	34	0.2	
CG1746	RAB-BUA-KIE	DH8	24	70%	17	0.2	
CG8747	KIE-BUA-RAB	AT7	48	70%	34	0.2	
CG1747	KIE-BUA-RAB	DH8	24	70%	17	0.2	
CG8736	POM-RAB-KVG	AT7	24	70%	17	0.3	
CG8737	KVG-RAB-POM	AT7	24	70%	17	0.3	
CG8910 CG8912	POM-RAB-LNV	AT7	24	70%	17	1.7	
CG8911 CG8913	LNV-RAB-POM	AT7	24	70%	17	1.7	
CG1913	LNV-RAB-POM	DH8	12	70%	8	0.3	
CG8915	LNV-RAB	AT7	72	70%	50	0.5	
CG1915	LNV-RAB	DH8	36	70%	25	0.2	
CG8916 CG8920	RAB-LNV	AT7	72	70%	50	0.3	
CG1914 CG1916	RAB-LNV	DH8	36	70%	25	0.3	
CG8924	LNV-KVG-RAB	AT7	48	70%	34	0.5	
CG8925	RAB-KNG-LNV	AT7	48	70%	34	0.7	
Subtotal		DH8				2.3	4 times
		AT7				9.7	10 times
Total						12.0	14 times

Source: JICA Survey Team

Table 48 Forecasted Number of Aircraft Movements of Peak Day
(by Route and Aircraft Type, PNG Air, 2035)

Code	Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
CG8704	POM-RAB	AT7	72	70%	50	0.2	
CG1704	POM-RAB	DH8	36	70%	25	0.4	
CG8705	RAB-POM	AT7	72	70%	50	0.2	
CG8720	POM-LAE-HKN-RAB	AT7	36	70%	25	1.5	
CG8721	RAB-HKN-LAE-POM	AT7	36	70%	25	1.5	
CG8724	POM-RAB-BUA	AT7	24	70%	17	0.4	
CG1744	RAB-BUA	DH8	36	70%	25	0.4	
CG8725	BUA-RAB	AT7	72	70%	50	0.4	
CG1725 CG1745	BUA-RAB	DH8	36	70%	25	0.6	
CG8746	RAB-BUA-KIE	AT7	48	70%	34	0.2	
CG1746	RAB-BUA-KIE	DH8	24	70%	17	0.2	
CG8747	KIE-BUA-RAB	AT7	48	70%	34	0.2	
CG1747	KIE-BUA-RAB	DH8	24	70%	17	0.2	
CG8736	POM-RAB-KVG	AT7	24	70%	17	0.4	
CG8737	KVG-RAB-POM	AT7	24	70%	17	0.4	
CG8910 CG8912	POM-RAB-LNV	AT7	24	70%	17	2.1	
CG8911 CG8913	LNV-RAB-POM	AT7	24	70%	17	2.1	
CG1913	LNV-RAB-POM	DH8	12	70%	8	0.4	
CG8915	LNV-RAB	AT7	72	70%	50	0.6	
CG1915	LNV-RAB	DH8	36	70%	25	0.2	
CG8916 CG8920	RAB-LNV	AT7	72	70%	50	0.4	
CG1914 CG1916	RAB-LNV	DH8	36	70%	25	0.4	
CG8924	LNV-KVG-RAB	AT7	48	70%	34	0.6	
CG8925	RAB-KNG-LNV	AT7	48	70%	34	0.9	
Subtotal		DH8				3.0	4 times
		AT7				12.4	14 times
Total						15.4	18 times

Source: JICA Survey Team

Table 49 Forecasted Number of Aircraft Movements of Peak Day
(by Route and Aircraft Type, PNG Air, 2040)

Code	Route	Aircraft	Seats	Load Factor	Passenger Number	Aircraft Movements	Rounding
CG8704	POM-RAB	AT7	72	70%	50	0.3	
CG1704	POM-RAB	DH8	36	70%	25	0.5	
CG8705	RAB-POM	AT7	72	70%	50	0.3	
CG8720	POM-LAE-HKN-RAB	AT7	36	70%	25	1.9	
CG8721	RAB-HKN-LAE-POM	AT7	36	70%	25	1.9	
CG8724	POM-RAB-BUA	AT7	24	70%	17	0.5	
CG1744	RAB-BUA	DH8	36	70%	25	0.5	
CG8725	BUA-RAB	AT7	72	70%	50	0.5	
CG1725 CG1745	BUA-RAB	DH8	36	70%	25	0.8	
CG8746	RAB-BUA-KIE	AT7	48	70%	34	0.3	
CG1746	RAB-BUA-KIE	DH8	24	70%	17	0.3	
CG8747	KIE-BUA-RAB	AT7	48	70%	34	0.3	
CG1747	KIE-BUA-RAB	DH8	24	70%	17	0.3	
CG8736	POM-RAB-KVG	AT7	24	70%	17	0.5	
CG8737	KVG-RAB-POM	AT7	24	70%	17	0.5	
CG8910 CG8912	POM-RAB-LNV	AT7	24	70%	17	2.7	
CG8911 CG8913	LNV-RAB-POM	AT7	24	70%	17	2.7	
CG1913	LNV-RAB-POM	DH8	12	70%	8	0.5	
CG8915	LNV-RAB	AT7	72	70%	50	0.8	
CG1915	LNV-RAB	DH8	36	70%	25	0.3	
CG8916 CG8920	RAB-LNV	AT7	72	70%	50	0.5	
CG1914 CG1916	RAB-LNV	DH8	36	70%	25	0.5	
CG8924	LNV-KVG-RAB	AT7	48	70%	34	0.8	
CG8925	RAB-KNG-LNV	AT7	48	70%	34	1.1	
Subtotal		DH8				3.8	4 times
		AT7				15.7	16 times
Total						19.5	20 times

Source: JICA Survey Team

5-5-4 Forecast Result of Domestic Flight Aircraft Movements

The forecasted values of peak day aircraft movements by route and aircraft type were aggregated to movements by aircraft type, and the annual and peak aircraft movements are summarized in Table 50. The forecasted values of GA were assumed to be the same as the present values (see Table 51).

Annual aircraft movement = Peak day aircraft movement / Peak day coefficient

Peak hour aircraft movement = Peak day aircraft movement × Peak hour ratio

Peak hour ratio (domestic flight) = 1.51 / Daily aircraft movement + 0.1151

Table 50 Forecasted Results of Domestic Flight Aircraft Movements
(Air Niugini and PNG Air)

	Aircraft	2025	2030	2035	2040
Annual aircraft movement		7,900	9,200	11,800	13,800
Peak day aircraft movement	Total	24	28	36	42
	DH8-Q400	8	10	12	16
	B737-max8	4	4	6	6
	DH8	2	4	4	4
	AT7	10	10	14	16
Peak hour aircraft movement	Total	6	6	7	8
	DH8-Q400	2	2	2	3
	B737-max8	1	1	1	1
	DH8	1	1	1	1
	AT7	2	2	3	3
Peak hour ratio		0.178	0.169	0.157	0.151

Unit: times
Source: JICA Survey Team

Table 51 Forecast Results of Domestic Flight Aircraft Movements (GA)

	2025	2030	2035	2040
Annual aircraft movement	1,800	1,800	1,800	1,800
Peak day aircraft movement	8	8	8	8

Unit: times
Source: JICA Survey Team

5-6 Forecast of Passenger Traffic and Aircraft Movements of International Flights

5-6-1 Forecasting Method

International flights are not in service at the Tokua Airport. Consequently, international visitors arrive at the Tokua Airport via Port Moresby and are categorized as domestic passengers. These visitors will travel via international flights from their origin airport or international airport hub to Tokua Airport, if available. Therefore, the JICA Survey Team assumed the international visitors traveling to Rabaul to be potential international passengers at the Tokua Airport.

In this section, international passenger traffic was forecasted in the case of international flights going into service at the Tokua Airport. The JICA Survey Team could not obtain the passenger origin and destination data (O/D data) from either NAC or the airlines, so they utilized data from TPA. TPA is responsible for international visitor statistics, which enable the analysis of the

destination and purpose of the trip. To analyze the potential traffic of international passengers, the JICA Survey Team hypothesized the following conditions:

- PNG residents do not travel via international flights.
- International visitors traveling to Rabaul and its adjacent islands use the Tokua Airport.
- The share of international visitors traveling to Rabaul and its adjacent islands via cruise is 47%. The remaining 53% of visitors use aircrafts.
- Visitors traveling by air avail roundtrip flights.

The estimation formula is:

Potential international passenger = International visitors to Rabaul and its adjacent island × Aircraft share (53%) × Round trip (2)

If there is enough potential of international passenger traffic at an origin airport, the international flight will be in service between the origin airport and the Tokua Airport. If not, passengers will travel via Port Moresby to Tokua Airport and will be consequently categorized as domestic passengers.

5-6-2 Visitors to PNG

TPA has several types of statistical data on visitors to PNG. The JICA Survey Team examined the data and found discrepancies. Inquiries regarding discrepancies were sent to TPA, but there was no reply.

Therefore, the JICA Survey Team compared the visitor data with economic indicators and selected the data to be used for traffic analysis.

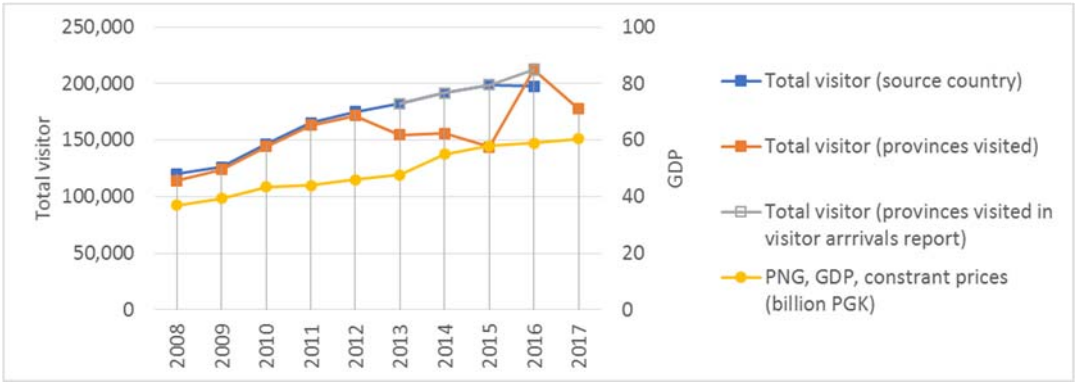
There are three types of data on visitors to PNG:

- Source country: statistics of country of origin of international visitors
- Provinces visited: statistics of destination province in PNG of international visitors
- Provinces visited in visitor arrivals report: statistics of destination province in PNG of international visitor shown in Visitor Arrivals Report 2014 and Visitor Arrivals Report 2016

Visitors traveling for business shared 35% of the total number of visitors, while those traveling for employment accounted for 23%; therefore, there is some relation between visitor number and GDP of PNG. In comparing the total visitors to PNG and the GDP of PNG (Figure 42), there are gaps in the data on provinces visited after 2013 (excluding 2016). In addition, 20% and 10% of purposes of visit are for vacation by air and vacation by cruise, respectively. Visitors from Australia accounted for 48% of the total. Therefore, there is also some relation between the

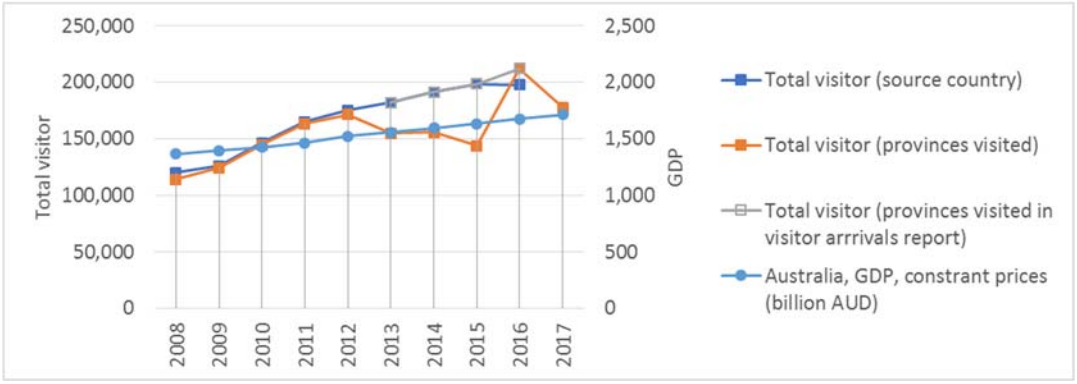
number of visitors and the GDP of Australia. In comparing the total visitors to PNG and the GDP of Australia (Figure 43), there are gaps in the data on provinces visited after 2013 (excluding 2016).

From the above described reasons, the data on provinces visited after 2013 (excluding 2016) was not utilized for the analysis in this section.



Source 1: TPA
Source 2: International Monetary Fund, World Economic Outlook Database, October 2018

Figure 42 Comparison of Total Visitors to PNG and GDP of PNG



Source 1: TPA
Source 2: International Monetary Fund, World Economic Outlook Database, October 2018

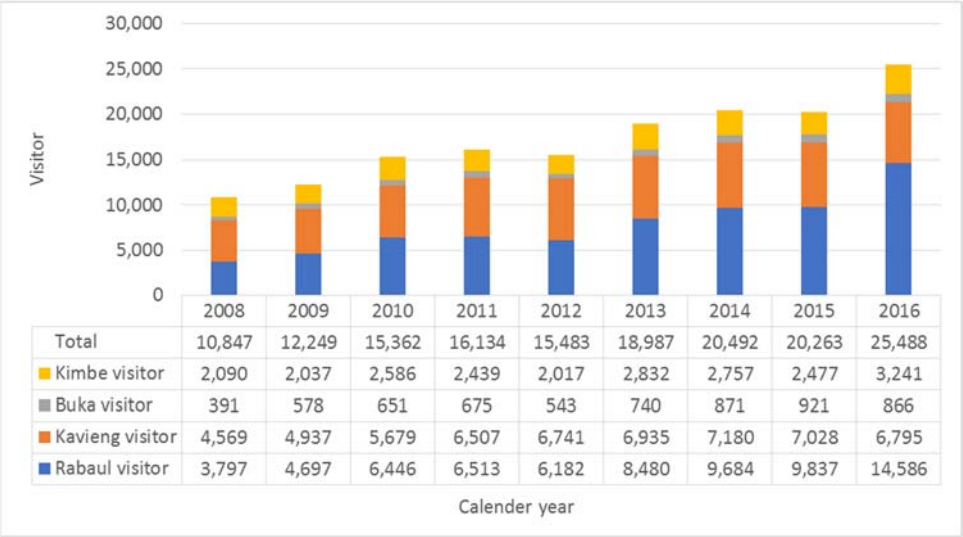
Figure 43 Comparison of Total Visitors to PNG and GDP of Australia

5-6-3 Forecast of Number of International Visitors to Rabaul and its Adjacent Islands

The destination provinces of international visitors were surveyed TPA. The JICA Survey Team assumed that the visitors to the following four provinces traveled via the Tokua Airport. The number of visitors is shown in Figure 44.

- East New Britain Province (ENBP), Rabaul
- West New Britain Province (WNBP), Kimbe
- New Ireland Province (NIP), Kavieng

- North Solomon Province (NSP), Buka



	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	10,847	12,249	15,362	16,134	15,483	18,987	20,492	20,263	25,488
Kimbe visitor	2,090	2,037	2,586	2,439	2,017	2,832	2,757	2,477	3,241
Buka visitor	391	578	651	675	543	740	871	921	866
Kavieng visitor	4,569	4,937	5,679	6,507	6,741	6,935	7,180	7,028	6,795
Rabaul visitor	3,797	4,697	6,446	6,513	6,182	8,480	9,684	9,837	14,586

Source (2008-2012): TPA, Provinces visited
Source (2013-2016): TPA, Visitor Arrivals Report 2014 and 2016

Figure 44 International Visitors to Rabaul and its Adjacent Islands

Table 52 Visiting Purpose to Rabaul and its Adjacent Islands

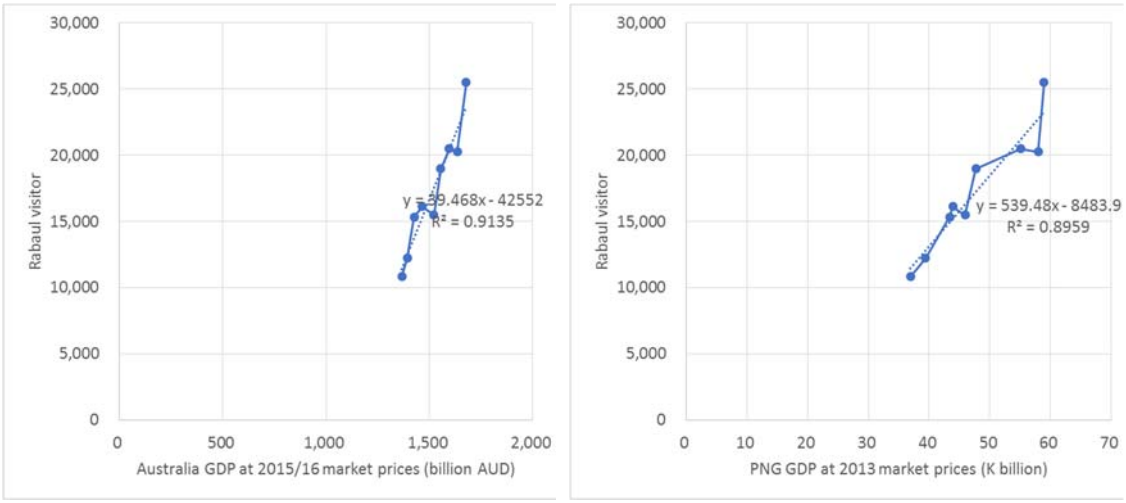
	Cruise	Total
ENBP Rabaul	10,985	14,586
NIP Kavieng	0	6,795
NSP Buka	0	866
WNBP Kimbe	917	3,241
Total	11,902	25,488
Share	47%	100%

Unit: people
Source: TPA, 2016

Traveling for vacation by cruise accounted for 47% of purpose of visit to Rabaul and its adjacent islands (Table 52), and most of the visitors came from Australia. Therefore, it was assumed that there was a relation between the number of visitors to Rabaul and its adjacent islands and the GDP of Australia, and the number of visitors was forecasted by regression analysis. The correlation between the number of visitors to Rabaul and its adjacent islands and the GDP of Australia was checked with the R^2 value. The resulting R^2 value was 0.913, which was high enough high to confirm a correlation between two valuables (Figure 45 a). In addition, a T-test was conducted, and the T-value obtained was 8.60. The result of T-test cleared the criteria of T=2, which was indicated in the Manual on Air Traffic Forecasting (ICAO, 2006).

Moreover, the correlation between the number of visitors to Rabaul and its adjacent islands and the GDP of PNG was checked. The R^2 value was 0.896, so it can be concluded that there is a correlation between the two variables (Figure 45 b). There is no major difference on the R^2 values of the two cases. In the case of the GDP of Australia, the R^2 value is slightly larger than PNG's; therefore, the GDP of Australia was selected as an explanatory variable of the visitor forecast.

The results of the visitor forecast are shown in Table 53.



(a) Australia (b) PNG

Source: JICA Survey Team

Figure 45 Scatter Plots of the Number of Visitors to Rabaul and its Adjacent Islands and the GDP

Table 53 Forecast of Number of Visitors to Rabaul and its Adjacent Islands

	2025	2030	2035	2040
Visitors	41,300	52,700	65,700	80,400

Source: JICA Survey Team

GDP elasticity was checked similar to domestic passenger analysis (Table 54). The calculated GDP elasticity is around 2, which means that the forecasted results are not overestimated.

Table 54 Analysis Results of GDP Elasticity

Analysis Period	2020-2025	2025-2030	2030-2035	2035-2040
Annual average GDP growth rate (Australia)	2.6%	2.6%	2.6%	2.6%
Annual average growth rate of visitor number	5.8%	5.0%	4.5%	4.1%
GDP elasticity	2.2	1.9	1.7	1.6

Source: JICA Survey Team

5-6-4 Forecasting Results of Potential International Passenger Traffic

Forecasting of potential international passenger traffic was done using the following formula:

Potential international passenger traffic
= Number of visitors to Rabaul and its adjacent islands × Share of air travel (53%) × Round trip (2)

The forecasted results of potential international passenger traffic are shown in Table 55. The projected value of international passenger traffic is 56,000 people per year in 2030, and 85,000 people per year in 2040.

Table 55 Forecasted Results of Potential International Passenger Traffic

2025	2030	2035	2040
43,800	55,900	69,600	85,200

Source: JICA Survey Team

5-6-5 Forecasted Results of International Passenger Traffic

The potential international passenger traffic was split by route, and the possibility of international scheduled flight service on each route was examined.

The JICA Survey Team examined five international routes to Tokua Airport (RAB) from Cairns (CNS), Brisbane (BNE), Narita (NRT), Manila (MNL), and Singapore (SIN). International visitors to PNG were allocated to five routes as shown in Table 56. Visitors from Australia were equally allocated to CNS (50%) and to BNE (50%). Visitors from Oceania were assumed to arrive at Tokua Airport via Port Moresby.

The aircraft type in service of international flights was assumed to be B737-Max8. The criteria of load factor are as follows: 30% for a 3-point connection (POM-RAB-Origin or Destination), 60% for a 2-point connection (RAB-Origin or Destination), and the upper is 90%.

The equation used is shown below, and the calculation results are shown in

Table 57.

Potential international passenger traffic per year (by route)
= Potential international passenger traffic per year × Route share

Potential international passenger traffic per week (by route)
= Potential international passenger traffic per year (by route) / 52 weeks

Load factor = Potential international passenger traffic per week (by route) × Flight number / 152 seats (B737-Max8)

As a result of the calculation, the team forecasted that two flights (one round trip) per week would be in service on each route in 2030.

International passenger traffic by route was estimated, and the annual and peak demands were calculated as indicated in Table 58.

International passenger traffic per year
= International passenger traffic per week × 52 weeks

International passenger traffic on peak day
= International passenger traffic per week / International aircraft movements per week × 2 times

International passenger traffic at peak hour
= International passenger traffic per week / International aircraft movements per week × 1 time

Table 56 Passenger Share Allocation on Five International Routes

	CNS	BNE	NRT	MNL	SIN
Australia	24.2%	24.2%			
New Zealand		5.0%			
Oceania					
China				4.7%	
Japan			2.0%		
Korea			0.9%		
Malaysia				3.3%	
Singapore					1.0%
Philippines				8.3%	
Indonesia					
India					2.4%
Other Asia				2.2%	
United Kingdom					3.3%
Germany					1.5%
France					0.7%
Netherlands					0.4%
Other Europe					1.5%
USA			5.8%		
Canada			1.2%		
Other America			0.4%		
Africa					0.7%
Russia					0.3%
Italy					0.2%
Scandinavia					0.3%
Chile					0.0%
Israel					0.1%
Total	24.2%	29.2%	10.2%	18.6%	12.3%

Source: JICA Survey Team

Table 57 Forecast of Aircraft Movements and Load Factor of Five International Routes

Rout	Calculation Item	Share	2025	2030	2035	2040
CNS	Potential passenger traffic per year (person)	24.2%	10,590	13,517	16,842	20,621
	Potential passenger traffic per week (person)		204	260	324	397
	Load factor		67.0%	85.5%	90.0%	65.2%
	Passenger traffic per week (person)		204	260	274	397
	Aircraft movements per week (times)		2	2	2	4
BNE	Potential passenger traffic per year (person)	29.2%	12,778	16,310	20,322	24,881
	Potential passenger traffic per week (person)		246	314	391	478
	Load factor		80.8%	90.0%	64.3%	78.7%
	Passenger traffic per week (person)		246	274	391	478
	Aircraft movements per week (times)		2	2	4	4
NRT	Potential passenger traffic per year (person)	10.2%	4,464	5,697	7,099	8,691
	Potential passenger traffic per week (person)		86	110	137	167
	Load factor		28.2%	36.0%	44.9%	55.0%
	Passenger traffic per week (person)		0	110	137	167
	Aircraft movements per week (times)		0	2	2	2
MNL	Potential passenger traffic per year (person)	18.6%	8,139	10,389	12,945	15,849
	Potential passenger traffic per week (person)		157	200	249	305
	Load factor		51.5%	65.7%	81.9%	90.0%
	Passenger traffic per week (person)		157	200	249	274
	Aircraft movements per week (times)		2	2	2	2
SIN	Potential passenger traffic per year (person)	12.3%	5,383	6,870	8,560	10,481
	Potential passenger traffic per week (person)		104	132	165	202
	Load factor		34.0%	43.5%	54.2%	66.3%
	Passenger traffic per week (person)		104	132	165	202
	Aircraft movements per week (times)		2	2	2	2

Source: JICA Survey Team

Table 58 Forecasted Results of International Passenger Traffic

	2025	2030	2035	2040
Annual	36,900	50,700	63,200	78,900
Weekly	710	980	1,210	1,520
Peak day	177	195	202	217
Peak hour	89	98	101	108

Source: JICA Survey Team

5-6-6 Forecasted Results of International Aircraft Movements

The number of international aircraft movements per week was calculated for each route, and the annual and peak demands were calculated (see Table 59).

International aircraft movements per year
= International aircraft movements per week × 52 weeks

International aircraft movements on peak day
= International aircraft movements per week / 7 days = 2 times

International aircraft movements at peak hour = 1 time

Table 59 Forecasted Results of International Aircraft Movements

	2025	2030	2035	2040
Annual aircraft movements	416	520	624	728
Weekly aircraft movements	8	10	12	14
Peak day aircraft movements	2	2	2	2
Peak hour aircraft movements	1	1	1	1

Unit: times
Source: JICA Survey Team

5-6-7 Cargo Demand Forecast

It was assumed that the air cargo handling volume was proportionate to the passenger traffic. Cargo volume per passenger was calculated in Table 60.

Table 60 Cargo Volume per Passenger

	2016	2017	2018 up to Sep.	Average
Arrival passenger	18,484	21,394	22,195	
Cargo volume	129,959 kg	197,433 kg	166,807 kg	
Cargo volume per passenger	7.0 kg	9.2 kg	7.5 kg	7.9 kg

Source: PNG Air

Domestic and international cargo volumes were forecasted considering the calculated value of 7.9 kg of cargo per passenger (Table 61).

Table 61 Forecasting Results of Cargo Volume

	2025	2030	2035	2040
Domestic cargo	1,900 tons	2,500 tons	3,200 tons	4,100 tons
International cargo	290 tons	400 tons	500 tons	620 tons

Source: JICA Survey Team

5-7 Summary of Traffic Demand Forecasting Results

The results of the traffic demand forecast are shown in Table 62.

Table 62 Summary of Traffic Demand Forecasting Results

		2017	2025	2030	2035	2040
Domestic passenger traffic (person)	Annual	162,427	243,000	315,000	405,000	514,000
	Peak day	617	870	1,120	1,450	1,840
	Peak hour	95	154	190	227	277
International passenger traffic (person)	Annual	---	36,900	50,700	63,200	78,900
	Peak day	---	177	195	202	217
	Peak hour	---	89	98	101	108
Domestic aircraft movements (times)	Peak day	20.9	24	28	36	42
	Peak hour	3.6	6	6	7	8
International aircraft movements (times)	Weekly	---	8	10	12	14
	Peak hour	---	1	1	1	1
Domestic cargo (tons)	Annual	No data	1,900	2,500	3,200	4,100
International cargo (tons)	Annual	---	290	400	500	620

Source: JICA Survey Team

Chapter6 Airport Development Plan and Preliminary Cost Estimate

6-1 Basic Policy

6-1-1 Role of Tokua Airport

NAC has a policy to utilize the Port Moresby International Airport as an international gate way airport and 4 regional airports, Tokua, Nadzab Mount hagen and Goroka, as regional hub airports. Tokua Airport is a hub airport of surrounding islands area.

The Government of PNG stated in PNG Tourism Master Plan 2007-2017 that East Highland, East New Britain, Madan and Milne Bay are important area for tourism development. The World Bank has conducted Tourism Sector Development Plan in Milne Bay and East New Britain.

Source: ENB Tourism Master Plan 2017-2022

Figure 46 Major Tourist Spots in ENB

Tokua Airport is expected to be a regional hub for northern islands area and an international airport.

6-1-2 Long Term Development Plan

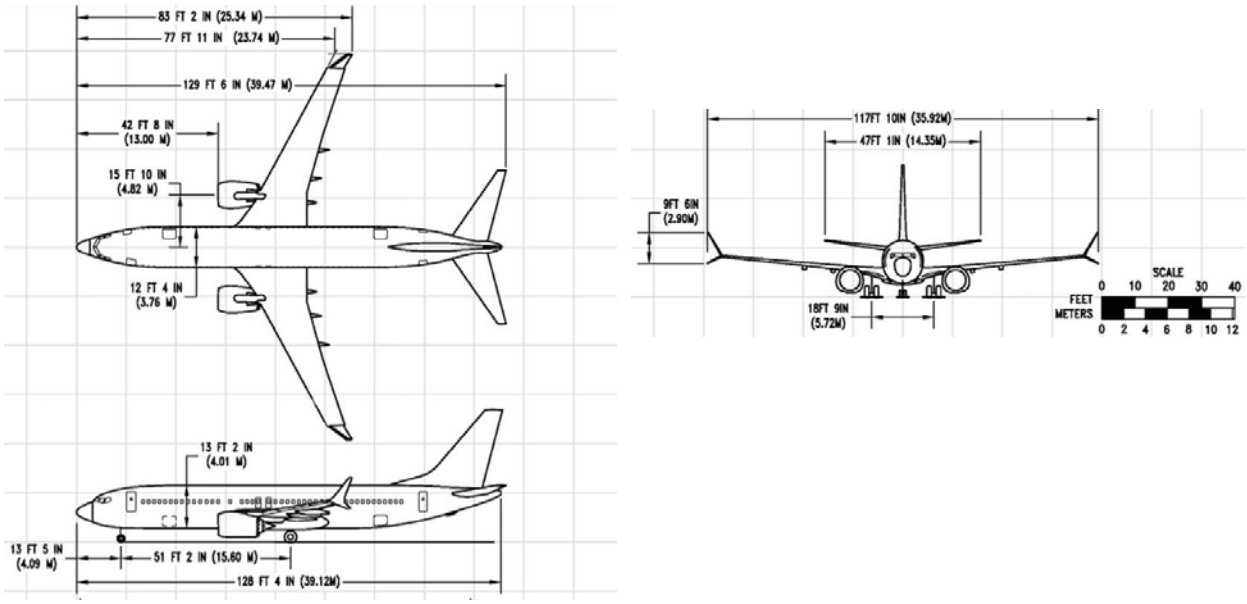
Because there is no long term development plan of Tokua Airport, there is a possibility that locations of the current plan of fences, power station and market by CADIP may cause constrains of utilization of area and future development. It is necessary to prepare long term development plan (Airport Master Plan) during the next study phase and phased development plan should be prepared.

NAC and airlines plan to use Tokua Airport as a hub airport for northern island area. To reflect this policy, it is planned to introduce larger aircraft than current F100 (100 seats). Air Niugini ordered 4 B737 Max 8 to Boeing and 2 of them will be delivered in 2020 and another 2 in 2021. Seat capacity of the B737 Max 8 will be between 150 to 150 seats. Air Niugini plans to retire F100 and Mitsubishi MRJ is one of the candidates.

It is presumed that in 2025, when the project will be completed, the maximum aircraft operated in Tokua Airport is B737 Max 8 so that the design aircraft is B737 Max 8.

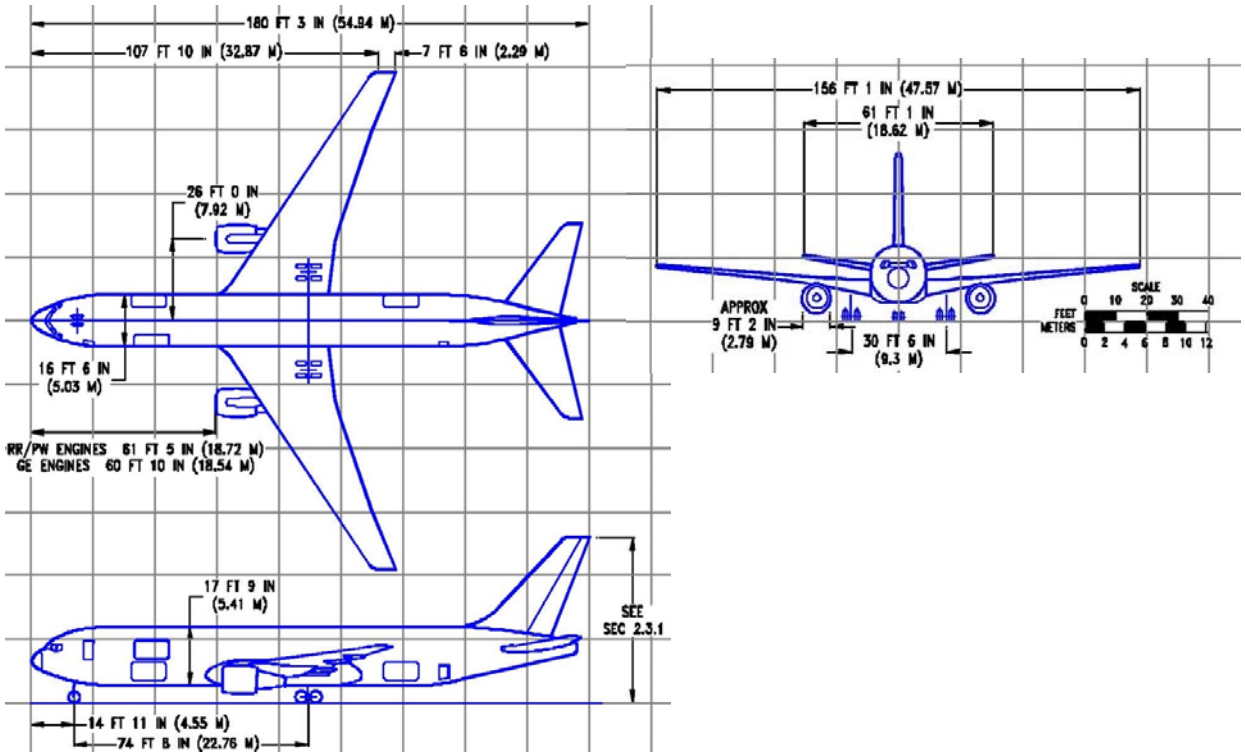
Because it is possible for Tokua Airport to be an alternate airport to Port Moresby International Airport and it is not easy to large scale expansion of apron pavement, B767 is selected as the design aircraft for the apron.

The shape and size of B737 Max 8 and B767-300 are as shown in Figure 47 and Figure 48.



Source: Boeing "Airplane Characteristics for Airport Planning" D6-38A004, June 2018

Figure 47 Shape and size of B737 Max 8



Source: Boeing "Airplane Characteristics for Airport Planning" D6-58328, September 2005

Figure 48 Shape and size of B767-300

6-2 Airport Basic Facilities

6-2-1 Runway

(1) Cross Wind Runway

Orientation of the existing runway is 101/281 degrees. According to interviews from airlines, it is difficult for a small propeller airplane to land Tokua Airport during strong cross wind period and it was requested to consider construction of a cross wind runway. Wind velocity and direction are observed 4 times are day in every 3 hours between 7 and 16 o'clock in Tokua Airport. 5 years records from January 2013 to December 2017 was used to analyze the necessity of the cross wind. As the result of the analysis, necessity of the cross wind runway was not technically adjusted. The result is attached in the appendix of the report.

(2) Runway Length

Runway length requirements for B737 Max 8 was studied. B737 Max 8 is small size jet with seat capacity of 178 to 189 and this is a single aisle aircraft. The wing span is 35.92m, length is 39.47m, the Outer Main Gear Wheel Span (OMGWS) is 7.0m. ICAO aircraft reference number and letter is 4C. The required runway width is 45m and no shoulder is required.

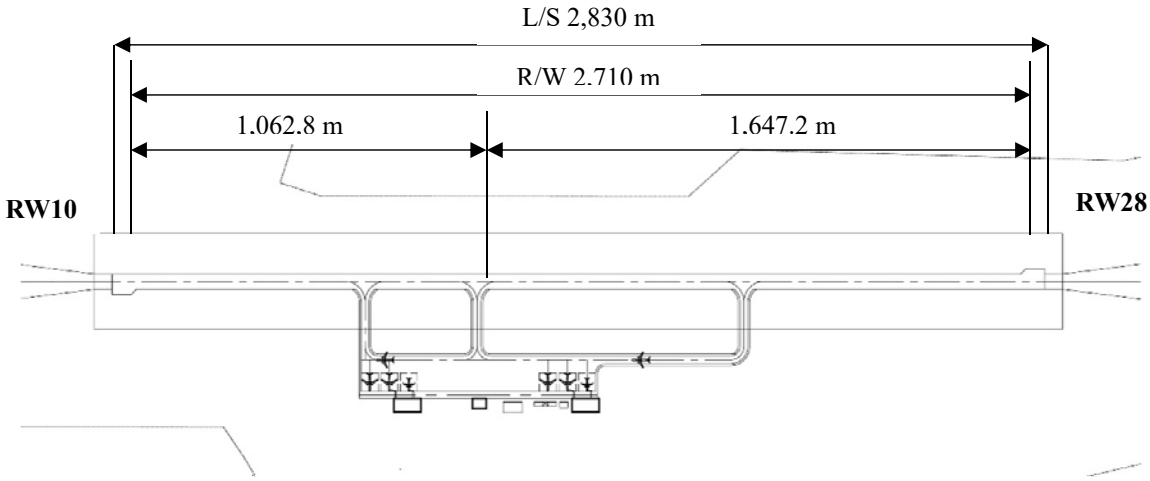
According to the Airplane Characteristics for Airport Planning of B737 Max provided by the Boeing, the maximum take off weight is 32,190 thousand kg (181,200 ponds) and based on the payload and range chart, 3,706 km (2,000 nautical miles) is the maximum range with full payload. In case of traveling longer distance than the range, weight restriction to reduce number of passengers are required. The runway length requirement for maximum takeoff weight at sea level runway with 15 degrees Centigrade plus international standard atmosphere day, is 2,600 m (8,700 feet). The reference temperature of Tokua Airport, which is 31.6 degrees Centigrade and elevation of 15 m are used to calibrate the length and after the calibration, the runway length requirement is 2,710m.

NAC and Air Niugini requested the team to develop the runway of 2,170 m in Tokua Airport. There is enough space to extend the runway to 2,710 m in Tokua Airport, it was planned extend 500 m in the runway 28 side and 490 m in the runway 10 side.

6-2-2 Taxiway

One of the particular characteristic of Tokua Airport is that there are many operators to operate small aircraft in the airport. There are sometimes waiting time to enter the runway because there

is only one connecting taxiway between the runway and the apron, it takes time to enter the apron after touch down on the runway. It is necessary to add a new taxiway and to expand and rehabilitate the existing taxiway. It should be considered on planning the new taxiway for landing aircraft not to move to the runway end in either direction of the landing and leave the runway to the taxiway in between the end of the runway. In some cases, partial parallel taxiway should be considered to reduce runway occupancy time during landing and takeoff.



Source: JICA Survey Team

Figure 49 Layout Plan of Runway and Taxiway

6-2-3 Apron

The number of existing apron spots is not enough for the use of many small aircrafts classified as General Aviation (GA), though there are three spots for F100, two spots for DHC8, and two or three spots for GA. Additional spots for B737-Max8 will be required in 2025.

Based on the situation above, it is required not to disturb existing apron operations during the construction period for the new apron. As the apron pavement for B737-Max8 and B767-300 aircrafts should be applied with cement concrete because of their heavy wheel load on the parking area, the location of the new apron for B737-Max8 should be planned next to the existing apron, not exactly in the existing apron. Therefore, the new apron will be constructed without stopping existing apron operations.

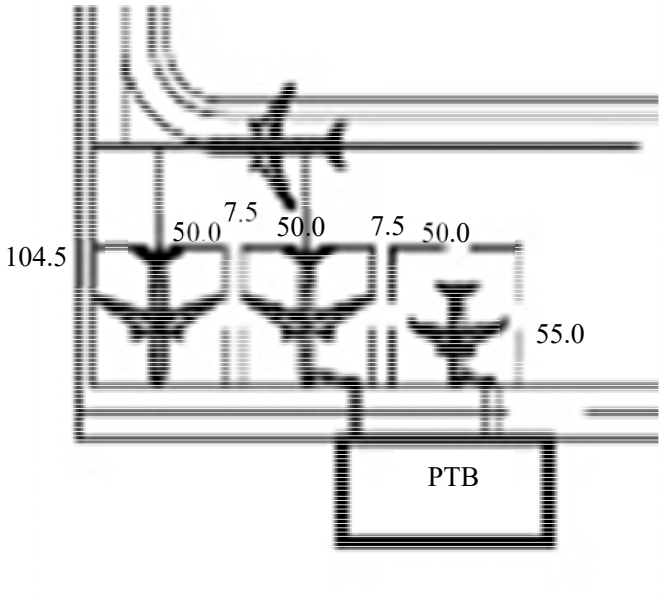
Three spots are required for domestic aircrafts and two for international aircrafts based on the peak hour aircraft. The size of the parking spot is a 50 m x 55 m square to accommodate B767-

300 aircrafts which will be assigned to non-scheduled flights in Tokua. Then, there is one spot for domestic scheduled flights, one spot for both domestic and international flights, and one as a reserve, so a total of three spots should be constructed. A spot for small aircrafts, such as the DH8-Q400, for domestic scheduled flights will be used in the existing apron. There are two options for the expansion plan as shown in Figure 51 and Figure 52. However, NAC had a facility layout plan located in the east of the existing apron area, so the future land use plan should be discussed with NAC in case B.

Table 63 Numbers of Aircrafts during Peak Hour

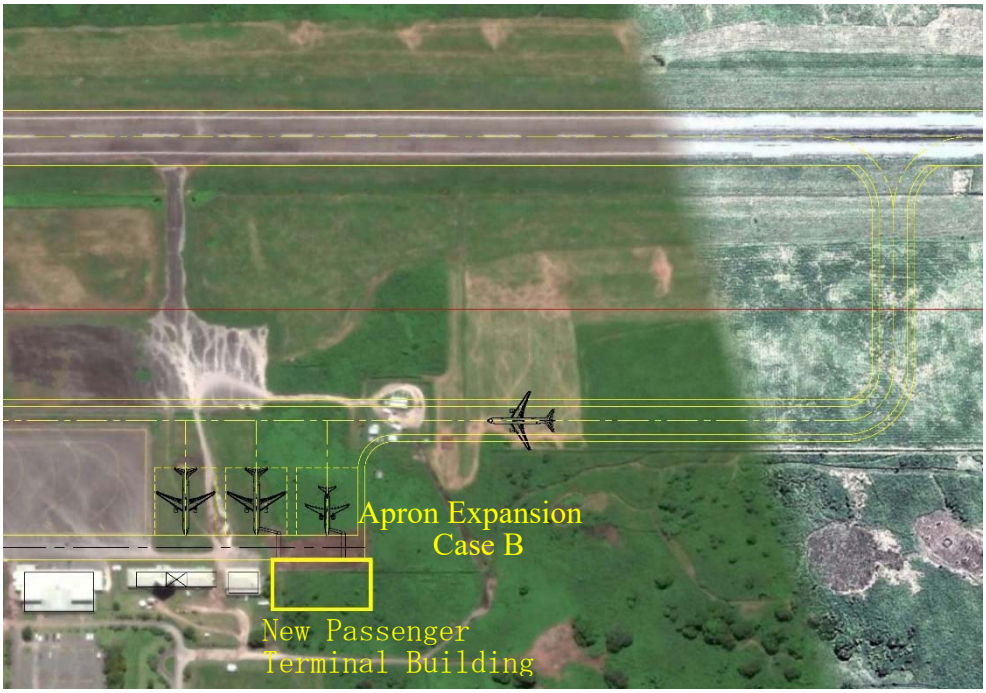
		Year 2025	Year 2035	Spot Operation
Domestic	B737 Max 8	1	1	Park at the spot for B767-300
Domestic	DH8-Q400	2	2	Park at the exist apron
International	B737Max or B767-300	1	1	Park at the spot for B767-300
Reserve	B767-300	1	1	

Source: JICA Survey Team



Source: JICA Survey Team

Figure 50 Apron Layout Plan



Source: JICA Survey Team

Figure 51 Apron Expansion Plan Case B

Source: JICA Survey Team

Figure 52 Apron Expansion Plan Case A

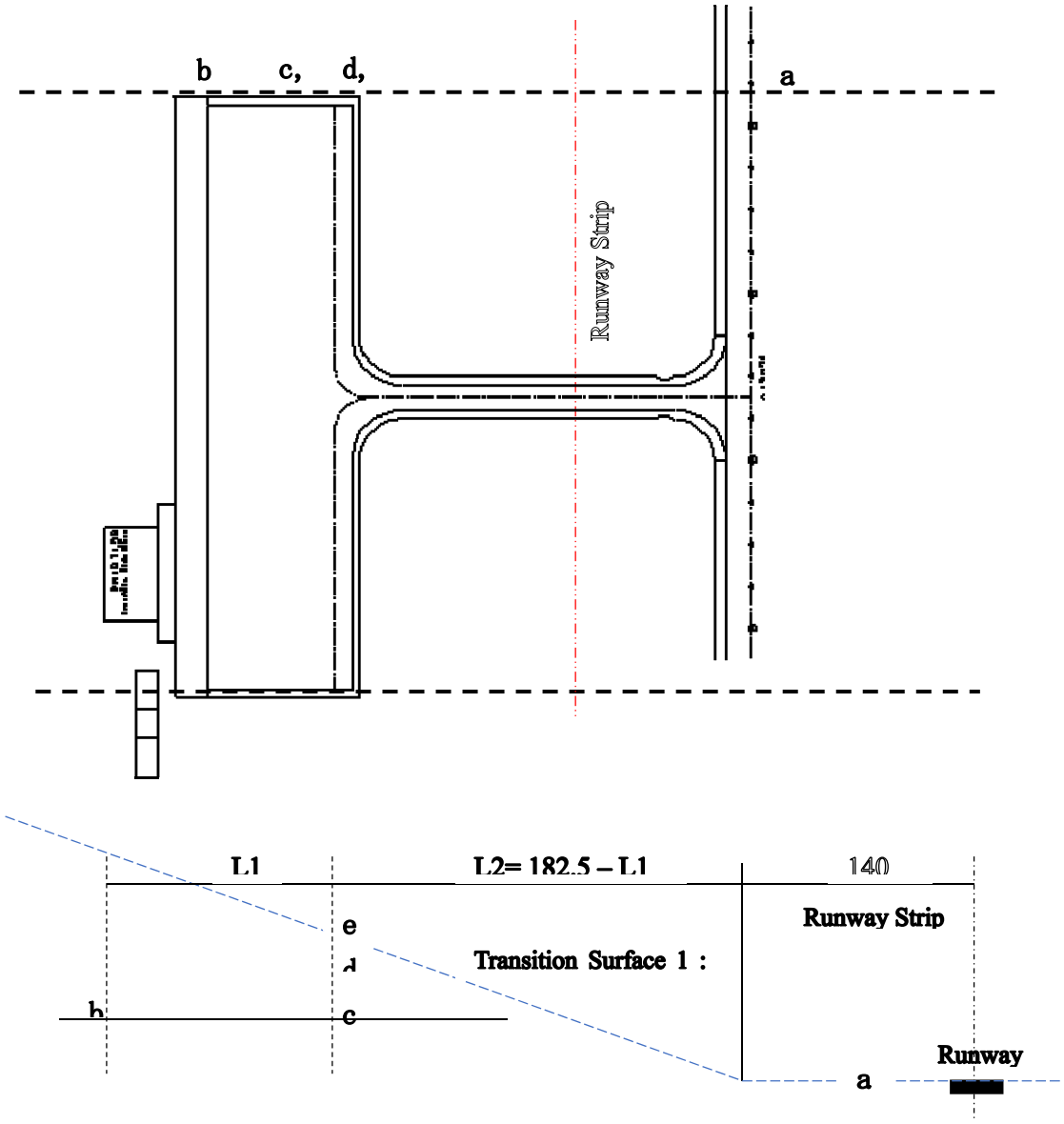
6-2-4 Apron Edge Line

The existing apron was designed to have a depth of 85 m, taking into consideration obstacles for the transitional surface when a mid-sized jet aircraft is parked at the apron. It is expected that a B767-300 can use the new apron, and the apron depth line has to be set without obstructions to the B767-300. Clearance between the altitude of the top of the aircraft and the altitude of the transition surface at the edge of the existing apron was examined, as shown in Table 64. The clearance in the case of the B737-Max8 parking will be over 5 m, satisfying requirements; however, the clearance in the case of the B767-300 parking will be inadequate at only 0.4 m. Obstructions will be cleared by lowering the design altitude of the new apron. Then, the apron depth line was planned same as the existing line.

Table 64 Obstruction of Transition Surface on Parking Apron

Item	B737 Max 8		B767-300	
ICAO Code	4C		4D	
Length of Aircraft L_1 (m)	39.5		55.0	
Distance from Runway Strip L_2(=182.5- L_1)	143.0		127.5	
Height of Aircraft H (m)	12.45		16.13	
Apron Side	West	East	West	East
Runway Altitude : a (m)	7.085	9.377	7.085	9.377
Apron Altitude at Edge: b (m)	10.000	12.100	10.000	12.100
Altitude of Apron at Tail : c (= b-L_1 x x0.8%)	9.684	11.784	9.560	11.660
Altitude of Top of Aircraft : d (=H+ c)	22.134	24.234	25.690	27.790
Altitude of Transition Surface e (= a + L_2 x 1/7)	27.514	29.806	25.299	27.591
Obstacle Clearance between d and e f(= e – d)	5.380 ok	5.572 ok	-0.391 out	-0.199 out

Source: JICA Survey Team



Source: JICA Survey Team

Figure 53 Relation between Transition Surface and Aircraft on Apron

6-2-5 Pavement Structure

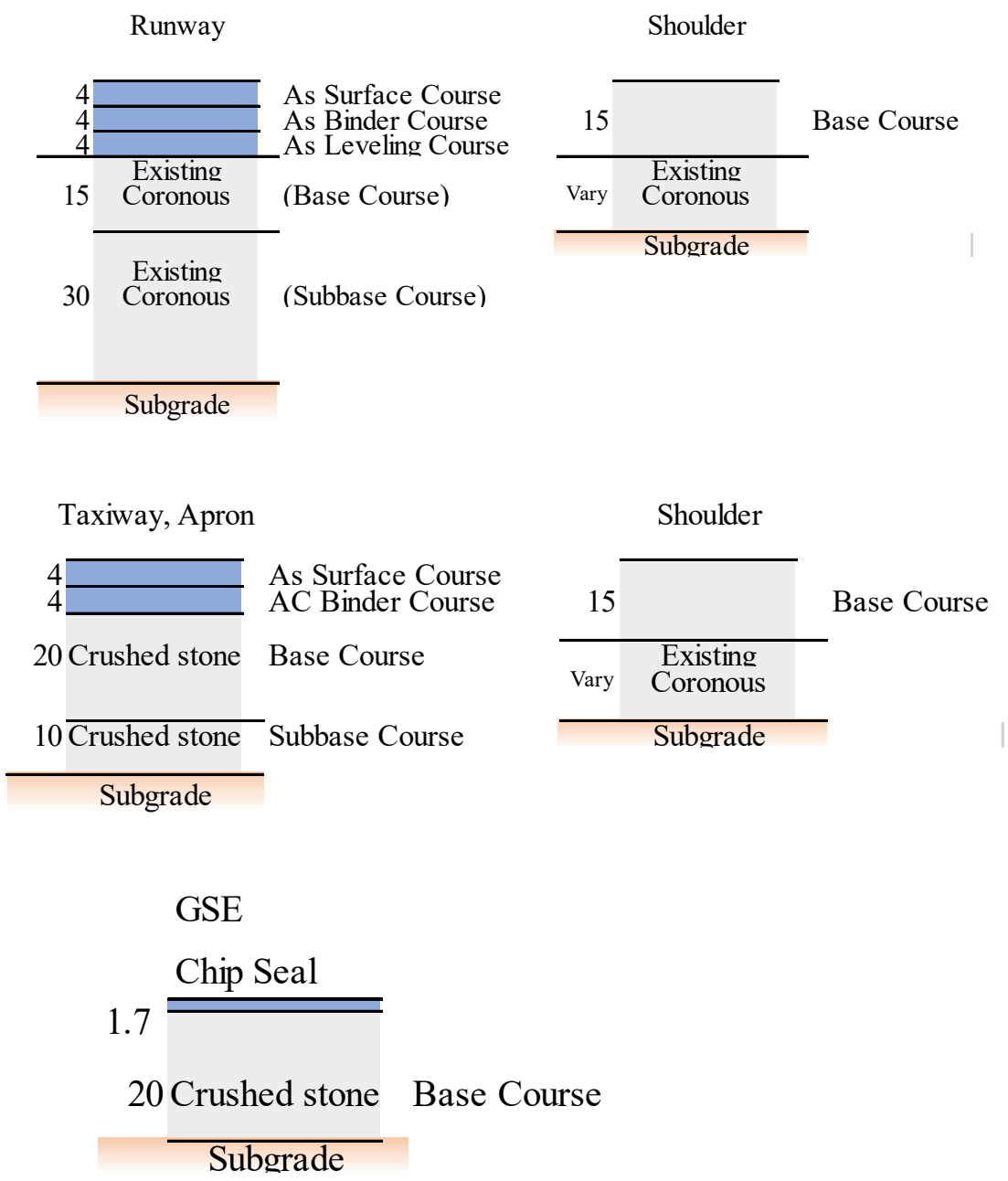
Because there was no major rehabilitation of the pavement at Tokua Airport for 20 years since it inauguration in 1998, pavement deterioration is significant. There were partial repair on the runway, but as there is no hot mix asphalt plant in Kokopo, room temperature asphalt mix is used.

Runway extension, expansion of the apron, runway overlay associated with introduction of larger aircraft are planned. The new pavement should apply the design conditions below. Figure 54 shows the existing pavement, while Figure 55 shows the new pavement.

Design Aircraft: Mainly B737-Max 8 and partially B767-300 for apron

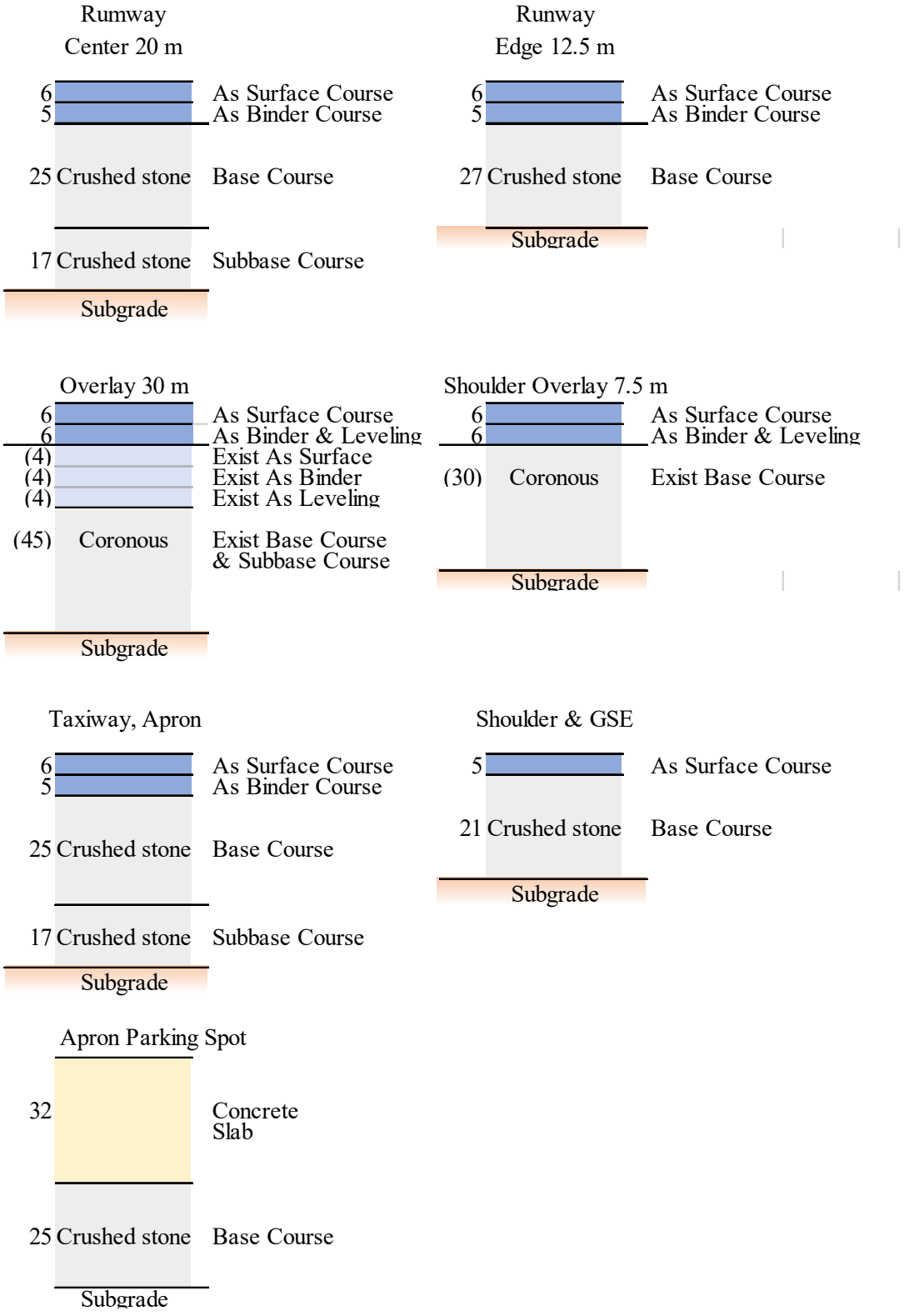
Design CBR: 10%

Original Design Thickness 52cm



Source: JICA Survey Team

Figure 54 Exist Pavement Structure



Source: JICA Survey Team

Figure 55 New Pavement Structure

6-2-6 Passenger Terminal Building

The required area for the domestic and international terminal buildings were calculated as shown in Table 65 and Table 65 using formulas from the "Airport Development Reference Manual 10th Edition" issued by the International Air Transport Association (IATA). The new terminal building should have two stories because NAC requested two boarding bridges for the new passenger terminal building. It will thus be reasonable to have only one new terminal building that will operate for both domestic and international passengers because B737-Max8 is expected to be used for both domestic and international routes. So, one new terminal building with both domestic and international functions was planned. The area for the domestic terminal was calculated as 3,500 m^2, and was 4,000 m^2 for the international terminal.

Table 65 Required Area for Domestic Passenger Terminal Building

Item	Unit	2017 (Exist)	2025 (Forecast)	2035 (Forecast)
Annual Passenger	-	162,427	243,000	405,000
Peak Day Passenger	-	617	870	1450
Peak Hour Passenger	-	―	154	227
1) Departure Lobby	m^2		165	228
2) Check-in Lobby	m^2		45	65
3) Departure Gate Lounge	m^2		285	416
4) Baggage Claim area	m^2		64	93
5) Arrival Lobby	m^2		68	99
6) Baggage Make up area	m^2		90	133
7) Baggage Break down area	m^2		75	110
Processing area A1=1)～7) Total	m^2		792	1,144
Airline office, Concession, Restaurant, A2= A1 x 2	m^2		1,584	2.288
Total Area A= A1 + A2	m^2	1,300	2,376	3,432

Source: JICA Survey Team

Table 66 Required Area of International Passenger Terminal Building

Item	Unit	2017 (Exist)	2025 (Forecast)	2035 (Forecast)
Annual Passenger	-	0	36,900	63,200
Peak Day Passenger	-	0	100	170
Peak Hour Passenger	-	―	65	111
1) Departure Lobby	m^2		76	126
2) Check-in Lobby	m^2		25	40
3) Immigration Area	m^2		179	179
4) Departure Gate Lounge	m^2		244	416
5) Immigration Area	m^2		72	109
6) Baggage Claim Area	m^2		27	46
7) Tax	m^2		63	67
8) Arrival Lobby	m^2		29	49
9) Baggage Make up Area	m^2		90	154
10) Baggage Break down Area	m^2		75	128

Processing area A1=1)～10) Total	m^2		880	1,314
Airline Office, Concession, Restaurant, A2= A1 x 2	m^2		1,760	2,628
All Area A= A1 + A2	m^2	0	2,640	3,942

Source: JICA Survey Team

6-2-7 Cargo Terminal Building

Tokua airport is a hub airport for small airport and airfield in northern islands area and it was confirmed there are certain volumes of air cargo. Major transport items are clothing, spare parts of machine and computers, spare parts of construction equipment in the mine and fresh food to the mine. There are international shipment via Port Moresby such as sea cucumbers and balsa woods.

There is no facility to handle cargo in the airport and cargo handling is conducted under the open air. It is necessary to construct a new cargo facility with refrigerator.

6-2-8 Fire Station

There are bays to store 3 fire fighting vehicles in the existing fire station. 3 fire fighting vehicles are sufficient to cope with the operation of larger aircraft so that expansion of the fire station is not necessary. However, the airport is aging and it is necessary to renovate the building for water leaks and air conditioning.

6-2-9 Control Tower

There are many cracks on the structure of the control tower. According to the structural analysis report by an Australia consultant contracted by PNG Air Services, the remaining life of the building is 5 years and structural reinforcement or re-building was recommended.

In case of runway extension is took place, line of sight and view angle from the control cabin and extended runway threshold may not meet the international standard and in that case, a new control tower is necessary.

6-2-10 Air Navigation Equipment

There is VOR/DME in Tokua Airport, which was installed in 1998 by Japanese Grant Aid but this equipment hasn't been used and maintained. PNG Air Services has introduced new satellite based navigation system and the VOR/DME is not necessary in future so that no new air navigation equipment is necessary.

6-2-11 Other facility and equipment

The power supply system and the generator, which will be installed by ADB CADIP, are not considered future airport development. Expansion of the capacity of the power supply system is necessary as a new building, new airfield lighting system associated with the runway, the taxiway and the apron expansion are planned. It is necessary to replace the fence as the runway will be extended.

Since there is only one pump at the well for the existing water supply system, it is possible to stop the water supply during maintenance and break down. Expansion of the capacity of the water supply system is necessary for new facilities.

6-2-12 Present Condition of Equipment Procured by Japanese Grant Aid

The table below summarizes present condition of equipment, which was procured by Japanese Grant Aid Project in 1998, and necessity of replacement of the Project.

Table 67 Present Condition of Equipment Procured by Japanese Grant Aid Project

Facilities	Quantity	Specifications	Condition	Necessity of Replace by the Project
Navigation and Communication				
(1) VOR/DME	1 lot	VOR: 111.95-117.97Hz, 100W DME: 962-1212MHz Power Supply / UPS	Stop radio wave	Yes
(2) Communication Console 1)Tower 2) AFTN	 1 lot 1 lot	 3 Consoles for Aerodrome, Ground & Coordinator 3 Consoles for AFTN	 Using No use	Yes*1 No
(3) ATC Tape Recorder	1 lot	Magnetic Head 10ch	No use	Yes*1
(4)VHF Transmitter & Receiver 1)Tokua TWR 2)Transmitter & Receiver 3)Power Supply	1 lot 1 lot 1 lot	 Communications between ATC & Pilots, 120.9 MHz Emergency Communication from aircraft, 121.5MHz Power supply / UPS	 Using Using Using	 Yes*1 Yes*1 Yes*1
(5)HF AFS SSB	1 lot	Buck-up system for PTC 2.8MHz ～22MHz	Using	Yes*1
(6)VHF FM 無線機	2 lots 5 lots	Communications between ATC, Fire Trucks, & other car 145-150MHz	Using	Yes*1

Meteorological System				
Surface Weather Observatory System	1 lot	Wind Speed & Direction, Temperature, Barometer	Replaced system	No
Airfield Lighting System				
(1) Runway Edge (REDL)	1 lot	Above-surface type, 150W Buried type, 185W Turning pad portion / above surface type, 45W (both RW)	Using	Yes*2
(2) Runway Threshold/End (RENL/RTHL)	54 sets 24 sets 6 sets	Above-surface type, 200W Buried type, 200W	Using	Yes
(3) Taxiway Edge (TEDL)	4 sets 12 sets	Above-surface type, 45W	Using	Yes*3
(4) Runway End Indicator (REIL)	26sets	2 Flashings x 2	Using	Yes*2
(5) Wind Direction Indicator (WDIL)	4sets	Both sides RWY28/10 ends	Using	Yes
(6) Aerodrome Beacon (ABN)	2sets	On ATC Tower top, 1000W	Using	Yes
(7) Apron Flood (FLO)	2 sets	On Terminal Bldg. roof, 1000W x 2	Using	Yes*4
(8) Lights Control Panel / Power Supply				
1) Lights Control	1 lot	Console in ATC room 5F	Using	Yes*5
2) Power Supply	1 lot	Console in Power room 1F CCR 30KVA x 2、5KVA x 2、3.5KVA x 2	Not use Using	Yes Yes
(9) Light Gun	1 lot	In ATC room, 100W	Using	Yes*1
Power Supply				
(1) Commercial Power Receiving Station	1set	Convert 22KV to 11KV & 450V		Yes
(2) Generator System	1set	Provide fuel tank capable to run 48hrs, 415V 3φ, 350KVA、	Not use Out of order	Yes*6
(3) Aerodrome Power Line	1set	11K & 415KV underground	Using	Yes

*1: It is necessary to replace to enable parallel operation of the existing and the new control tower on construction of a new control tower

*2: New lights are required on both runway extension area and the existing runway because the existing runway will be widened.

*3: New lights for a new taxiway and replacement on the existing taxiway are required.

*4: New lights of a new apron and replacement on the existing apron are required.

*5: New installation is planned by CADIP but it is necessary to renew because of the new airfield lighting system

*6: Replacement is planned by CADIP but total power requirements will be large so that new system is required.

Source: JICA Survey Team

6-3 Trial Calculation of Construction Cost

Table 68 shows the rough estimate for the construction cost which is based on the documents collected by the JICA Survey Team and shown in Table 67. It was assumed that there were many differences in the unit rate or unit cost for construction between the Port Moresby area and the islands of East New Britain area; therefore, appropriate costs should be applied. The rough estimate was not based on the detailed design conditions discussed with NAC or any concerned party and should be more accurate in the next stage.

Table 68 Collected Documents for Rough Estimate of Construction Cost

Organization	Document	Reference Area	Year of Estimation
NAC/ CADIP	Mt. Hagen Airport New Terminal Building and Associated Work	Mt. Hagen	2015
NAC/ CADIP	Mt. Hagen Airport Aircraft Strengthening New Air Traffic Control Tower & Associated Works	Mt. Hagen	2017
NAC/ CADIP	Tokua Airport and Nadzab Airport Standby Power Supply Upgrade Works	Nadzab Tokua	2018
NAC/ CADIP	Tokua Airport Supply and Installation of Security Fencing and Associated Works	Tokua	2018
Gazelle Restoration Authority Project Implement Unit	Rough Estimation for Tokua Airport Expansion Project	Tokua	2018
MPW (Dai Nippon Construction)	Waste Water Treatment Construction Project	POM	2015

Source: JICA Survey Team

Table 69 Preliminary Construction Cost Estimate

33 JPY／kina

Item 1	Item 2	Quantity	Unit	Unit Cost (JPY)	Cost(JPY)
(Civil Work)					
New Runway work	Center portion w=20m	20,000	m^2	24,848	496,969,616
New Runway work	Edge portionw=25m	25,000	m^2	24,848	621,212,020
Runway Overlay	Exist w=30m	51,600	m^2	22,944	1,183,890,090
Runway Shoulder Overlay	Both side w=7.5m	25,800	m^2	22,944	591,945,045
New Overrun	W45m x L60m	5,400	m^2	14,109	76,191,121
New Taxiway	W23m x L196m	4,497	m^2	23,054	103,664,508
New Apron Hot mixed As	W172m x L52m	8,951	m^2	22,008	196,995,657
New Apron Cement concrete	W165m x L55m	9,075	m^2	44,202	401,136,067
Runway Grooving	W45m x L2700m	121,500	m^2	1,833	222,723,716
Pavement work Total					3,894,727,839
Runway Strip Development	Cut & Fill	239,200	m^3	858	205,233,600
Runway Fill side 28	Fill	420,000	m^3	1,287	540,540,000
Runway Fill side 10	Fill	700,000	m^3	1,287	900,900,000
Drainage work	Trench, Ditch	6,000	m	42,900	257,400,000
New Security Fence	H 1.8m	2,000	m	25,740	51,480,000
Exist Security Fence Moving	H 1.8m	800	m	429	343,200
Perimeter road in Airfield	W=5m、Coral stone	6,600	m	9,116	60,167,250
New Parking Area		10,000	m^2	14,109	141,094,668
Exist Parking Improvement		3,000	m^2	7,055	21,164,200
Sub total					2,178,322,918
Civil Work Total					6,073,050,757
(Architectural Work)					
Passenger Terminal Building	RC/ 2 Story	8,000	m^2	315,000	2,520,000,000
Cargo Terminal Building	RC/ 1 Story	1,200	m^2	252,000	302,400,000
Special Equipments work	PBB, EV, ES	1	lot		260,000,000
New Control Tower	RC/ 5 Story	250	m^2	315,000	78,750,000
Water Supply system work		1	lot		100,000,000
Waste Water Treatment work		1	lot		200,000,000
Security Equipment		1	lot		120,000,000
Architectural Work Total					3,581,150,000
(Airfield Lighting & Communication)					
Air Navigation & Communication		1	lot		100,000,000
Runway Light work		1	lot		180,000,000
Taxiway Light work		1	lot		30,000,000
Apron Light work		1	lot		80,000,000
Power Supply worfk		1	lot		100,000,000
Total					490,000,000
All Total					10,144,200,757

Source: JICA Survey Team

6-4 Trial Calculation of Project Cost

The trial calculation of the project cost, based on the construction cost applied Special Terms for Economic Partnership (STEP) Loan, was estimated as shown in Table 69. In comparison with the project for the Nadzab Airport, the foreign exchange rate between JPY and PGK in 2014 was JPY 15 lower than the rate in 2018, and the cost of local currency portion was relatively lower. Also, the applied rate of price escalation on this project was lower than the one applied for the project for the Nadzab Airport, such that the ratio was from 3% to 2% in foreign portion and the ratio from 9.9% to 3%. Taking into consideration recent conditions in the Tokua area (e.g., fewer security fee, low cost aggregate, labor costs, stable foreign exchange rate, and price escalation), the total project cost for the Tokua Airport is expected to be lower than the project cost for the Nadzab Airport.

Table 70 Preliminary Project Cost Estimate

33JPY／kina 48.2JPY／kina

Unit：Million JPY 109JPY／U$ 108.1JPY／U$

Item	Foreign Currency		Local Carrency		Tokua Airport Total	Nadzab Airport 2014[*1]
	Ratio%	Cost	Ratio%	Cost		
1) Procurement / Construction						
Civil Work	38%	2,308	62%	3,765	6,073	8,166
Architectural work	59%	2,113	41%	1,468	3,581	7,282
Airfield Lighting & Communication work	60%	294	40%	196	490	735
Fire Fighting Vehicle		0		0	0	120
Sub total a)		4,715		5,429	10,144	16,303
Dispute Board b)		60			60	57
Base Cost for JICA Financing (= a) + b))		4,775		5,429	10,204	16,360
Price Escaration c) (2.0% / 3.0%)		191		332	523	5,931
Physical Contingency (a) + b) + c)) x 10%		497		576	1,073	2,229
Total		5,463		6,337	11,800	24,520
2) Consulting Services						
Base Cost d) = a) x 12%		566		651	1,217	2,136
Price Escaration e) (2.0% / 3.0%)		42		73	115	623
Physical Contingency (d) + e)) x 10%		61		72	133	276
Total		668		797	1,465	3,035
3) Interest during Construction						
Procurement / Construction (0.10 %)		41		47	88	122
Consulting Services (0.01%)		0.13		0.15	0.27	2
Total		41.19		47.43	88.62	124
4) Front End Fee (0.10 %)		0.7		0.8	1.55	55
JICA Finance Portion =1)+2)+3)+4)		6,173		7,183	13,355	27,734

*1：Preparatory Survey on the Project Nadzab (Lae) Airport Rehabilitation in PNG(2015.3)

Source: JICA Survey Team

6-5 Expected Project Period

Regarding the expected project period for procurement of goods, construction, and consulting services, the PNG side requested the Japan side to implement this project as quickly as possible. A period from the beginning of consultant selection to the completion of detailed design is uncertain. Hence, the expected project period from the procurement of contractor, or the day of distribution of bidding documents, up to the completion of the project was roughly estimated as 32 months.

Chapter7 Applicability of Japanese Technology

7-1 Japanese Companies in Tokua Airport Area

There are Japanese companies implement a project in East New Britain Province, they are Cho Dai Co., Ltd. And Dai Nippon Construction and has carried out bridge rehabilitation project by Japanese Grant Aid (The Project for Reconstruction of Bridges on New Britain Highway, E/N in 2014 and the amount is 3.16 billion JPY). Open Bay Timber Ltd., which is subsidiary of Sumitomo Forestry Co. Ltd. is conducting planting and harvesting business in Open Bay. Open Bay Timber Ltd. was established in 1971 and they have an office in Kokopo and there are five Japanese staffs.

7-2 Applicability of Japanese Technology

Nadzab Airport Development Project is implemented by STEP loan and interview was conducted to the consultant of the project, Oriental Consultants Global (OCG), about Japanese technologies applied in the design of the Nadzab Project. The technologies shown in the table 70 were considered as Japanese material.

Table 71 Japanese Technologies applied in Nadzab Airport

Material	Suppliers
Cement	PNG Taiheiyou Cement Ltd. (100% Subsidiary of Taiheiyo Cement)
Asphalt	PS Nichireki Pte. Ltd. (Joint Venture of Nichireki in Singapore)
Structure steel	Overseas factory of Japanese Firm
Environmental Technologies	Solar power system, LED illumination, human sensor light switch, recycled water for toilet, etc.
Others	Sanitary ware, air condition, power cables, ceramic duct, etc.

There is no asphalt produced in PNG, so that asphalt is import material and it is assumed as Japanese product that produced in Singapore by a joint venture with a Japanese company. Cement, which is major material for pavement works and building works, is produced in Lae by a subsidiary of a Japanese company and this material can be assumed as Japanese product. The material for structural steel is also import material and it is presumed to procured from overseas factories of Japanese companies. Construction equipment such as for asphalt pavement and concrete pavement works is not available in PNG so that the equipment will be imported from Japan. Other than these materials, energy conservation technologies and environmental related technology to lower environmental load, which Japanese companies have, can be applied. Eco

Airport Technology, which lower environmental load is used in airports in Japan. The technology includes solar power system, electrical GSE vehicle, recycle water, geothermal power, photocatalytic tile, etc. Japanese equipment will be used in airport special equipment such as passenger loading bridges, elevators, escalators, baggage handling systems. Lumps of the airfield lighting system will be procured from third countries but power cable and duct will be Japanese products.

The foreign currency ratio of work components in this project was estimated at 39%, as shown in the table 71 The values are based on the rough estimate of construction cost as discussed in Chapter 6, which meets the condition of over 30% in the Special Terms for Economic Partnership (STEP) loan.

Table 72 Expected Foreign Currency Ratio in Work Component

Item	Assumption	Construction Cost (JPY in Million)	Foreign Currency Cost (JPY in Million)	Foreign Currency Ratio (%)
Civil Works		6,073	1,293	21.3%
1) Asphalt Bitumen	2,362 m^3	3,895	624	16.0%
2) Cement	1,016 tons	401	10	2.5%
3) Construction Machinery	6% of pavement works	3,895	234	6.0%
4) Overhead	7% of civil works	6,073	425	7.0%
Architectural Works		3,581	2,533	70.7%
1) Common Works	40% of architectural works	580	232	40.0%
2) Building Works	60% of construction cost	2,901	1,741	60.0%
3) Water Supply Works	60% of construction cost	100	60	60.0%
4) Wastewater Treatment Works	60% of construction cost	200	120	60.0%
5) Special Equipment Works	100% of construction cost	380	380	100.0%
Lighting and Communication Works	100% of construction cost	490	109	22.2%
1) Airfield Lighting Works	50% of construction cost	390	59	15.1%
2) Air Communication Works	15% of construction cost	100	50	50.0%
Total		10,144	3,935	38.8%

Source: JICA Survey Team

Chapter8 Preliminary Economic Evaluation of the Project

The preliminary economic evaluation of the Tokua Airport Expansion Project was conducted referring to the data of the "Preparatory Survey on the Project for Nadzab (Lae) Airport Rehabilitation" (JICA, 2015).

8-1 Basic Condition of Economic Analysis

8-1-1 With Project Case and Without Project Case

In order to figure out the economic feasibility of the project, the difference in economic productivity between the case with implementation of the project (hereinafter referred to as "with project case") and the case without implementation of the project (hereinafter referred to as "without project case") is studied.

With project case

The Tokua Airport Expansion Project will be implemented. Consequently, the airport capacity of domestic passenger traffic will be strengthened, and the operation of international scheduled flights will be started anew.

Without project case

No investments will be made on the existing facilities. Air passenger traffic will reach the capacity limit of existing facilities. International scheduled flights will not be operated.

Incremental case

Incremental case is difference between with project case and without project case.

8-1-2 Standard Price

Benefits and costs were estimated using rates as of 2018 in Papua New Guinean Kina (PGK).

8-1-3 Commencement of Service

The new facilities are expected to be operational in 2025.

8-1-4 Project Evaluation Period

The project evaluation period is 30 years from commencement of the operations in 2025 until 2054.

8-1-5 Discount Rate

The discount rate to calculate Net Present Value (NPV) was estimated at 10%.

8-1-6 Standard Conversion Factor

Standard Conversion Factor (SCF) for conversion from financial cost to economic cost was assumed to be 1.00. The financial cost was assumed to be equal to the economic cost.

8-2 Annual Air Traffic Demand for Economic Evaluation

The future annual air traffic demand at the Tokua Airport for both with project case and without project case was calculated based on the air traffic demand forecast (Table 73 エラー! 参照元が見つかりません。). This preliminary economic analysis targeted only the economic impact of passenger demand increase.

In with project case, the limits of passenger facilities were set to the total passengers in 2035, and no increase in traffic after 2035 was assumed. The domestic passenger demand was assumed to reach a peak of 405,000 in 2035 and be constant afterwards. The operations of international flights were assumed to start in 2025, and the traffic demand was assumed to increase until 2035 and be constant afterwards.

In without project case, the passenger traffic was set equal to the capacity limit of existing facilities. The domestic passenger demand was assumed to be constantly at 167,000, which is equal to the capacity of existing facilities. The operations of international scheduled flights were not assumed to start.

Table 73 Results of Air Traffic Demand Forecast

	CY 2025	CY 2030	CY 2035
Domestic passenger	243,000	315,000	405,000
International passenger	36,900	50,700	63,200

Source: JICA Survey Team

In the section of estimate of economic benefits to be hereinafter described, the economic benefits are estimated for PNG residents and international visitor. Therefore, the breakdown of passenger traffic was studied (see Table 74) and rearranged (see Table 75). The passenger traffic for economic analysis was finalized with linear interpolation as illustrated on Figure 56.

Table 74 Breakdown of Passenger Traffic Demand

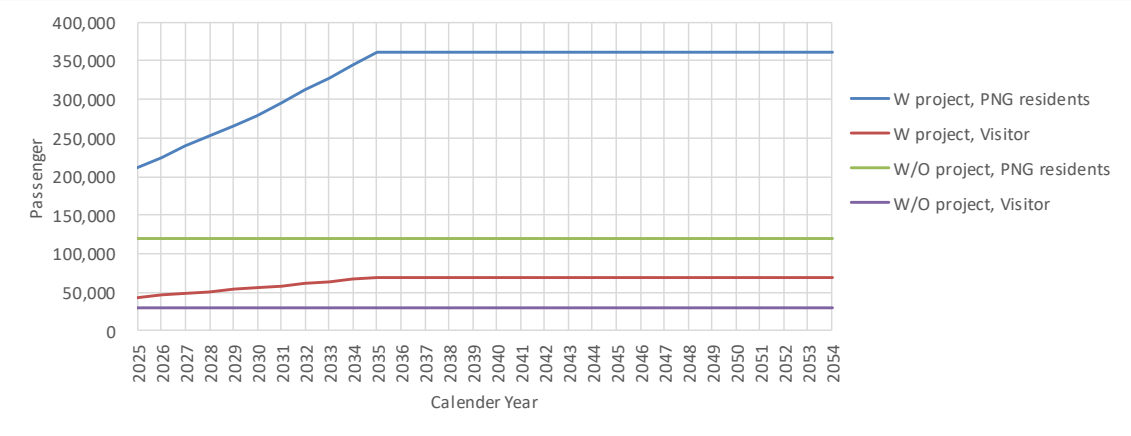
	CY 2019	CY 2025	CY 2030	CY 2035
Domestic passenger (a)	167,000	243,000	315,000	405,000
International visitor via POM (b) =(e)-(f)	30,800	6,900	5,200	6,400
International visitor transit (c) =(e)×54.8%	16,900	24,000	30,600	38,100
PNG residents (d)=(a)-(b)-(c)	119,000	212,000	279,000	361,000
Potential international passenger (e)	30,800	43,800	55,900	69,600
International passenger (f)	0	36,900	50,700	63,200

Unit: person
Source: JICA Survey Team

Table 75 Passenger Traffic for Each Study Case

	CY 2025	CY 2030	CY 2035
With Project Case			
PNG residents (g)=(d)	212,000	279,000	361,000
International visitor (h)=(e)	43,800	55,900	69,600
Without Project Case			
PNG residents (i)=(d, 2019)	119,000	119,000	119,000
International visitor (j)=(e, 2019)	30,800	30,800	30,800
Incremental Case			
PNG residents (k)=(g)-(i)	92,500	159,000	241,000
International visitor (l)=(h)-(j)	13,000	25,100	38,800

Source: JICA Survey Team



Source: JICA Survey Team

Figure 56 Passenger Traffic for Economic Analysis

The transit traffic of international visitor (table 74 c) was estimated by using the equation below with the breakdown of international visitors to Rabaul and its adjacent islands (Table 76). In addition, the transit traffic of international visitor was not accounted for the passenger traffic for economic analysis to avoid duplication in economic benefit estimation.

Traffic of international visitor transit = Traffic of potential international passenger × 54.8%

Table 76 Breakdown of International Visitors to Rabaul and its Adjacent Islands

Destination	Visitor	Share	Share
Rabaul	70,222	45.2%	45.2%
Kavieng	56,371	36.3%	54.8%
Buka	6,236	4.0%	
Kimbe	22,476	14.5%	
Total	155,305	100.0%	100.0%

Note: summation of visitors from 2008 to 2016
Source: TPA

The traffic of international visitor in without project case (Table 74 c 2019 and Table 74 e 2019) includes traffic, which does not use RAB. The affection of the traffic on economic benefits was ignored due to lack of data.

8-3 Estimate of Economic Costs

8-3-1 Project Implementation Costs

The project implementation cost consists of the construction cost, consulting service cost, physical contingencies, and administration cost, but excludes the price escalation interest during construction and taxes (エラー! 参照元が見つかりません。Table 77).

Based on the study of Nadzab Airport Rehabilitation Project, the administration cost for project implementation was estimated as shown below. Tokua and Nadzab airports are respectively abbreviated as RAB and LAE referring to airport code of IATA.

Ratio of construction costs of RAB and LAE
= Construction costs of RAB / Construction costs of LAE
= PGK 307,394,000 / PGK 377,713,000 = 81.38%

Price adjustment = Deflator 2018 / Deflator 2014 = 114.67 / 103.05 = 111.28%

Administration cost for project implementation of RAB
= Administration cost for project implementation of LAE × Price adjustment × Ratio of construction costs of RAB and LAE
= PGK 17,766,000 × 111.28% × 81.38% = PGK 16,089, 000

Table 77 Project Implementation Costs for Economic Analysis

	Total (million JPY)	Total (PGK '000)	2020	2021	2022	2023	2024	2025	2026
Eligible portion		**398,725**	**8,550**	**2,850**	**116,768**	**150,940**	**116,768**	**1,710**	**1,140**
Construction cost	10,144	307,394			92,218	122,958	92,218		
Dispute board	60	1,818			545	727	545		
Physical contingency	1,073	32,515			9,755	13,006	9,755		
Consulting fee	1,217	36,879	5,532	1,844	9,220	9,220	9,220	1,106	738
Physical contingency	133	4,030	605	202	1,008	1,008	1,008	121	81
Non-eligible portion		**16,089**	**2,413**	**804**	**4,022**	**4,022**	**4,022**	**483**	**322**
Administration cost		16,089	2,413	804	4,022	4,022	4,022	483	322

Source: JICA Survey Team

8-3-2 Operation and Maintenance Costs

The operating expenses of new facilities were estimated by referring to the budget of National Airports Corporation (NAC) (Table 78).

Table 78 Budget of NAC (2014)

Item	Budget (PGK '000)
Expenditures	104,002
Finance and Administration	46,985
Salaries and Other Personnel Expenses	30,900
Others	16,085
Operations	57,017
Maintenance (subtotal)	14,995
Civil Works	5,700
Building Works	3,235
Others	6,060
Electricity, Water, Sewerage, and Garbage	11,250
Safety Levy - CASAPNG	3,200
Security Levy - CASAPNG	5,100
Others	22,472

Source: NAC

(1) Administration Cost

Administration cost was assumed as fixed cost and calculated as the total of personnel cost and other administration costs.

In without project case, the personnel cost in RAB was calculated as follows:

Ratio of the number of employee in RAB and NAC = Employee in RAB / Employee of NAC
= 31 / 417 = 7.43%

Personnel cost in RAB (without) = Personnel cost of NAC × Price adjustment × Ratio of the number of employees in RAB and NAC
= PGK 33,400,000 × 111.28% × 7.43% = PGK 2,763,000

In with project case, the personnel cost in RAB was calculated as follows:

Ratio of the number of employees in with and without project cases of LAE
= Employee in LAE (with) / Employee in LAE (without)
= 92 / 45＝204%

Personnel cost in RAB (with)
= Personnel cost in RAB (without) × Ratio of the number of employee in with and without project cases of LAE
= PGK 2,763,000 × 204% = PGK 5,649,000

In incremental case, the personnel cost in RAB was calculated as follows:

Personnel cost in RAB (with) - Personnel cost in RAB (without)
= PGK 5,649,000－PGK 2,763,000 = PGK 2,886,000

The other administration cost was calculated based on the ratio between other administration cost and personnel cost as follows:

Ratio of other administration cost and personnel cost
= Other administration cost (NAC) / Personnel cost (NAC)
= PGK 16,085,000 / PGK 33,400,000 = 48.16%

Other administration cost (without project case) = PGK 2,763,000 × 48.16%
= PGK 1,331,000

Other administration cost (with project case) = PGK 5,649,000 × 48.16% = PGK 2,720,000

Other administration cost (incremental case) = PGK 2,720,000－PGK 1,331,000
= PGK 1,390,000

(2) Operation Cost

Operation cost was assumed as fixed cost and was calculated as the total of utility cost (electricity, water, sewerage, and garbage) and other operation cost.

In without project case, the utility cost was calculated as follows:

Utility cost in RAB (without) = Utility cost in NAC × Price adjustment × Ratio of the number of employees in RAB and NAC
= PGK 11,250,000 × 111.28% × 7.43%
= PGK 931,000

In with project case, the utility cost was calculated as follows:

Ratio of the new and existing facility area in RAB
= Area of new facilities in RAB/ Area of existing facilities in RAB
= 7,500 m^2 / 1,300 m^2 = 577%

Utility cost in RAB (with) = PGK 931,000 × 577% = PGK 5,369,000

In incremental case, the utility cost was calculated as follows:

Utility cost in RAB (with)－Utility cost in RAB (without)
= PGK 5,369,000－PGK 931,000 = PGK 4,439,000

The other operation cost was calculated as follows:

Ratio of other operation cost and utility cost
= Other operation cost in NAC / Utility cost in NAC
= PGK 22,472,000 / PGK 11,250,000 = 200%

Other operation cost in RAB (without project case) = PGK 931,000 × 200%
= PGK 1,859,000

Other operation cost in RAB (with project case) = PGK 5,369,000 × 200%
= PGK 10,725,000

Other operation cost in RAB (incremental case) = PGK 4,439,000 × 200%
= PGK 8,866,000

(3) Maintenance Cost

Maintenance cost was assumed as fixed cost and was estimated as shown below. The estimation results are shown in Table 79.

In without project case, the maintenance cost was calculated as follows:

Maintenance cost in RAB(without)
= Maintenance cost in NAC × Price adjustment × Ratio of the number of employees in RAB and NAC
= PGK 14,995,000 × 111.28% × 7.43%＝PGK 1,240,000

In with project case, the maintenance cost was calculated as follows:

Maintenance cost in RAB (with, 2025-2029) = Construction cost × 1.0%
= PGK 307,394,000 × 1.0% = PGK 3,074,000

Maintenance cost in RAB (with, 2030-2034) = Construction cost × 2.0%
= PGK 307,394,000 × 2.0% = PGK 6,148,000

Maintenance cost in RAB (with, 2035-2054) = Construction cost × 3.0%
= PGK 307,394,000 × 3.0% = PGK 9,222,000

In incremental case, the maintenance cost was calculated as follows:

Maintenance cost in RAB (incremental case, 2025-2029)
= PGK 3,074,000－PGK 1,240,000 = PGK 1,833,000

Maintenance cost in RAB (incremental case, 2030-2034)
= PGK 6,148,000－PGK 1,240,000 = PGK 4,907,000

Maintenance cost in RAB (incremental case, 2035-2054)
= PGK 9,222,000－PGK 1,240,000 = PGK 7,981,000

Table 79 Operation and Maintenance Costs

	CY 2025-2029	CY 2030-2034	CY 2035-2054
Administration cost	PGK 4,276,000	PGK 4,276,000	PGK 4,276,000
Operation cost	PGK 13,305,000	PGK 13,305,000	PGK 13,305,000
Maintenance cost	PGK 1,833,000	PGK 4,907,000	PGK 7,981,000
Total	PGK 19,414,000	PGK 22,488,000	PGK 25,562,000

Source: JICA Survey Team

8-4 Estimate of Economic Benefits

From the viewpoint of national economy, items in Table 80 エラー! 参照元が見つかりません。 were quantified as the economic benefits attributable to the implementation of the project.

The incremental air passenger traffic (incremental case) attributable to the implementation of the project was assumed to cancel the trip if the project was not implemented. In other words, the incremental traffic was assumed to be the induced traffic. The economic benefits of Papua New Guinea (PNG) residents were estimated with the consumer surplus, and the international visitors' economic benefits were derived from the consumption in PNG.

The economic benefits of existing passengers using Tokua Airport were not considered.

Table 80 Estimated Items of Economic Benefit

Route	Passenger Type	Estimation Method of Passenger	Estimation Method of Economic Benefits
Incremental domestic passenger	PNG residents	Domestic passenger minus international visitor	Consumer surplus (willingness to pay amount)
	International visitor (transit)	International visitor transferring to the island region by domestic flights	Consumption in PNG was excluded to avoid double count
	International visitor (via POM)	Potential international visitors minus international passenger	Consumption in PNG
Incremental international passenger	PNG residents	Not considered	Not considered
	International visitor	Equal to international passenger	Consumption in PNG

Source: JICA Survey Team

8-4-1 Incremental Domestic Passenger (PNG Residents)

Passengers decide to fly and are willing to pay for airfare because they benefit from flight services. Net economic benefits (difference between gross benefits and costs) of passengers are called “consumer surplus”. Consumer surplus of passengers is defined by the following formula:

Net economic benefit (consumer surplus) of passengers (PNG residents)
= Gross economic benefit (willingness to pay amount－Economic cost

The gross economic benefit or willingness to pay amount was assumed to be defined by ticket prices. It was assumed that the maximum gross benefit of passengers was equal to twice the ticket price. In other words, no one would book a flight if the ticket price was double the present price. On the other hand, the minimum gross benefit was equal to the ticket price. The reason was that a passenger would not purchase a ticket if the price was higher than the economic benefit. Gross economic benefit was assumed to be distributed evenly among all passengers.

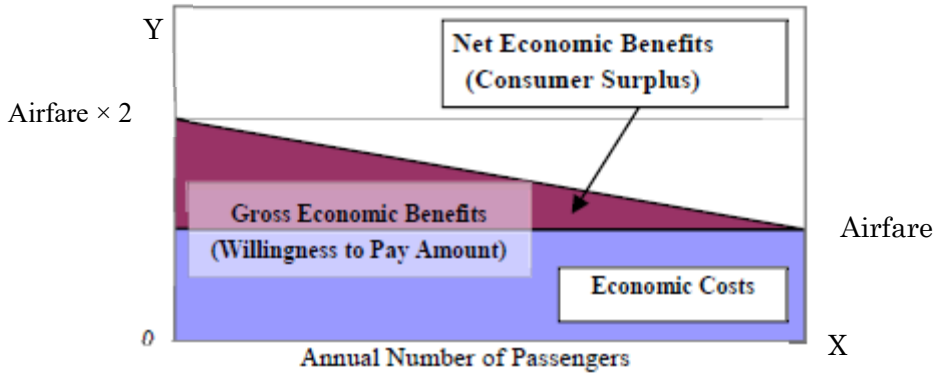
Economic costs were assumed to be equal to the ticket prices paid by passengers.

The total consumer surplus of PNG resident passengers on domestic routes in a year, for instance, is exemplified by the area generated by the right triangle of the graph in Figure 57. The one-way ticket price of domestic flights was PGK 434.5, which was the weighted average price of each

route and airline (Table 81 and Table 82). The ticket price of PGK 434.5 on the y-axis indicates economic cost and minimum gross economic benefit. The maximum gross economic benefit of passengers is PGK 869. The x-axis indicates the number of PNG resident passengers on domestic routes in a year.

From the above assumption, the net economic benefits of total PNG resident passengers on domestic flights in a year were calculated using the following equation:

Annual net economic benefits of total PNG resident passengers on domestic flights
(consumer surplus)
= (PGK 869 – PGK 434.5) × annual PNG resident passengers × 1/2



Source: JICA Survey Team

Figure 57 Consumer Surplus

Table 81 Airfare by Route and Airline (2019 February)

Air Niugini				PNG Air			
Route	Passenger Share	Airfare (PGK)	Weighted Price (PGK)	Route	Passenger Share	Airfare (PGK)	Weighted Price (PGK)
RAB-BUA	12.4%	369	45.8	RAB-BUA	15.9%	355	56.5
RAB-HKN	4.8%	340	16.3	RAB-HKN	6.4%	305	19.4
RAB-KVG	29.0%	342	99.2	RAB-KIE	2.7%	355	9.7
RAB-LNV	9.2%	423	38.9	RAB-KVG	8.2%	305	25.0
RAB-POM	44.6%	518	231.0	RAB-LAE	6.4%	861	54.8
Total	100.0%		431.2	RAB-LNV	33.6%	451	151.7
				RAB-POM	26.8%	470	126.0
				Total	100.0%		443.1

Source: Calculated based on data from Air Niugini and PNG Air

Table 82 Mean Airfare (2019 February)

Airline	Passenger Share	Weighted Price (PGK)
Air Niugini	71.9%	310.0
PNG Air	28.1%	124.5
Total	100.0%	434.5

Source: Calculated based on data from Air Niugini and PNG Air

8-4-2 Incremental Domestic Passenger (International Visitor (Transit))

The international visitors, bound for Rabaul and its adjacent islands, arrive at RAB and transfer to domestic flights. The economic benefits of those visitors were accounted for international passenger benefit, as described in the following subclause. Therefore, the international visitors to Rabaul and its adjacent islands out of the total passengers in domestic flights were not accounted for the economic benefit to avoid double count.

8-4-3 Incremental Domestic Passenger (International Visitor (via POM))

The incremental domestic passengers of international visitors via POM are studied together with the incremental international passengers of international visitors in the later clause.

8-4-4 Incremental International Passenger (PNG Resident)

In the traffic demand analysis, it was hypothesized that PNG residents did not travel by international flights. Therefore, the economic benefits of PNG resident passengers on international flights were not considered.

8-4-5 Incremental International Passenger (International Visitor)

In the traffic demand analysis, it was assumed that all international passengers were international visitors. The part of international visitors' consumption in PNG was accounted for the economic benefits. The added value of consumption was considered as the economic effect. The data of international visitors' consumption in PNG, reported by IFC in Infographics - International Visitors in Papua New Guinea in 2017, was used for the economic analysis.

Consumption in PNG per visitor = USD 2,371

Price adjustment = 2018 deflator / 2017 deflator = 114.67 / 105.65 = 108.54%

Exchange rate = PGK 3.3 per USD

Economic effect per visitor = Consumption in PNG per visitor × Exchange rate × Price adjustment × Added value ratio

= USD 2,371 × PGK 3.3 /USD × 108.54% × 25% = PGK 2,123

The study of Travel and Tourism sector contribution to GDP was used as reference to set the added value ratio.

The direct contribution of Travel & Tourism to GDP in 2017 = PGK 470.9 million (WTTC[6])

Number of total visitors = 212,000

Added value per visitor = PGK 470.9 million / 212,000 × 108.54% = PGK 2,411

8-5 Results of Economic Analysis

The results of economic analysis are indicated in Table 83. Detailed results are attached at the end of report.

Table 83 Results of Economic Analysis

Indicator	Results
Economic Internal Rate of Return (EIRR)	14.5%
Economic Net Present Value (ENPV)	185,773,000 PGK
Benefit Cost Ratio (BCR)	1.42

Source: JICA Survey Team

8-6 Sensitivity Analysis

Sensitivity analysis of the economic internal rate of return (EIRR) was conducted (Table 84). The standard criterion measure of EIRR ranges from 10% to 12%. All cases in Table 84 passed the criterion. Therefore, the Tokua Airport Expansion Project is feasible from the viewpoint of national economy.

Table 84 Results of Sensitivity Analysis

Case Description	EIRR
Case 1: Cost +10%	13.2%
Case 2: Benefit -10%	13.1%
Case 3: Cost +10%, Benefit -10%	11.9%

Source: JICA Survey Team

[6] World Travel and Tourism Council (WTTC), March 2018, The Economic Impact of Travel and Tourism

Chapter9 Environmental and Social Considerations

9-1 Category Classification

Development of the airport facilities through this project could produce limited negative impacts to environment and target society because it is implemented within area owned by NAC and does not requires land acquisition and/or resettlements. Impacts caused by the project are not irreversible, but dealt with standard procedures. Under consideration of these conditions the project is clarified as Category B.

9-2 Arrangement of Matters for Consideration and Procedures in Implementing the Project

Environment Act 2000 is registration related to environmental and social considerations in PNG. Each project is categorized into three levels based on Environment (Prescribed Activities) Regulation 2002. Although development and expansion of existing airport is not included in the list for the category, some airport development projects have been categorized in Category A which has less influence than Level 2 Activity. According to the Environment Act 2000 projects categorized in Level 2A are required to apply to environment permission.

Environmental (Fee and Charges) Regulation 2002 regulates payment of the environment tax to each project based on categorized level and requires each contractor to pay the tax during construction period.

Chapter10 Lessons Learned from Nadzab Airport Redeployment Project

10-1 Project Outline

The preparatory survey of Nadzab Airport Redevelopment Project was implemented from 2014 to 2015. Loan agreement was signed in October 2015. The consultant agreement was signed in February 2017 and detailed design was completed. At the time of this survey in December 2018, tendering was conducted. The scope of the work of Nadzab Airport Redevelopment Project includes runway expansion and rehabilitation, taxiway expansion and rehabilitation, a new apron, a new 2 story passenger terminal building of 10,000 m2, renovation of the existing passenger building to the cargo terminal building, rehabilitation of the control tower and office building, a new fire station, airfield lighting system, procurement of fire fighting vehicles, and flood control, etc. Loan amount is 26.942 billion Japanese Yen. The project is STEP scheme project and it is expected that Japanese Technology such as LED lightings for low power consumption, low energy air condition system, water supply to reduce environmental load, etc., will be well used.

10-2 Project Progress

Although tender was planned to notice in January 2017 when loan agreement was signed in 2015, actual tender announcement was November 2018 and there was almost 2 years delay. Main reason of the delay was that it took long time for consultant agreement and there was design change to add one passenger boarding bridge to two sets. The delay of the consultant agreement was occurred because procedure in the Ministry of Finance of PNG took longer time than expected. Number of the passenger boarding was decided as one set from a technical view point during planning and design phase but there was political decision to add another at the late stage of the detailed design so that it needed time to accommodate the change.

10-3 Issues on Implementation

10-3-1 Construction prices

Construction prices in PNG is higher than Australia and Japan and it is sometimes cheaper to procure material from overseas even the material is available domestically. The balance between imported material and domestic material should be considered on estimating the project cost.

10-3-2 Organization character of NAC and the Ministry of Finance and NAC and billing procedure

NAC is managed as a company and decision making and administration process is quick. But person in charge sometimes absent for foreign travel and international conference and in such case waiting time is occurred.

Regarding the billing procedure, the procedure in NAC is quick but on the other hand, it is necessary to obtain approval from the Ministry of Finance and administrative procedure in the Ministry needs time. There was a case to take months to receive payment from submission of the invoice.

10-3-3 Foreign Company Registration

It is necessary to register to many organizations other than the implementation agency and the ministries for a foreign company to conduct business in PNG. Registration for a consultant includes company registration to Investment Promotion Authority (IPA), tax payer number and tax payment to Internal Revenue Committee (IRC), engineer's registration to Institute of Engineer in PNG (IEPNG) and opening of bank account, etc. It is necessary to employ a local public officer and a tax agent to conduct these works. Personal income tax to Japanese nationals working in Japanese Yen Loan project is exempted but local employees and third country people should pay the income tax.

10-3-4 Aid Worker VISA

In principle, it is necessary to obtain Aid Worker VISA for employee of Japanese Yen Loan project, however it takes a few months to obtain the Aid Worker VISA and during the application, it is necessary to enter the country by Business VISA. In such a case, as permitted length of stay is shorter and it is necessary to go out of the country on expiring of the Business VISA.

10-3-5 Accommodation

Cost of accommodation for foreigners to stay safe is more than 700 thousand Japanese Yen per month in Port Moresby and the budget should considered the cost. Since most of daily necessary goods are imported, the price of the goods is expensive and thus cost of living is expensive.

10-3-6 Skill and employment condition of local engineers

Utilization of local engineer is difficult from both quality and quantity. It is necessary to employ

the third country middle class engineer but income tax for the engineer is not exempted so that these tax and accommodation cost should be included in the project implementation budget. As the conditions of local public transport is bad and it is necessary to provide transport for employees.

10-3-7 Internet condition and software availability

Quality of internet condition is not sufficient to utilize it for works using large volume of data communication and expensive. Cost of pre-paid data plan is almost as same as such cost in Japan. Mobile phones and personal computers are expensive and it is necessary to import such IT equipment. Engineering software such as CAD is not available in PNG and necessary to import.

10-3-8 Daily security measures

Security condition in Port Moresby is worse as compared to a capital of other countries and it is necessary to pay caution to daily activities. As security measures are expensive in general and it is considered as one of the major invisible costs.

10-3-9 Medical condition

Level of medical technic is not high and if advanced medical treatment is required, it is necessary to emergency transport to Australia so that subscription to medical assistant service is mandatory.

10-3-10 Tax for consultant service

Income tax for Japanese nationals working for Japanese Loan project is exempted but local and third country employee should pay the tax. Group policy, an employee pays tax method, not withhold tax is applied. There is a case for employer to pay superannuation fund to the employees. Goods and service tax are handled case by case.

Appendix 1: Meeting Records

Date	Organization	Person	JICA PNG	Consultant
First Field Survey				
2018/10/29	JICA PNG Office	Toyama, Watanabe, Thomas and Samson		Yamaguchi, Hatayama and Wasa
2018/10/29	NAC (National Airport Corporation)	Gebo and Beatus Kili	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/10/29	Consultant for Nadzab Airport Redevelopment Project	Nagasawa	—	Yamaguchi, Hatayama and Wasa
2018/10/30	World Bank PNG Office	Andrew W. Cooper, Allan Oliver	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/10/30	Asian Development Bank, PNG Office	Bashirullah Khpalwan, Ganiga G. Ganiga	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/10/30	Air Niugini	Russell Veoli	Samson	Yamaguchi, Hatayama and Wasa
2018/10/30	PNG Air	Glenn Dunstan	Samson	Yamaguchi, Hatayama and Wasa
2018/10/30	Department of Treasure	Ohno	Watanabe and Nakasone	Yamaguchi, Hatayama and Wasa
2018/10/31	Tokua Airport	Samson Kakai Kennedy Mong	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/10/31	Volcanological Observatory, Department of Mineral Policy and Geohazards Management (DMPGM)	Ima Itikarai, Steve Saunders	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/11/1	East New Britain Tourism Authority (ENBTA)	Gard M. Renson, Manuel Sialis, Nakamine Kiyomitsu	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/11/1	OISCA	Ehara and other 4 people	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/11/1	East New Britain Provincial Government (ENBP)	Hon. Nakikus Konga MP, Levi Mano	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/11/2	NAC (National Airport Corporation)	Beatus Kili	—	Yamaguchi, Hatayama and Wasa
2018/11/2	Papua New Guinea Tourism Promotion Authority (TPA)	Alcinda Trawen, Michael Taia	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/11/2	Dai Nippon Doboku	Kawakami	Watanabe and Samson	Yamaguchi, Hatayama and Wasa
2018/11/2	Japanese Embassy	Ambassador Nakajima	Watanabe	Yamaguchi, Hatayama and Wasa
2018/11/2	National Airport Corporation	Beatus Kili		
Second Field Survey				
2018/11/26	CADIP PIU Tokua Airport	Allan Dromenge, Wellington T. Warren	—	Yamaguchi and Hatayama
2018/11/26	PNG Air Service	Phil Irvin, Henry Kigolena	Nakasone and Eko Allan	Yamaguchi and Hatayama
2018/11/27	PNG Japan	Kamioka	—	Yamaguchi and Hatayama
2018/11/27 - 12/10	Tokua Airport	Kennedy Mong	—	Yamaguchi and Hatayama
2018/11/30	Open Bay Timber Ltd	Tsukihara and Nakaoka	—	Yamaguchi and

				Hatayama
2018/11/30	G-Man Construction	Jeffrey Simewa, William Leves Tenga Koniel Richard Paiva	—	Yamaguchi and Hatayama
2018/12/3	Air Niugini Cargo	Cargo Manager	—	Yamaguchi and Hatayama
2018/12/3	Oro Logistics (PNG Air)	Lucas Walmsley	—	Yamaguchi and Hatayama
2018/12/3	Puma (Fuel Company)	William	—	Yamaguchi and Hatayama
2018/12/4	Covec Crusher Plant		—	Yamaguchi and Hatayama
2018/12/4	Works	John Saici, Benson Tamgoi	—	Yamaguchi and Hatayama
2018/12/5	Gazelle Restoration Authority	Chanel Tade Joseph Enman Marion Hidelgo Martina Ikau Kiramin Karani	—	Yamaguchi and Hatayama
2018/12/5	APEC ENB Coordination Center	Gordon Gaius	—	Yamaguchi and Hatayama
2018/12/5	Covec	Lance	—	Yamaguchi and Hatayama
2018/12/6	Nivani Ltd	David Stein Tony Henderson	—	Yamaguchi and Hatayama
2018/12/7	PNG Port Rabaul	Niason Pukai Leonard Katinia	—	Yamaguchi and Hatayama
2018/12/10	East New Britain Provincial Government	Levi Mano	Nakasone Eko Allan	Yamaguchi and Hatayama
2018/12/11	NAC (National Airport Corporation)	Beatus Kili	—	Yamaguchi, Hatayama and Wasa
2018/12/12	National Planning and Monitoring	Ohno	Watanabe	Yamaguchi, Hatayama and Wasa
2018/12/12	Department of Treasure	Ohno	Nakasone	Yamaguchi, Hatayama and Wasa
2018/12/13	NAC (National Airport Corporation)	Beatus Kili	—	Yamaguchi, Hatayama and Wasa
2018/12/13	Air Niugini	Navaulioni Ravai George Greig	—	Yamaguchi, Hatayama and Wasa
2018/12/14	JICA PNG Office	Toyama		Yamaguchi, Hatayama and Wasa
2018/12/14	Japanese Embassy	Ambassador Nakajima	Nakasone	Yamaguchi, Hatayama and Wasa
2018/12/14	Papua New Guinea Tourism Promotion Authority (TPA)	Alcinda Trawen, Michael Taia	Nakasone	Yamaguchi, Hatayama and Wasa
2018/12/14	NAC (National Airport Corporation)	Gebo, Beatus Kili	—	Yamaguchi, Hatayama and Wasa

Titles Omitted

Appendix 2: Study Schedule

First Field Survey

Num.	Date	Day	Time	Venue	Purpose of Visit
1	2018/10/27	Sat	21:35	Depart Haneda Airport	HND-MNLPR421 15:05-18:55
2	2018/10/28	Sun	7:25	Arrive at POM Documentation	MNL-POM PR215 23:55-07:15
3	2018/10/29	Mon	09:00-10:00	JICA Office	Courtesy call and explanation of the IR
			11:00:12:00	Japanese Embassy	Courtesy call and explanation of the IR
			13:00-15:00	NAC	Courtesy call and explanation of the IR Data collection of Nadzab project and CADIP POM Airport Privatization
			15:00-16:00	OCG Nadzab Airport Project Office	Information of Nadzab project
4	2018/10/30	Tue	09:00-10:00	World Bank PNG Office	Explanation of the study and data collection of tourism development project
			11:00-12:00	ADB PNG Office	Progress of CADIP and scope for Tokua Airport
			13:00-14:00	Air Niugini	Courtesy call and request for cooperation Future fleet plan Passenger statistics
			15:00-16:00	PNG Air	Courtesy call and request for cooperation Future fleet plan Passenger statistics
			16:30-17:30	Mr Ohno	Aviation sector in MTDP 3 Financial condition of PNG, GDP trend and advice to the traffic forecast
5	2018/10/31	Wed	9:30	Move to Kokopo	PX252 09:30-10:55
			13:00-16:00	Tokua Airport	Survey of existing facilities, maintenance and operation, airport boundary
6	2018/11/1	Thu	09:00-11:00	JOCV for TPA ENB	Tourism development in ENB Number of visitors, hotel rooms, tourism sports
			13:00-14:00	ENB Governor	Courtesy call, request for cooperation, development plan of ENB Tourism statistics
7	2018/11/2	Fri	6:50	Move to POM	PX275 06:50-08:10
			09:00-10:00	NAC	Report of findings and explanation of second site survey
			11:00-12:00	PNG Tourism Promotion Authority	Tourism development plan in ENB and request for statistics
			13:00-14:00	JICA Office	Report of the result of first field survey
8	2018/11/3	Sat	Whole day	Report Preparation	
9	2018/11/4	Sun	14:40	Leave to Japan	POM-MNL PR216 08:20-11:40 MNL-NRT PR432 14:50-20:10

Second Field Survey

Num.	Date	Day	Time	Venue	Purpose of Visit
1	2018/11/24	Sat	21:35	Leave Honiara to POM	HIR-POM 09:50-11:10
2	2018/11/25	Sun	5:25	Arrive POM	NRT-POM 21:35-05:25
				Report Preparation	
3	2018/11/26	Mon	09:00-10:00	NAC	Courtesy call and request for information
			13:00-14:00	NAC CADIP Project Team	
			16:00-17:00	OCG Nadzab Project Office	Information of Nadzab Airport Project
4	2018/11/27	Tud	10:00-11:00	PNG Japan	Data collection of tourism sector in PNG
			13:00-14:00	JICA Office	
			14:00-15:00	TAP	Data collection of tourism statistics
5	2018/11/28	Wed	09:30-10:55	Move to Kokopo	POM-RAB PX252 09:30-10:55
			14:00-16:00	Tokua Airport Survey	
6	2018/11/29	Thu	09:00-16:00	Tokua Airport Survey	
7	2018/11/30	Fri	09:00-11:00	Tokua Airport Survey	
			11:00-12:00	Open Bay Timber	Visit Japanese company
8	2018/12/1	Sat	Whole Day	Report Preparation	
9	2018/12/2	Sun	Whole Day	Report Preparation	
10	2018/12/3	Mon	09:00-11:00	Tokua Airport Survey	
11	2018/12/4	Tue	09:00-11:00	Waranoi River	Gravel plant
12	2018/12/5	Wed	10:00-11:00	Gazel Restoration Authority	GRA
			11:00-12:00	ENB Government	Request to visit Rabaul Port
			14:00-15:00	Covac Kokopo	Chinese company
13	2018/12/6	Thu	11:00-12:00	NIVARI	Local contractor
			13:00-16:00	Tokua Airport Survey	
14	2018/12/7	Fri	10:00-12:00	Rabaul Port Survey	
			15:00-16:00	Interview an architect	Construction condition in Kokopo
15	2018/12/8	Sat	Whole Day	Report Preparation	
16	2018/12/9	Sun	Whole Day	Report Preparation	
17	2018/12/10	Mon	10:00-11:00	ENB Government	Discussion on Tokua Airport Development
			13:00-14:00	Tokua Airport	Explanation of the survey results
18	2018/12/11	Tue	06:50-08:10	Move to POM	RAB-POM PX275 06:50-08:10
			15:00-16:00	NAC POM	Explanation of the survey results
19	2018/12/12	Wed	11:00-12:00	JICA Office	Explanation of the survey results
			13:30-14:30	DNP	Explanation of the survey results
			14:00-15:00	DOT	Explanation of the survey results
20	2018/12/13	Thu	10:30-11:30	NAC	Explanation of the survey results
			14:30-15:30	Air Niugini	Future fleet plan and Tokua Airport Plan
21	2018/12/14	Fri	9:30-10:30	JICA Office	Explanation of the survey results
			11:00-12:00	Japanese Embassy	Explanation of the survey results
			13:00-14:00	TAP	Explanation of the survey results
			15:00-16:00	NAC	Explanation of the survey results
22	2018/12/15	Sat	14:40-20:25	Leave to Japan	POM-NRT PX054 14:40-20:25

Appendix 3: Wind velocity and direction analysis

1. Wind Direction

Wind velocity and direction analysis was conducted utilizing five years meteorological observation data from 1st January 2013 to 31st December 2017. There are four daily observation in every three hours from 7 o'clock in the morning to 4 o'clock in the evening in Tokua Airport.

Wind direction changes every half year, north west wind is predominant from December to May and south east wind in June to November. Observation data was grouped in 16 directions and south east wind was most observed direction, which was 34.4% and second was north west wind and it was 18.9%. There are 22.0% of calm condition, which wind velocity was less than 5knots and direction was not significant. Regarding southern wind, south south west wind was very few, which was only 2.2% as compared to south west wind (34.4%) and south wind (12.7%). It is because there is a hill at south west side of Tokua Airport and south south west cannot leached to the airport.

Table A1 Ratio of 16 direction wind

Direction	Calm	N	NNE	NE	ENE	E	ESE	SE	SSE
Ratio	22.0%	2.6%	0.0%	0.2%	0.0%	0.8%	0.1%	34.4%	2.2%
Direction		S	SSW	SW	WSW	W	WNW	NW	NNW
Ratio		12.7%	0.0%	0.3%	0.0%	2.7%	0.2%	18.9%	2.9%

Monthly wind velocity and direction chart is shown in the next page.

2. Wind Velocity

Observation of wind velocity of more than 5 knots and not more than 10 knots was predominant and which was 45.8%. Ratio of wind velocity of more than 10 knots and not less than 13 knots was 27.9%. Total of 95.9% wind velocity was not more than 13 knots. The strongest wind during the 5 years observation was 30 knots west wind at 13:00 on 29th January 2014. There are very few wind more than 20 knots and the ratio was only 0.3%.

Table A2 Ratio of Wind Velocity

Velocity (knots)	Not more than 5	5 to 10	10 to 13	13 to 15	15 to 20	More than 20
Probability (Accumulate)	22.2%	45.8% (68.0%)	27.9% (95.9%)	2.8% (98.7%)	1.0% (99.7%)	0.3% (100%)

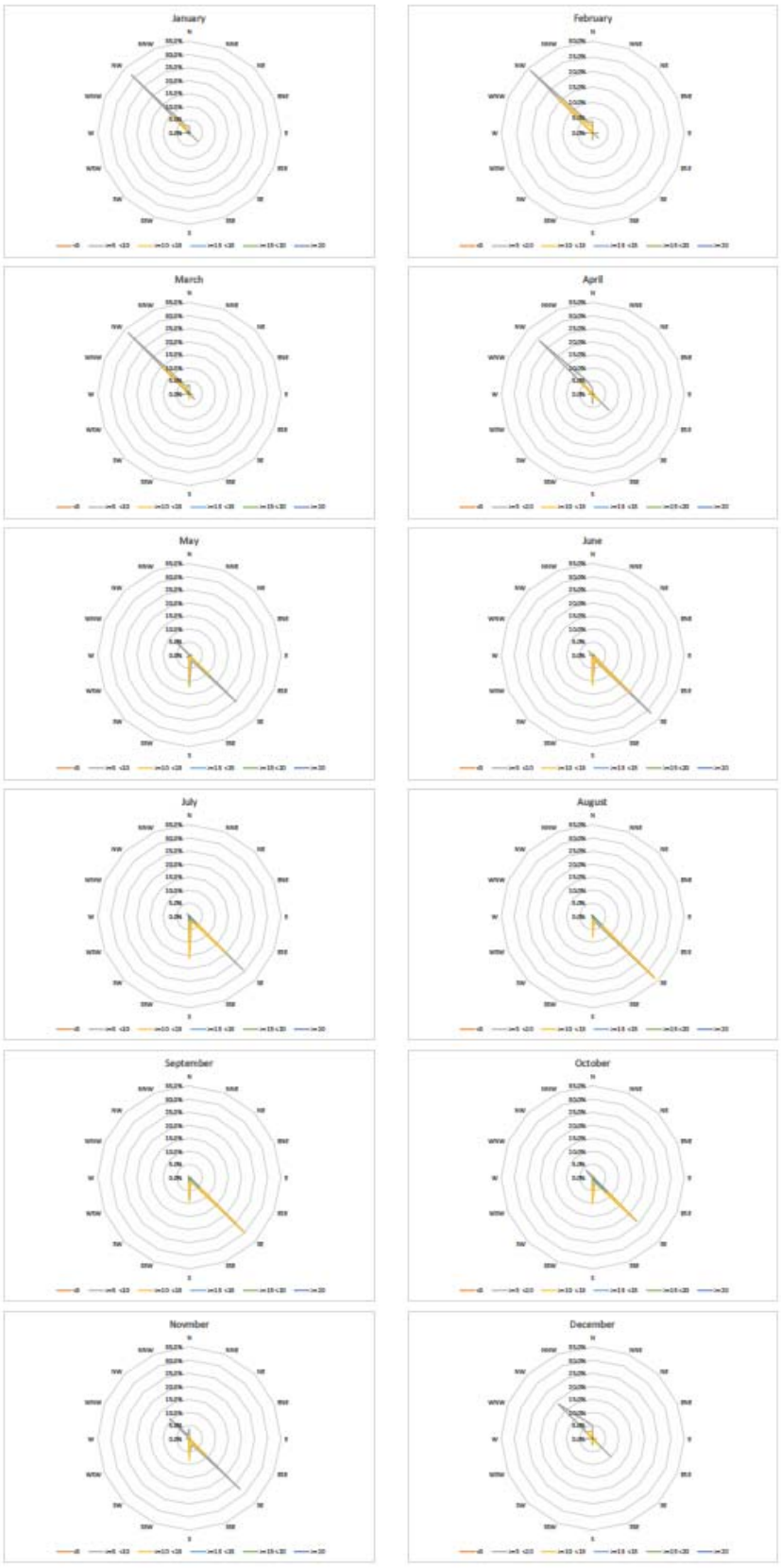


Figure A1 Monthly Wind Velocity and Direction Charts

3. Cross Wind

According to Annex 14 of ICAO, the runway direction should be decided so that the usability factor of the runway should not be less than 95%. The maximum permissible cross wind component for airplane, which reference runway length is not less than 1500m, is 20 knots, for airplane, which reference runway length is 1200m to 1500m is 13 knots and for airplane, which reference runway length is less than 1200m is 10 knots. To apply these to airplane operated in PNG, the maximum permissible cross wind for small jet such as B737 and Airbus 320 (A320) and medium jet such as B767 and A300 is 20 knots. That for propeller airplane such as ATR 42 and small jet airplane such as F100 is 13 knots and for smaller propeller airplane is 10 knots. It is necessary if probability of occurrence of the maximum cross wind is more than 95%, a cross wind runway will be necessary.

Table A3 Maximum Permissible Wind

Cross Wind Component	Less than 10 knots	Less than 13 knots	Less than 20 knots
Airplane type	Small propeller	F100, ATR4, ATR72	B737, A320, B767, A300

As runway direction of Tokua Airport is 101/281 degrees, cross wind component of each wind velocity and direction data was calculated and the result is shown in the table below.

Table A4 Annual Cross Wind Components

Cross Win Components	Less than 10 knots	10 to 13 knots	13 to 20 knots	Not less than 20 knots
Ratio	97.16%	2.07%	0.77%	0.00%

As shown in the results, it was 97.16% which cross wind component is less than 10 knots and it means the usability factor of the existing runway is not less than the ICAO recommendation of 95%, so that a cross wind runway is not necessary.

Table below shows summary of probability of monthly cross wind components. The probability of not less than 10 knots cross wind is less than 95% in most of months but it was 91.6%, 94.7% and 94.7% in July, September and October, respectively. Especially, in July and September, the probability of not less than 13 knots wind is 2.9% and 2.5%, respectively and it means there are strong cross wind. It is necessary to caution to pilots of small propeller and small jet such as F100 about strong cross wind and turbulence in these months. There is no probability of wind velocity to be over 20 knots, there is no problem to operation aircraft such as B737 and A320.

Table A5 Monthly Cross Wind Component

Month/Cross Wind Components	Not more than 10 knots	10 knots to 31 knots	13 knots to 20 knots	More than 20 knots
Jan	98.71%	0.81%	0.48%	0.00%
Feb	98.40%	1.42%	0.18%	0.00%
Mar	98.23%	1.45%	0.32%	0.00%
Apr	98.83%	1.17%	0.00%	0.00%
May	98.23%	1.45%	0.32%	0.00%
Jun	98.17%	1.67%	0.17%	0.00%
Jul	91.61%	5.48%	2.90%	0.00%
Aug	97.20%	1.97%	0.82%	0.00%
Sep	94.67%	2.83%	2.50%	0.00%
Oct	94.68%	4.35%	0.97%	0.00%
Nov	99.00%	0.83%	0.17%	0.00%
Dec	98.39%	1.29%	0.32%	0.00%
Total	97.16%	2.07%	0.77%	0.00%

Appendix 4: Runway Length Chart by Boeing

3.2.2 Payload/Range for Long Range Cruise: Model 737-8

Payload/Range
737-8 (LEAP-1B series)

- STANDARD DAY, ZERO WIND
- CRUISE MACH = LRC
- NORMAL POWER EXTRACTION AND AIR CONDITIONING BLEEDS
- TYPICAL MISSION RULES
- CONSULT USING AIRLINE FOR SPECIFIC OPERATING PROCEDURE AND OEW PRIOR TO FACILITY DESIGN.

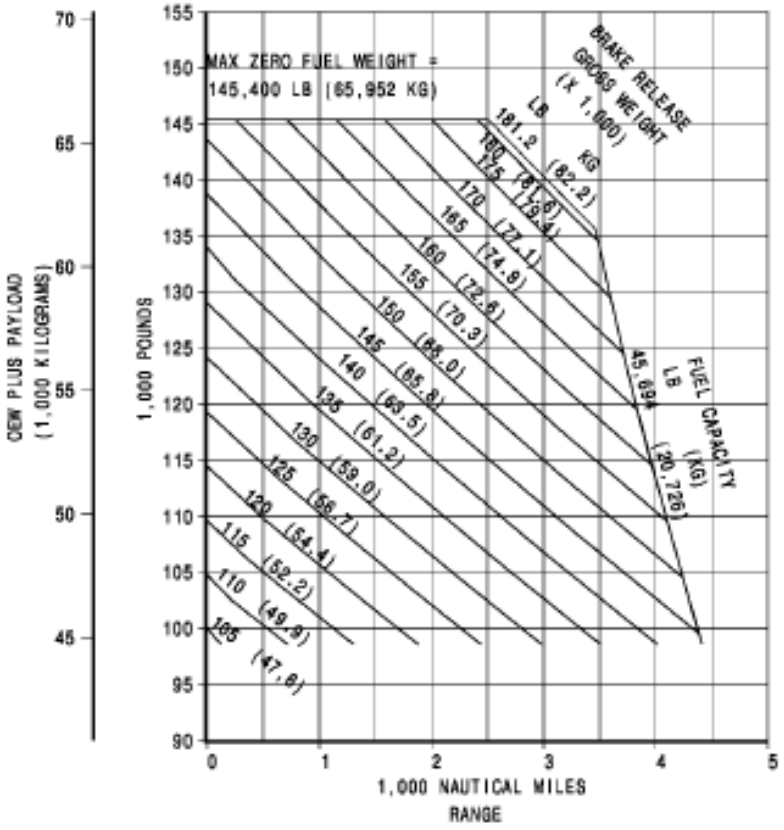


Figure 2 Range and Takeoff Weight

3.3.3 FAA/EASA Takeoff Runway Length Requirements - Standard Day + 27°F (STD + 15°C), Dry Runway: Model 737-8 (LEAP-1B25 Engine)

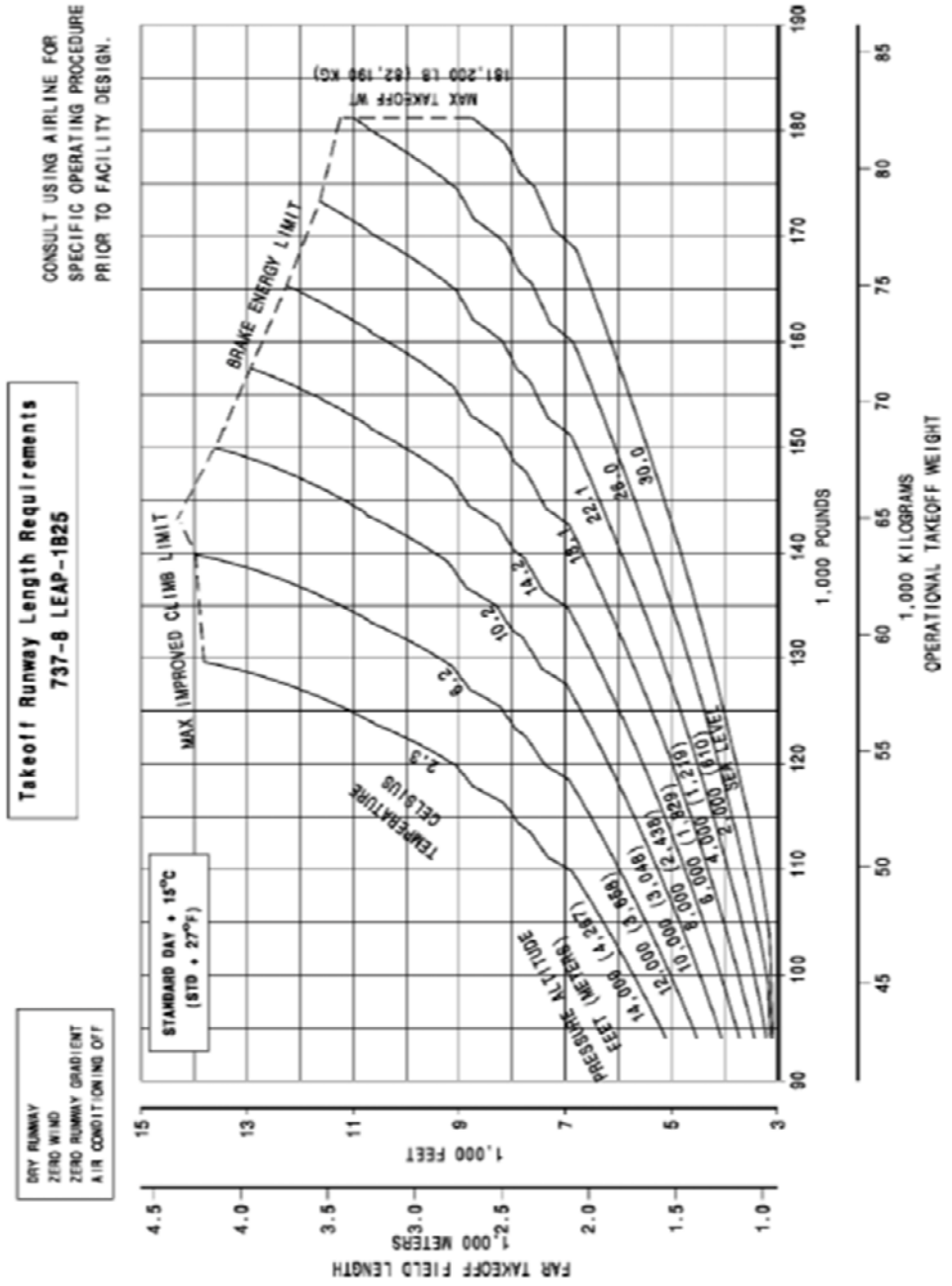


Figure A3 Runway Length and Takeoff Weight

Appendix 5: Result of Financial Analysis

Flow of Economic Cost and Benefit

		Total	NPV	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
				Construction												O & M							
Traffic forecast (with - without)																							
PNG residents									92,496	105,893	119,289	132,686	146,083	159,480	175,854	192,228	208,602	224,977	241,351	241,351	241,351	241,351	241,351
Visitor									12,980	15,399	17,818	20,237	22,656	25,075	27,823	30,571	33,320	36,068	38,816	38,816	38,816	38,816	38,816
Project cost	**1000 PGK**	**1,119,466**	**446,230**	**8,550**	**2,850**	**116,768**	**150,940**	**116,768**	**21,124**	**20,554**	**19,414**	**19,414**	**19,414**	**22,488**	**22,488**	**22,488**	**22,488**	**22,488**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**
Investment cost	1000 PGK	398,725	302,506	8,550	2,850	116,768	150,940	116,768	1,710	1,140													
O & M cost	1000 PGK	720,741	210,427						19,414	19,414	19,414	19,414	19,414	22,488	22,488	22,488	22,488	22,488	25,562	25,562	25,562	25,562	25,562
National economic benefit	**1000 PGK**	**3,548,894**	**632,004**	**0**	**0**	**0**	**0**	**0**	**47,651**	**55,697**	**63,743**	**71,790**	**79,836**	**87,882**	**97,274**	**106,666**	**116,058**	**125,450**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**
PNG residents	1000 PGK	1,387,055	249,271	0	0	0	0	0	20,095	23,005	25,916	28,826	31,737	34,647	38,204	41,762	45,319	48,876	52,433	52,433	52,433	52,433	52,433
Visitor	1000 PGK	2,161,839	382,732	0	0	0	0	0	27,556	32,692	37,828	42,964	48,099	53,235	59,070	64,905	70,739	76,574	82,409	82,409	82,409	82,409	82,409
Sensitivity analysis																							
Cost +10%	1000 PGK	1,231,413	490,853	9,405	3,135	128,444	166,034	128,444	23,236	22,609	21,355	21,355	21,355	24,736	24,736	24,736	24,736	24,736	28,118	28,118	28,118	28,118	28,118
Benefit -10%	1000 PGK	3,194,005	568,803	0	0	0	0	0	42,886	50,127	57,369	64,611	71,852	79,094	87,547	96,000	104,452	112,905	121,358	121,358	121,358	121,358	121,358
Balance																							
Base case	1000 PGK	2,429,428	185,773	-8,550	-2,850	-116,768	-150,940	-116,768	26,527	35,143	44,330	52,376	60,422	65,394	74,786	84,178	93,570	102,963	109,281	109,281	109,281	109,281	109,281
Case 1: Cost +10%	1000 PGK	2,317,481	141,150	-9,405	-3,135	-128,444	-166,034	-128,444	24,415	33,088	42,388	50,434	58,481	63,145	72,538	81,930	91,322	100,714	106,724	106,724	106,724	106,724	106,724
Case 2: Benefit -10%	1000 PGK	2,074,538	122,573	-8,550	-2,850	-116,768	-150,940	-116,768	21,762	29,574	37,955	45,197	52,438	56,606	65,059	73,512	81,965	90,418	95,796	95,796	95,796	95,796	95,796
Case 3: Cost +10%, Benefit -10%	1000 PGK	1,962,592	77,950	-9,405	-3,135	-128,444	-166,034	-128,444	19,650	27,518	36,014	43,255	50,497	54,357	62,810	71,263	79,716	88,169	93,240	93,240	93,240	93,240	93,240

				2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
				21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Traffic forecast (with - without)																		
Domestic passenger				241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351	241,351
International passenger				38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816	38,816
Project cost	**1000 PGK**			**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**	**25,562**
Investment cost	1000 PGK			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O & M cost	1000 PGK			25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562	25,562
National economic benefit	**1000 PGK**			**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**	**134,842**
Domestic passenger, PNG residents	1000 PGK			52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433	52,433
International passenger, visitor	1000 PGK			82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409	82,409
Sensitivity analysis																		
Cost +10%	1000 PGK			28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118	28,118
Benefit -10%	1000 PGK			121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358	121,358
Balance																		
Base case	1000 PGK			109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281	109,281
Case 1: Cost +10%	1000 PGK			106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724	106,724
Case 2: Benefit -10%	1000 PGK			95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796	95,796
Case 3: Cost +10%, Benefit -10%	1000 PGK			93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240	93,240

Discount Rate	10%
EIRR	14.5%
B/C	1.42

EIRR (Case 1)	13.2%
EIRR (Case 2)	13.1%
EIRR (Case 3)	11.9%