CIVIL AVIATION AUTHORITY, BANGLADESH
MINISTRY OF CIVIL AVIATION AND TOURISM
THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

PREPARATORY SURVEY FOR DHAKA INTERNATIONAL AIRPORT EXPANSION PROJECT

FINAL REPORT

March 2017

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.

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Preparatory Survey for the Dhaka International Airport Expansion Project in the People's Republic of Bangladesh

EXECUTIVE SUMMARY

1. Background and Objective of the Project

In recent years, Bangladesh's economy has experienced an average annual growth rate of more than 6%. Against this background, the aviation demand at the international airport for the capital Dhaka has increased rapidly at an average pace approaching 10%. The Dhaka International Airport or the Hazrat Shahjalal International Airport (HSIA) handles nearly 70% of all domestic and international flights in Bangladesh and plays an important role as infrastructure supporting the rapidly growing economic activity.

The HSIA was planned for a capacity of 8 million passengers annually, but based on the data collection survey conducted in April 2016, the passengers for 2015 were approximately 6.5 million passengers per annum (mppa) (international: 5.57 mppa, domestic: 0.91 mppa) and the passenger handling capacity of the passenger terminal building (PTB) is expected to be saturated by 2019. In order to respond to this situation, the Government of Bangladesh (hereinafter referred to as "GoB") is considering the construction of a new international passenger terminal, the refurbishment of the cargo terminal and the construction of peripheral infrastructure including the approach road to the National Highway. The construction of the new international passenger terminal and the construction of peripheral infrastructure in particular are expected to be implemented quickly, having been prioritized as important projects in the Seventh Five-Year Development Plan by GoB. Furthermore, HSIA is located approximately 17 km north of central Dhaka and there are plans to make the approach to HSIA into a multimodal hub connected with urban railways and expressways planned for the future.

The Japan International Cooperation Agency (JICA) has been conducting a data collection survey for this project since April 2016. It has been confirmed that there is an immense amount of reference materials including the design drawings for civil and architectural works, which requires detailed review prior to the implementation of the project. The GoB has requested the early commencement of the project for completion by the end of 2019, requiring an immediate response. In addition, in the Japan-Bangladesh Summit Meeting held on May 28, 2016, the importance of the project was mutually confirmed.

The improvement of the navigation aid system at HSIA has been implemented under the Japanese grant aid scheme project entitled "The Project for Improvement of Airport Safety and Security Systems" (2014), which is expected to secure safety of aircraft guidance to destination airports and landings and improve responses to aircraft accidents and acts of terrorism. In order to respond to the future increase in demand and to secure convenience and safety, it is urgently necessary to implement the mid-term expansion projects for HSIA, as described above. Acting on this background, GoB has requested JICA to implement the study on the expansion projects of HSIA with the intention to secure future yen loans.

The objective of the present study is to conduct the necessary studies to review the appropriateness of the project for implementation under Japanese government loan. It includes the objectives of the project, general composition, project finances, implementation schedule, implementation method (procurement and construction), organization for project implementation, organization for operation and maintenance, and environmental and social considerations based on the existing Master Plan (M/P) for expansion of HSIA

2. Social and Economic Condition

Bangladesh is one of the poorest countries in Asia with a population of approximately 160 million people. According to the International Monetary Fund (IMF), Bangladesh's nominal gross domestic product (GDP) in 2013 was USD 161.3 billion, and the nominal GDP per capita was USD 1,030 (World Economic Outlook Database, April 2016). It is categorized as a least developed country (LDC) based on the standards of the United Nations.

Bangladesh has an eminently fertile land nurtured through the flooding of the Padoma River, the Jamuna River, and the Meghna River, and has been referred to as "the Golden Bengal". From the fact that the country has an enormous population and workforce, the economic potential is high; however, under the influence of natural disasters such as floods and cyclones, the development of its industries are delayed

Furthermore, even though Bangladesh has received technical and financial assistance over a long period, the country still faces challenges of economic and social development due to these natural disasters, excessive population, undeveloped infrastructure, and political confusion. However, they have shown a continuous steady economic growth after 2006 and are expected to achieve a nominal GDP per person of USD 1,900 in 2020 and to shift from LDC to middle-income country by 2021.

Table 2-1BasicSocioeconomic Indicator

Indicator	2012	2013	2014
Real GDP Growth Rate	6.26%	6.04%	6.31% (Estimation)
Current GDP	USD 141.71 billion	USD 161.30 billion	USD 184.00 billion (Estimation)
Current GDP per Capita	USD 916.03	USD 1,030.03	USD 1,163 (Estimation)
Consumer Price Growth Rate	6.23%	7.54%	7.01%
Unemployment Rate	6.52%	6.01%	6.06%

Source: World Economic Outlook Database, April 2016
Source (Unemployment Rate): Institute of Developing Economies, Japan External Trade Organization

3. Aviation Traffic Forecast

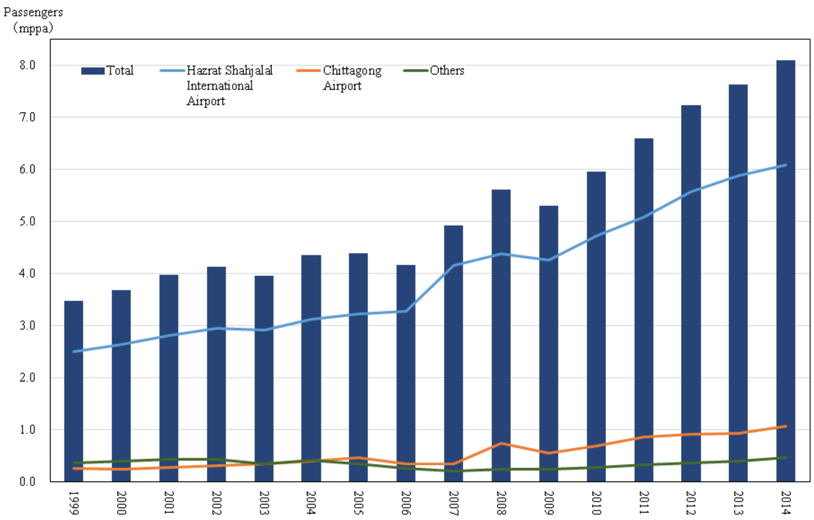
3.1 Aviation Demand in Bangladesh

HSIA handles approximately 75% of the total passenger demand and 90% of the total cargo demand in Bangladesh. Local airports such as Chittagong, Cox's Bazar, Jessore, and Sylhet handle the remaining demand. The passenger handling volume in 2014 at HSIA was approximately 6 million passengers per annum (mppa) and Chittagong Airport was second with approximately 1 mppa. The other airports handle much fewer passengers with annual passenger handling of less than 0.2 mppa each.

The annual average growth rate of the real GDP of Bangladesh has shown steady growth of 6% after 2004, achieving 6.85% in 2006. The rate in 2007-2008 decreased slightly and dropped to 5.3% in 2009 due to the financial crisis starting in September 2008. However, it recovered after 2010 and has maintained a growth rate of 6% or more.

The number of air passengers for Bangladesh as a whole and HSIA both increased in 2007 and 2008, but declined by approximately 300,000 passengers and 100,000 passengers, respectively, in 2009 due to the financial crisis. However, it has continued to grow by 6% after 2010 in step with economic growth.

Furthermore, although the annual average growth rate of passengers from 1999 to 2015 at HSIA was 6.17%, the growth rate after 2006 has increased to 7.88%, showing a prominent increase in demand in recent years.



Source: Statistical Year Book of Bangladesh 2014 and CAAB, JICA Study Team

Figure 3-1 Growth of Air Traffic Passenger Traffic in Bangladesh

In HSIA, the international passenger ratio was 77.2% in 1999, but the ratio has increased in recent years and international passenger has come to occupy approximately 90% of all passengers after 2011.

Domestic passenger numbers at HSIA have not seen major change from 1999 to 2009; while 0.7 mppa nationwide was recorded in 2007, it maintained approximately 0.6 mppa during this period, reducing to 0.52 mppa at its lowest in 2010. However, demand is now recovering after 2010 and the annual average growth rate from 2010 to 2015 was 5.84%.

3.2 Passenger Demand

The results of the passenger traffic forecast conducted by this study compared with the CAAB Master Plan forecast are shown in Table 3-1. The passenger numbers for high /low cases are derived by adjusting the GDP growth rate for base case by ±1.24% and forecasting the passenger demand numbers for each growth rate.

・The actual international passenger numbers for 2015 were approximately 5.6 million pax, but the CAAB Master Plan has assumed 6 million. Therefore, the CAAB forecast starts from a slightly inflated figure.

- ✈ The actual international passenger numbers for 2015 were approximately 5.6 mppa, but the CAAB Master Plan has assumed 6 million. Therefore, the CAAB forecast starts from a slightly inflated figure.

- The domestic passenger demand has previously trended from 10% to 15% of the international passengers, but the ratio has increased after 2010 and the domestic passenger numbers are expected to show further increase in the future. Based on the results of the forecast, the domestic passengers are expected to reach almost 5.2 mppa in 2035, approximately 20% of international passengers. This is a large revision of the CAAB Master Plan forecast.
- The combined demand for international and domestic passengers does show a large difference between the JICA Study Team and CAAB forecasts, but the differences can be explained by the following reasons:
- CAAB's forecast is based on aviation traffic demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- CAAB's forecast assumes GDP growth, which has a strong influence on aviation traffic demand, of 7% for 2015-2025, 6% for 2025-2030 and 5% for 2030-2035. In contrast, the JICA Study Team has assumed slightly lower GDP growth of 6.67% for 2013-2021, 6% for 2021-2025, 5.5% for 2025-2030, and 5% for 2030-2035, based on the latest data/forecast by IMF published in April 2016.

Table3-1Comparison of Passenger Demand Forecast (Million Passengers)

Category	Year	JICA Study Team (JST)			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Passenger	2015	5.569	5.569	5.569	6.120	5.997	5.875
	2020	9.252	8.669	8.112	9.312	8.671	8.069
	2025	13.662	12.042	10.583	14.206	12.564	11.100
	2030	19.366	16.082	13.295	20.623	17.313	14.513
	2035	26.611	20.835	16.214	28.451	22.659	18.012
	CAGR (2015-2035)		6.82%			6.87%	
Domestic Passenger	2015	0.913	0.913	0.913	0.691	0.685	0.679
	2020	1,493	1.379	1.270	0.820	0.796	0.773
	2025	2.410	2.086	1.793	0.974	0.926	0.881
	2030	3.632	2.959	2.388	1.134	1.056	0.983
	2035	5.226	4.017	3.050	1.294	1.179	1.073
	CAGR (2015-2035)		7.69%			2.75%	
Total	2015	6.482	6.482	6.482	6.811	6.682	6.554
	2020	10.745	10.047	9.382	10.132	9.467	8.842
	2025	16.072	14.127	12.376	15.180	13.490	11.981
	2030	22.997	19.041	15.683	21.746	23.838	19.085
	2035	31.837	24.852	19.264	29.746	23.838	19.085
	CAGR (2015-2035)		6.95%			6.57%	

Source: JICA Study Team

Note: CAGR: Compound Average Growth Rate; the mathematical average for the indicated period

3.3 Cargo Demand

Based on the actual numbers for international cargo, the cargo demand has shown a steady increase and a stable demand for cargo services can be assumed. However, the domestic cargo demand is very small and unstable compared with international cargo demand, having less than 1% of the volume and exhibiting violent fluctuations in demand. The combined cargo volume of international and domestic cargo for 2015 was approximately 260 thousand tons.

The following observations are made based on the comparison with the CAAB forecast:

- As shown in Table 3-2, the volumes for international cargo for 2015 in the JICA Study Team's and CAAB's forecasts are almost the same, but the growth rate afterwards is greater in the JICA Study Team forecast.
- The actual domestic cargo volume for 2015 is recorded at 1,900 tons, substantially larger than the 760 tons forecast by the CAAB Master Plan.
- The difference between the JICA Study Team and CAAB's forecasts for cargo volumes is due to the following reasons:
- The CAAB Master Plan is based on cargo demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- The growth in cargo volumes after 2010 is large and since the JICA Survey Team utilized the available data up to 2015 to build its forecasting model, the regression formula with the growth rate higher than that of CAAB model was derived.

Table3-2 Comparison of Cargo Demand Forecast (tons)

Category	Year	JICA Study Team (JST)			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Cargo	2015	258,010	258,010	258,010	261,000	257,000	254,000
	2020	449,790	418,152	387,953	350,000	333,000	317,000
	2025	689,105	601,172	522,012	472,000	433,000	396,000
	2030	998,588	820,411	669,181	615.000	543,000	479,000
	2035	1,391,731	1,078,310	827,570	773,000	662,000	479,000
	CAGR (2015-2035)		7.41%			4.84%	
Domestic Cargo	2015	1,888	1,888	1,888	770	760	750
	2020	3,732	3,447	3,174	950	900	860
	2025	7,231	6,257	5,380	1,170	1,070	980
	2030	12,710	10,357	8,359	1,380	1,220	1,070
	2035	20,902	16,068	12,201	1,550	1,360	1,120
	CAGR (2015-2035)		11.3%			2.95%	
Total	2015	259,898	259,898	259,898	261,770	257,760	254,750
	2020	453,523	421,599	391,127	350,950	333,900	317,860
	2025	696,336	607,429	527,392	473,170	434,070	396,980
	2030	1,011,299	830,768	677,539	616,380	544,220	480,070
	2035	1,412,633	1,094,378	839,771	774,550	663,360	559,120
	CAGR (2015-2035)		7.45%			4.84%	

Source: JICA Study Team

3.4 Aircraft Movement

The number of aircraft movement between 2011 and 2015 showed a marked increase from 56,000 to 57,000 movements annually in 2010 and 2011 to 73,000 movements annually for 2015.

The general aviation (GA) (sightseeing flights and training flights, aircraft owned by private companies and individuals) and military aircraft accounted for 5,000 to 7,000 movements annually with little variation. The records separately obtained from ATC for 2015 showing monthly movements of aircraft by category showed that GA and military aircraft movements are stable at around 200 and 430 movements per month, respectively.

The forecast for aircraft movements is calculated based on the passenger numbers forecast by the JICA Study Team and formulating an aircraft mix and the average numbers of passengers on each craft (load factor).

Based on this analysis, when the aircraft movements are determined using the aircraft mix and passenger forecast, movements reached approximately 17.1 million in 2030. The JICA Study Team forecast exceeds the CAAB forecast by approximately 10%. This was caused by assuming a lower number of passengers on each flight due to the small upsizing of the aircraft compared with the CAAB Master Plan.

Table 3-3 Comparison of Aircraft Movement Forecast (including GA and Military Aircraft)

Year	JICA Study Team			CAAB Master Plan		
	High	Base	Low	High	Base	Low
2015	73,235	73,235	73,235	70,400	69,400	68,500
2020	118,556	110,830	103,455	94,400	89,600	85,300
2025	165,430	145,460	127,483	129,100	117,700	101,400
2030	206,196	171,130	141,367	172,000	150,000	131,300
2035	264,178	206,900	161,077	222,100	185,000	154,900

Source：JICA Study Team

In addition, the JICA Study Team conducted a forecast for freighter aircraft movements. Freighter aircrafts are not used for domestic cargo in Bangladesh and are carried as belly cargo on passenger flights (permissible cargo on passenger flights). Domestic cargo volume will continue to be extremely low compared with international cargo even in 2035, accounting for only 1.5% of total volume. Since domestic cargo will continue to be carried as belly cargo in the future, the aircraft movement forecast for cargo was based on international cargo volume using freighter. The forecast for the base case is shown in Table 3 4.

Table3-4 Freighter Aircraft Movement Forecast

	2015	2020	2025	2030	2035
Freighter	1,248	2,023	2,908	3,969	5,216

Source: JICA Study Team

3.5 Peak Hour Traffic

Based on the statistical data of HSIA, the numbers of passengers and aircraft movements during peak hour in the traffic demand base case were calculated. The aircraft movement numbers are exclusive of GA and military aircraft.

Table 3-5 Passengers and Aircraft Movements during Peak Hourand Peak Day (Base Case)

			2015		2020		2025		2030		2035	
			Intl'	Dom	Intl'	Dom	Intl'	Dom	Intl'	Dom	Intl'	Dom
Passenger (mppa)		Intl'/Dom	5.569	0.913	8.669	1.379	12.042	2.086	16.082	2.959	20.835	4.017
		Total	6.482		10.047		14.127		19.041		24.852	
A/C Movement		Intl'/Dom	37,192	32,212	56,289	47,540	75,260	63,200	96,880	67,250	121,133	78,767
		Total	69,404		103,830		138,460		164,130		199,900	
Average Daily Flight			102	89	155	131	207	174	266	185	332	216
Passengers	Peak Day Ratio (Terminal Building)		1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300
	PAX at Peak Day	Intl'/Dom	18,563	3,043	28,895	4,596	40,138	6,952	53,607	9,863	69,450	13,390
		Total	21,607		33,491		47,091		63,470		82,840	
	Peak Hour Ratio		0.1225	0.138	0.1196	0.1145	0.1182	0.102	0.1173	0.0997	0.1166	0.0946
	PAX at Peak Hour	Intl'/Dom	2,273	402	3,456	526	4,744	709	6,285	984	8,098	1,267
		Total	2,694		3,982		5,453		7,269		9,365	
A/C Movement	Peak Day Ratio (Apron, Utilities, etc.)		1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330
	Peak Day Flight	Intl'/Dom	113	98	171	144	228	192	294	204	367	239
		Total	210		315		420		497		606	
	Peak Hour Ratio		0.1233	0.1305	0.1202	0.1099	0.1186	0.0985	0.1176	0.0964	0.1169	0.0917
	Peak Hour Flight	Intl'/Dom	14	13	21	16	28	19	35	20	43	22
		Total	27		37		47		55		65	
A/C Movement (Freighter)			1,248		2,023		2,908		3,969		5,216	
Peak Day Flight (Freighter)			4		6		9		12		16	

Source: JICA Study Team

4. Review of the Past Study on HSIA Expansion Project

In this chapter, information of the study, planning, and design works done by CAAB is organized, and the results of the review of each item are described.

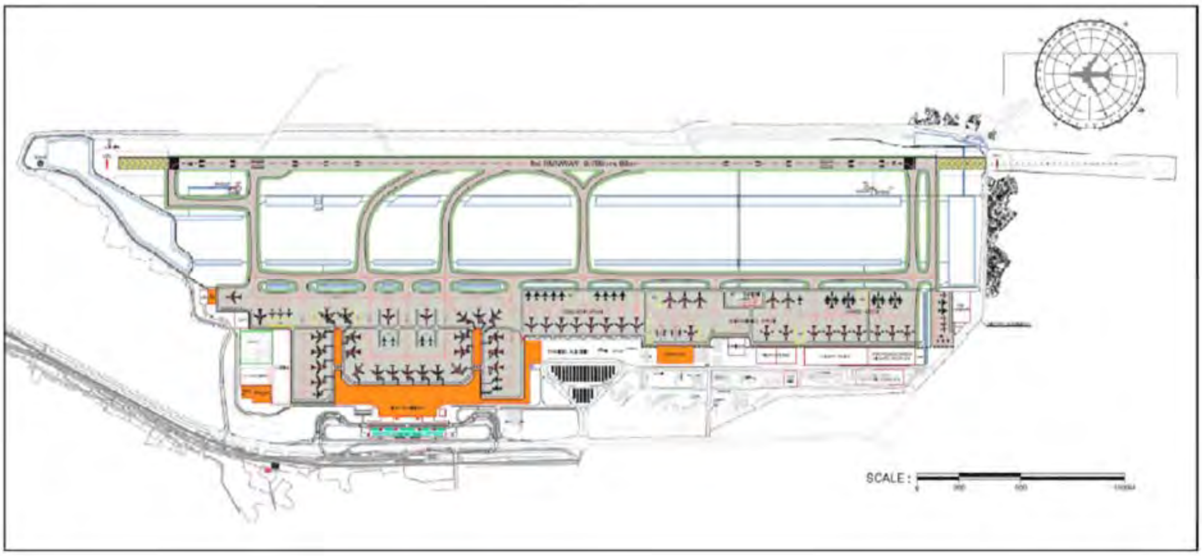
Table 4-1 Review on HSIA Expansion Project Made by CAAB

No	Title	Table of Contents	Date	Format	Remarks
1	MASTER PLAN AND FEASIBILITY STUDY	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Land Use Plan 6. Environmental Screening 7. Economic Analysis	February 2015	PPT	"5. Phased Development Plan" and "9. Financial Analysis" are not in this version
2	MASTER PLAN REPORT	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Phased Development Plan 6. Land Use Plan 7. Enviromental Screening 8. Economic Analysis 9. Financial Analysis	June 2015	PPT	The latest one of the Master Plan Report
3	FEASIBILITY STUDY REPORT	1. Economic Analysis 2. Financial Analysis	June 2015	PPT	Chapters 8 and 9 of No. 2
4	BASIC DESIGN REPORT (TERMINAL and LANDSIDE)	01 Project Background and Brief Description 02 Chapter: I Terminal Planning and Design 03 Chapter: II Structural: Terminal Buildings 04 Chapter: III Structural: Elevated Drive Way (EDW) 05 Chapter: IV Plumbing 06 Chapter: V Heating and Ventilation and Air Conditioning System	No information	PDF Report	The design report of Terminal 3, EDW, New VVIP, New Domestic Terminal,and OtherInfrastructures
5	BASIC DESIGN REPORT VOL. 1 Airside	Chapter I. Introduction Chapter II. Executive Summary of Master Plan and Feasibility Study Chapter III. Design of Civil Works Chapter IV. Design of NAVAIDS and AGL System	June 2015	PPT	The Civil Works, NAVAIDS and AGL System
6	TENDER DOCUMENT	Section - 1 Instruction to Tenderers (ITT) Section - 2 Tender Data Sheet (TDS) Section - 3 General Condition of Contract (GCC) Section - 4 Particular Conditions of Contract (PCC) Section - 5 Tender and Contract Forms Section - 6 Bill of Quantities Section - 7 1 General Items 2 Preliminaries 3 Earth and Pavement Works 4 Concrete and Reinforcement 5 Sealing 6 Marking 7 Airfield Ground Lighting System and Navigation Aid 8 Drainage and Protective Works 9 Civil Works 10 Plumbing and Sanitary Works 11 Electrical Works 12 Substation Equipment 13 Diesel Generator 14 Installation of Passenger Lifts 15 Fire Protection Works 16 Air Conditioning System 17 Installation of Deep Tube Well 18 Gas Connection System 19 Communication and CCTV 20 Steel Truss 21 Wastewater Treatment Plant 22 Siphonic Drainage System 23 Cargo Terminal 24 Intake Power Station 25 Pump House and Out Station 26 Landscaping / Particular 26 Specification / Drawings	June 2015	Word PDF CAD	

Source: JICA Study Team

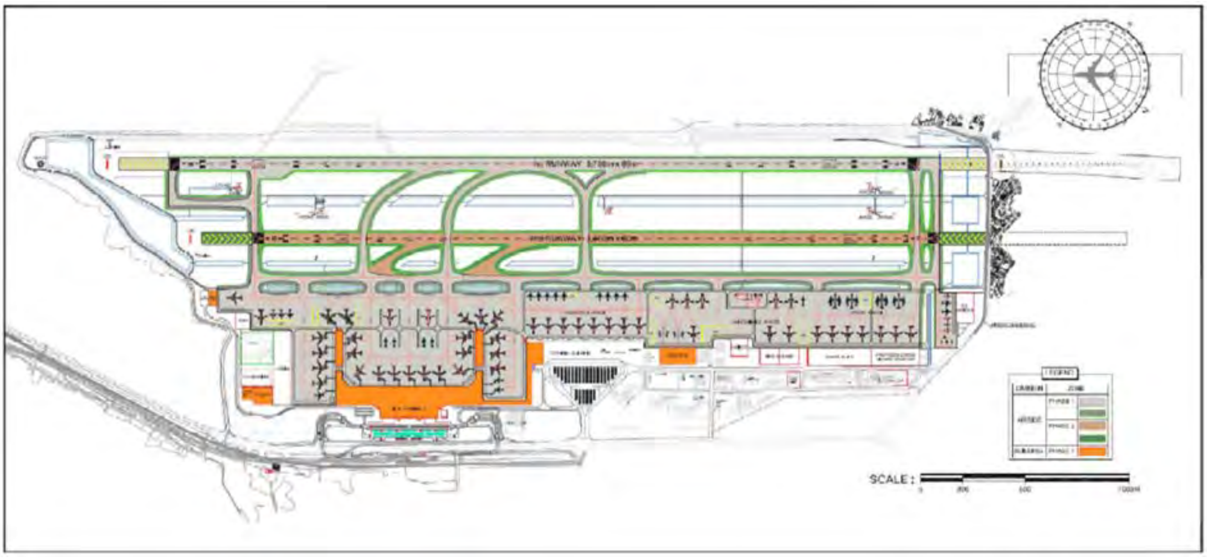
The CAAB conducted the "Master Plan and Feasibility Study, Construction of Second Runway and Other Infrastructure Development Works at Hazrat Shahjalal International Airport" for the Dhaka International Airport Expansion Project in February 2015. Thereafter, the study was updated in June 2015. In the updated study report, the phased development plan has been proposed. According to the phased development plan, the second runway will not be constructed under the phase-1 development (completion in 2019), but will be constructed under the phase-2 development. The completion year of phase-2 is not mentioned in the report.

Based on the report (June 2015 version), the scope of the expansion project is shown in Table 4-2, and the layout plans are shown in Figure4-1 and Figure4-2.



Source: CAAB

Figure4-1Master Plan Layout (Phase-1, Completion in 2019)



Source: CAAB

Figure4-2Master Plan Layout (Phase-2)

Table 4-2Scope of the HSIA Expansion Project by CAAB

Facilities	Contents	Remarks
Existing Runway	Extension and Widening 3,200 x 46 m → 3,692 x 60 m	
New Runway	3,292 x 60 m	For dependent operation
New Taxiway	Rapid exit taxiways and other taxiways	
Access Road	- New construction for new Terminal 3 - Improvement for existing Terminal 1 and Terminal 2 and new domestic terminal	
Apron	- Expansion and Reconstruction Area: around 1,000,000 m^2 - Apron Spot: 29 → 64	
New Terminal-3	Around 260,000 m^2	
New Domestic Terminal	Around 15,000 m^2	1.4 mppa
Existing Terminal-1 and Terminal-2	Following renovations: - Check-in Counter nos.: 56 → 84 - Gate nos.: 15 → 20 - Increase Number of Arrival Immigration Counter	
Navigation Aids	- Upgrade of ILS from CAT-I to CAT-II - New Installation of AWOS - Relocation of PSR/SSR	
Support Facilities	Relocation, expansion, and/or new construction of the following facilities: - VVIP Complex - RFFS - Sewage Treatment Plant - Intake Power Plant - PSR/SSR - Airport Traffic Control Tower - Maintenance Hangar - Catering Building - Cargo Complex - GA Apron and Hangar	

Source: CAAB

5. Analysis of Airport Capacity and Validity of the Project

5.1 Analysis of Capacity of Current Airport Facilities

The JICA Study Team clarifies the capacity limit of HSIA by analyzing the capacity of the current facilities, which include the runway, taxiway, passenger terminal building, cargo terminal, and car parking. The capacity analysis is conducted for the demand in 2020 when the development project of the Bangladeshi government will be completed. The summary of the capacity analysis is shown in Table 5.1.

Table 5-1 Summary of Capacity Analysis of Each Facility of HSIA

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Runway	Nos.	Approximately 170,000 movements/year	103,830 movements/year	It is possible to meet the demand until 2030 with one runway by maximizing the capacity for one runway.
	Length	3,200 m	3,200 m	All flights, except for long-haul flights with some large aircrafts, can be operated.
	Width	46 m	46 m	Width of 60 m is unnecessary although it is desirable for the operation of Code F aircrafts.
Rapid Exit Taxiways and Connection	Peak hour aircraft movements	35 movements/hour	24 movements/hour	Peak hour aircraft movements in 2015 was 18 and in 2020 will increase to 24, therefore, there will be no problem with

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Taxiways				the capacity of existing facilities.
Taxiway	Width	23 m	23 m	Width of 25 m is unnecessary although it is desirable for the operation of Code F aircrafts.
Apron	Spot Nos.	29	32	Although the demand will exceed the current capacity in few years later, other apron infront of the cargo terminal and maintenance area could be used in peak hour.
International Passenger Terminal Building	Check in Counter	56	60	The capacity of the existing international terminal building (Terminal 1/Terminal 2) is 8 mppa. According to the aviation traffic demand forecast in this study, the demand of international passengers in 2020 will reach to 8.7 mppa. Although it is concerned that the low service level will be found temporarily in peak hour, the exceed demand will not considerably affect the growth of future demand.
	Security Check Point	19	19	
	Emigration Counter	38	21	
	Immigration Counter	22	25	
	Baggage Claim Counter	8	8	
Domestic Passenger Terminal Building	Check in Counter	12	11	The capacity of the existing domestic terminal building is 640,000. Domestic passengers have already reached beyond 910,000. Therefore, severe congestion will be found in 2020.
	Security Check Point	3	4	
	Baggage Claim Counter	1	4	
Cargo Terminal Building	Area	27,800 m^2 Export: 12,800 m^2 Import: 15,000 m^2	42,000 m^2 Export: 14,000 m^2 Import: 28,000 m^2	According to future demand requirement, the capacity of cargo terminal is expected to be short in 2020.
Car Parking	Car Nos.	1,000 cars	1,008 cars	Although excess capacity at peak hour is concerned, it will not considerably affect the growth of future demand.
Utility	Power Supply	8 MVA	TBD	Temporary capacity and over load of each facility areconcerns since the required capacity will exceed the capacity of T1/T2 in 2020. However, it will not considerably affect the operation of the airport.
	Water Supply	Tube well	TBD	
	Waste Water Treatment	TBD	TBD	
	Fuel	TBD	TBD	
NAVAIDs	Communication	V/UHF	V/UHF	Since the age of most of the facilities will be less than 15 years at 2020, they have no problem indurability.
	PSR/SSR	PSR/SSR	PSR/SSR	
	DVOR/DME ILS (CAT-I)	DVOR/DME ILS (CAT-I)	DVOR/DME ILS (CAT-II)	

Source: JICA Study Team

5.2 Confirmation of the Necessity and Validity of the Expansion Project

Based on the capacity analysis of the existing HSIA and the CAAB Master Plan, the necessity and validity of the project planned by the Bangladeshi government are shown in Table 5-2.

Table 5-2Summary of the Project Scope and Evaluation

Facility	CAAB Master Plan (Target Year: 2035)	Phase 1 Plan (Target Year: 2025)	Evaluation
Existing Runway	Extension and widening From “3,200 x 46 m” to “3,692 x 60 m”	None	Importance and priority are low although extension and widening are desirable by considering Code F aircraft operation in the future.
New Runway	3,292 x 60 m	None	Currently, these are not important although it will be

Facility	CAAB Master Plan (Target Year: 2035)	Phase 1 Plan (Target Year: 2025)	Evaluation
			necessary for long-term plan from the view point of future demand.
New Taxiways	Rapid exit taxiways and the other taxiways	Rapid Exit Taxiway: 2 Attached Taxiway (RWY 14): 1 Attached Taxiway (Parallel Taxiway): 9	It is reasonable for maximizing the capacity for one runway.
Landside Service Road	Landside service road for the new T3	Landside service road for the new T3	It is necessary for the operation of the new T3
Apron	Area of expansion and reconstruction: approximately 1,000,000 m^2 Apron spot nos: from 29 to 64	Apron expansion: Approx. 520,000 m^2 Apron spot Nos: 42	Apron expansion and increase in apron spot are needed to meet the future demand in phase 1. In addition, the current apron improvement project is not included in phase 1 scope, because the project is progressed by CAAB.
New T3	Approximately 260,000 m^2 3 Stories Passenger Capacity: 16.2 mppa	Approximately 220,000 m^2 3 Stories Passenger Capacity: 12 mppa	Based on the future demand, the scale of expansion should be decided in 220,000 m^2 in phase 1. In phase 2, Terminal 3 needs to be expanded to 260,000 m^2.
New Domestic Terminal	Approximately 15,000 m^2	None	Considering priority of facilities, the new domestic terminal needs to be built in phase 2. In phase 1, the existing domestic terminal will be continuously used, a part of T1/T2 will be used temporarily, if necessary.
Existing T1 & T2	Following renovation works: - Nos. of check-in counter: from 56 to 84 - Addition of immigration and emmigration counter	None	Although the expansion of facilities is needed since it will be insufficient for future demand, it is not urgent if the new T3 will be constructed.
Cargo Terminal	40,000m^2 (Existing export cargo terminal: 12,800 m^2, Import cargo terminal: 27,200 m^2)	47,000 m^2 (Export cargo terminal: 27,000 m^2, Import cargo terminal: 20,000m^2)	Developing cargo terminal is necessary for increasing cargo capacity and operational improvement. Need to study about the necessary facility capacity.
VVIP Terminal	Approximately 5,000 m^2	Approximately 5,000 m^2	Relocation is needed according to the construction of new Terminal 3.
Car Parking	1,948 lots (T1/T2: 800, T3: 1,148)	T3: 1,148 lots	In phase 1, the capacity of new car parking for Terminal 3 is sufficient with demand of all passengers, who access the airport by car.
NAVAIDs	- Upgrading of ILS from CAT-I to CAT-II - Installation of AWOS - Relocation of Control Tower	- Upgrading of ILS from CAT-I to CAT-II - Installation of AWOS	ILS upgrade is appropriate to improve flight safety and efficiency. The relocation and upgrade of Control Tower is progressed by CAAB. Deploying new AWOS at the middle of RWY due to ILS upgrade.
Supply Facility	- RFFS	RFFS	New construction is reasonable considering the response time.
	- Waste water treatment plant	Waste water treatment plant	Expansion of facilities is needed according to the expansion of the airport.
	- Intake power plant with distribution system	Intake power plant with distribution system	

Facility	CAAB Master Plan (Target Year: 2035)	Phase 1 Plan (Target Year: 2025)	Evaluation
	- Maintenance hangar	Maintenance hangar	The upgrade and improvement of these facilities are progressed by CAAB.
	- Catering facility	Catering facility	
	- GA apron and hangar	GA apron and hangar	

Source: JICA Study Team

6. Basic Airport Plan

As to the scope of the project as shown in Table 6-1.

Table 6-1 Details of Scope of Works (Phase - 1)

Works	Division	Facilities
Building	New Passenger Terminal Building (Terminal 3)	3-story building with an area of approximately 220,000 m^2 including supply of related equipment capacity of 12.0 mppa
	Multi-level Car Parking with Tunnel	Area of approximately 62,000 m^2
	New Cargo Complex	Area of approximately 42,200 m^2
	VVIP Complex	Area of approximately 5,000 m^2
	Rescue and Fire Fighting Facilities	
Civil	Parking Apron (Terminal 3 Area)	Approximately 520,000 m^2
	Taxiways	9 connecting taxiways connecting to the Terminal 3 apron: approximately 35,000 m^2
	Landside Service Road with Elevated Road	
	Taxiways (two rapid exits and one connecting taxiway for the runway 14 threshold)	Approximately 60,000 m^2
	Improvement of Drainage System	
Utility	Water Supply System	
	Sewage Treatment Plant	Area of approximately 3,000 m^2
	Intake Power Plant with Distribution System	Area of approximately 7,000 m^2
	Hydrant Fuel Supply System	
	Communication System	
	Security and Terminal Equipment	

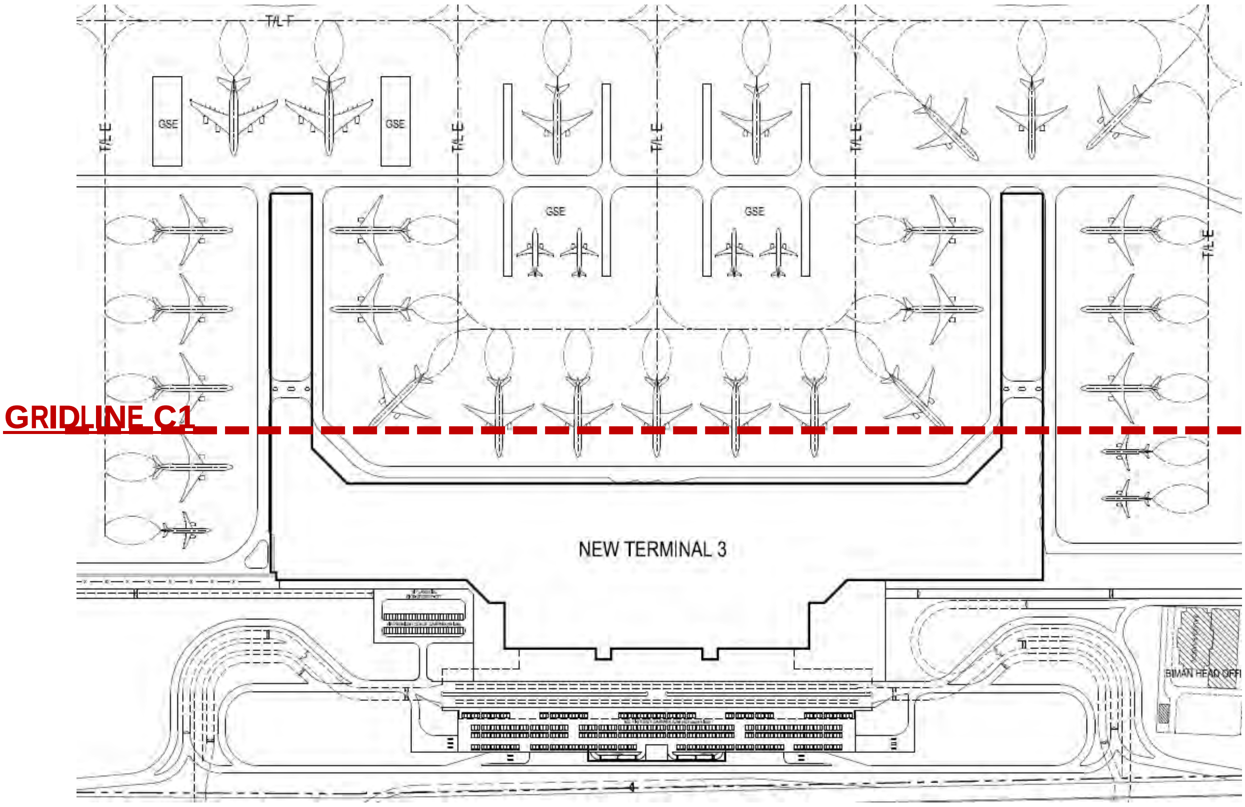
Source: JICA Study Team

6.1 Passenger Terminal Building

In the improvement plan for Terminal 3, the contact stand will secure 12 spots in accordance with the improvement plan area (about 220,000 m^2) corresponding to the target planning year (2025) of Terminal 3. The case that C1 line in Figure 6-1 is set as the boundary line of Phase-1 was confirmed in a meeting with CAAB. The result of confirmation with CAAB is shown in Figure 6-2 to Figure 6-4.

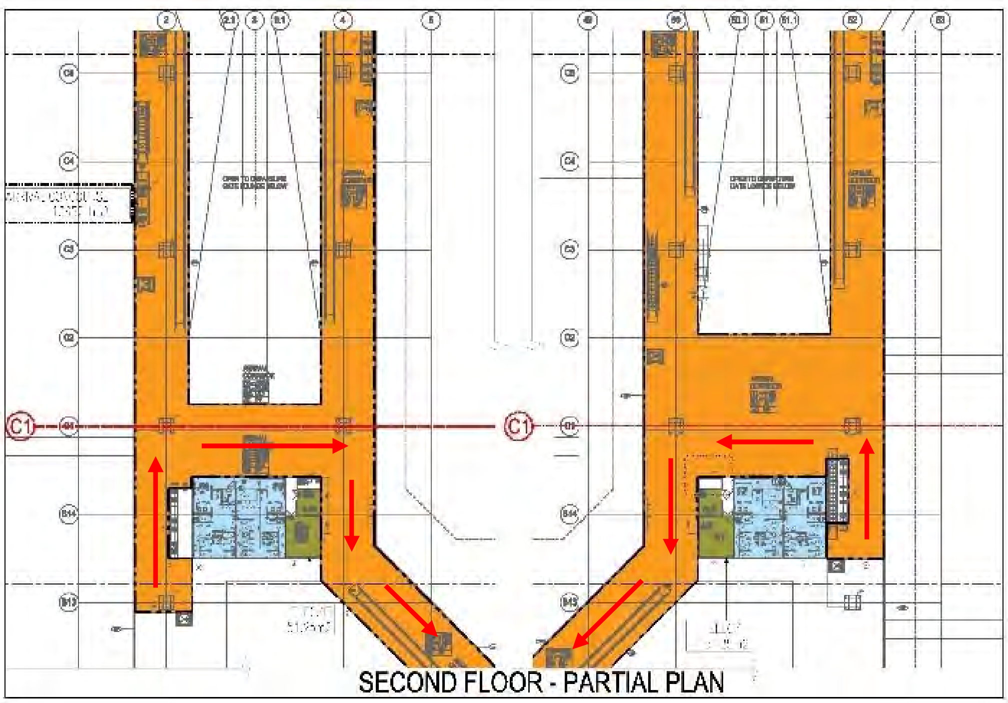
In case the scale of Phase-1 is up to the C1 line, the area is minimal, and passenger flow is not to be troublesome. However, it is necessary to consider the adjustment of the gate lounge area on the first floor and the concession area since the gate lounge area on the first floor is not large enough in this case. For this adjustment, a meeting with CAAB is necessary. Also, in the next stage, the detailed design based on the Phase-1 function is necessary.

In the 2nd meeting with CAAB held on 6th Feb 2017, the above scope of Phase-1 facilities was reconfirmed. The necessity for rearrangement of layout to satisfiy functional requirements of a 12 mppa terminal, especially the detailed design of M&E, TE, Security and Police Rooms required in the next stage was also comfirmed.



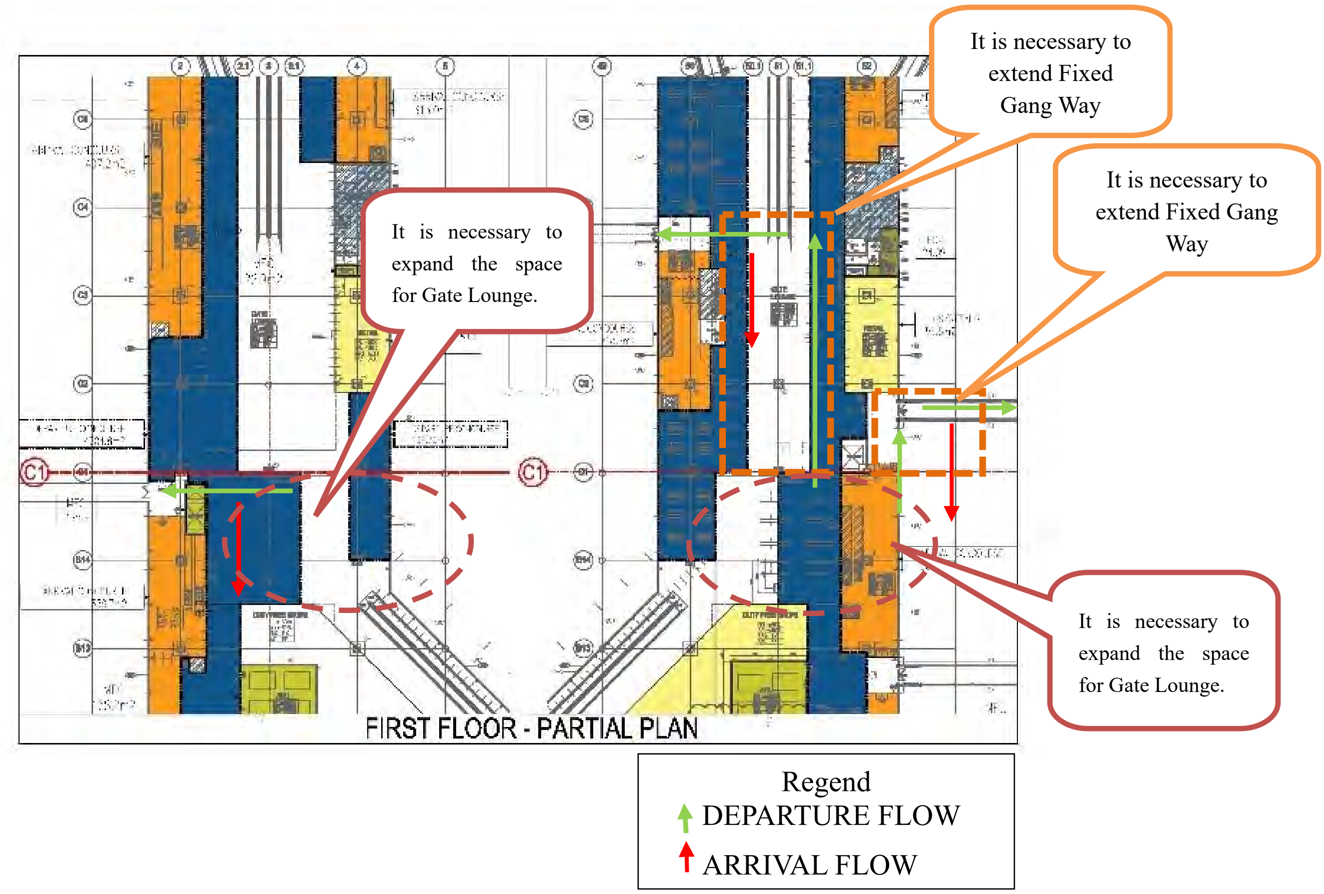
Source: JICA Study Team

Figure 6-1 Improvement Area of Phase-1（Up to Grid Line C1）



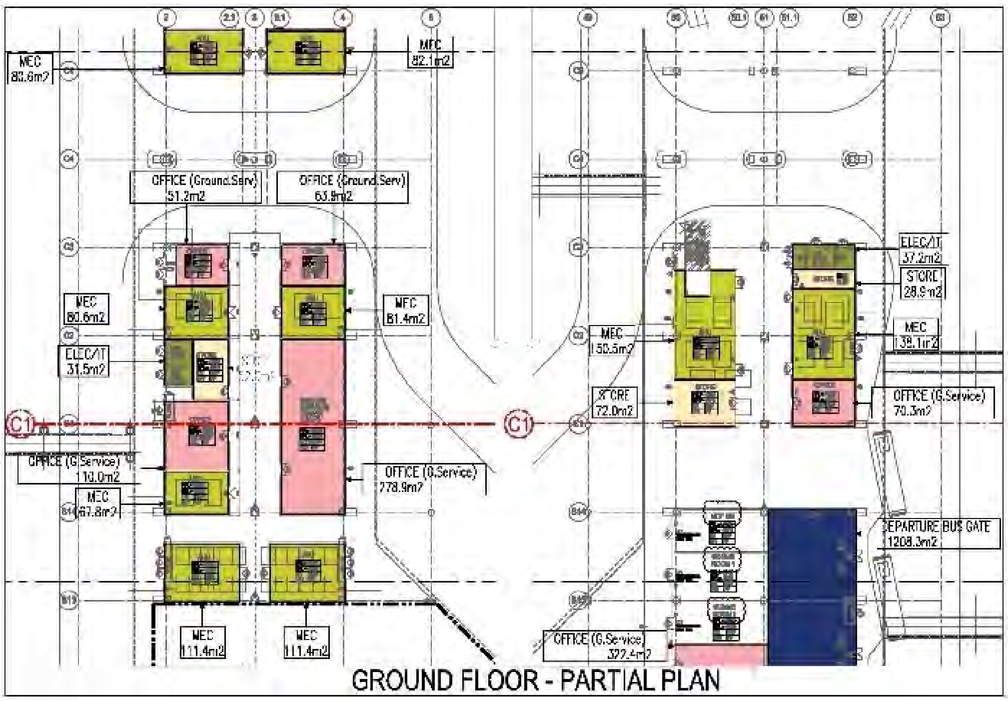
Source: JICA Study Team

Figure 6-2 Second Floor Plan



Source: JICA Study Team

Figure 6-3 First Floor Plan



Source: JICA Study Team

Figure 6-4 Ground Floor Plan

6.2 Cargo Terminal

More than a decade has passed since the construction of the current export cargo terminal, based on the explanation of CAAB and a structural evaluation is necessary regarding the soundness of the building.

In addition, unused equipment is left abandoned inside the building and layout of some equipment is not appropriate for operations.

In addition, part of the existing export cargo terminal building is included in the scope of the apron construction plan, and partial removal is necessary at the time of apron constraction.

Even if the existing building is kept available for the export cargo terminal, a drastic change of the layout, removal of some equipment, and installation of new equipment are considered necessary.

On the other hand, it is not permitted to close an existing export terminal during operation. Therefore, the new export cargo terminal will be built on the right side (northwest side) of the existing export cargo terminal. After moving export cargo operations to the new facility, the new import cargo terminal will be constructed on the left side (southeastern side).

At present export and import cargo terminal are operated separately. On site inspections revealed serious issues with the space for breakdown and build-up operations. Rebuilding the import and export cargo terminals as a single integrated structure is essential for the improvement of basic handling unit.

6.3 VVIP Building

The policy of the improvement plan for the VVIP building is as follows:

- The function of the new VVIP building will follow that of the existing VVIP building.
- In the interview with CAAB, the existing drawings of the new VVIP building are only general drawings (plan view, elevation view, sectional view), and since there are no more drawings, detailed designs including suggestions are required.

6.4 Fire Fghting Facility

Based on the rescue manual of ICAO, a Class 9 fire fighting facility with water tank capacity of more than 36,400 liters is necessary. A new Class 9 fire station shall be built.

Based on the above, the following table lists the scope of the fire fighting station to be built.

Table 6-2 Planning Scale of Fire Fighting Facility

Item	Standard	Qt	Remark
FFV	9,000 L	1	
FFV	11,200 L	1	
FFV	9,000 L	2	Install in Feb 2017
Ambulance		4	
Command car		1	
Water tank car		1	

Item	Standard	Qt	Remark
Crash tender		1	
Maintenance pit	Underground type	1	
Water hydrant		5	
Waiting room		1	
Control room		1	

Source: JICA Study Team

6.5 Apron

Based on aircraft movement forecast in this survey, the aircraft traffic volume for apron pavement design is calculated. The design period for apron pavement is 20 years, from 2016 to 2035.

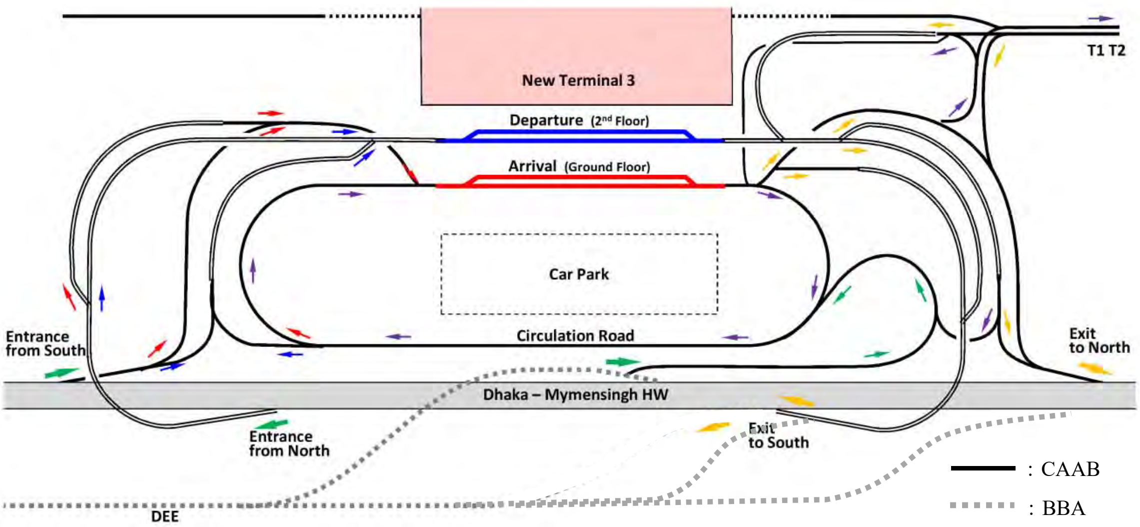
6.6 Taxiway

Since only 10% of aircrafts depart from the end of runway 32, the design traffic volume for the north rapid exit taxiway of the taxiway constructed in Phase1 is 10% of total arrival aircrafts. Based on the aircraft movement forecast in this survey, the aircraft traffic volume for the north rapid exit taxiway pavement design is calculated. The design period for rapid exit taxiway is 20 years, from 2016 to 2035.

6.7 Internal Road

The basic policy for planning the internal road is shown below.

- The road layout will follow the past conceptual design.
- The crossing of a major road should adopt elevated crossovers for smooth traffic.
- The circulation road should be provided for functional access in internal area.
- Highest possible service level should be provided in the limited landside space.
- The roads and bridges should be designed for easy recognition of directions.



Source: JICA Study Team

Figure 6-5 Traffic Line of Access / Approach Road

7. Airport Facility Plannning（Summary of Airport Facility Design）

7.1 Passenger Terminal Building（T3）

Meetings with Civil Aviation Authority, Bangladesh (CAAB), were held to confirm the scope of Phase-1 and requirements. The confirmed issues and conditions will form the basis for the airport facilities design.

(1) Results of Interview with CAAB

- There was no explanation by consultants (CPG and Yooshin) of final drawings and function of the Master Plan.
- The VIP arrival flow through the boarding bridge is mixed with ordinary passenger flow in the original design. The VIP arrival flow should be reconsidered.
- BHS design, especially VIP BHS circulation, in the original design is not clear.
- The mosque indicated in the original layout plan is independent from the terminal structure. It is not a prayer room and whether to include it in the scope of the project should be confirmed.
- After the meeting, JICA confirmed the mosque is part of the scope of this project, since the mosque is considered as one of the facilities in this airport.
- The required rooms of CIQ were verbally instructed by CAAB to CPG; however, the final drawings are not adequate. This issue shall be clarified.
- CAAB recognizes the need to confirm functions and the design intent in the original design for the Master Plan with the M/P consultant.

(2) Definate Design Requirement

JICA Study Team presented about the following matters at the 2nd CAAB meeting and confirmed that further re-check and re-arrangement shall be continued in the next stage.

- The Functional Occupation List to confirm the requirement of each room.
- The colored layout plans which show the function of airport facilities.

7.2 Cargo Complex Terminal

(1) Required Area of the Cargo Terminal Building

The required area of the cargo terminal building for the estimated cargo volume is set according to Table 7-1 and Table 7-2.

Table 7-1 Area of Cargo Terminal (Import)

Import Area	Area (m^2)	Remarks
ULD storage	4,500	477 ULD
Breakdown	3,650	
Storage, Custom, Dispatching	12,250	
Delivery	2,100	
Truck yard	6,150	
Total	28,650	Unit rate 7 tons / m^2

Source: JICA Study Team

Table 7-2 Area of Cargo Terminal (Export)

Export Area	Area(m2)	Remarks
Truck yard	6,150	
Unloading	3,300	
Ramp	2,700	
Security inspection	1,250	
Buildup	3,400	
ULD storage	1,900	
Total	18,700	Unit rate 21.4 tons/m2

Source: JICA Study Team

(2) Cargo Terminal Building Equipment

Two cases are presented for the cargo terminal, fully automated case and semi-automated case, the respective facilities.

It was decided to arrange MHS and ASRS (Full automated) as single systems for both import and export for the purpose of planning efficiency.

Table 7-3 Cargo Terminal Equipment (Full automated)

Equipment	Qty	Remarks
MHS (Material Handling System)	1	4 level
ETV (Elevating Transfer Vehicles)	3	600 ULD/Pallet
ASRS (Automatic Storage Rack System)	1	6,000 rack
X-ray (for small packages)	3	
X-ray (for large packages)	1	Pre-packed upto 4.5 m height
X-ray (for custom)	3	
X-ray (for staff)	2	
Freezer	6	Import=3, Export=3
Refrigerator	2	Import=1, Export=1
Elevating Workstations	8	
Dock-leveler	1	
Dock-lift table	1	
Floor scale	2	
CMS (Cargo Management System)	1	
RMS (Rack Management System)	1	
TRS (Truck Control System)	1	
Forklift	25	Spare: 3
Tag and dolly	13	Spare: 2
Hand fork	22	

Source: JICA Study Team

Table 7-4 Cargo Terminal Equipment (Semi automated)

Equipment	Qt	Remarks
MHS (Matrial Handling System)	1	4 level
ETV (Elevating Transfer Vehicles)	3	600 ULD/Parett
Rack	1	6,000 Rack
X-ray (for small packages)	3	
X-ray (for large packages)	1	Pre-packed upto 4.5 meters' height.
X-ray (for custom)	3	
X-ray (for staff)	2	
Freezer	6	Import=3, Export=3
Refrigerator	2	Import=1, Export=1
Elevating Workstations	8	
Dock-leveler	1	
Dock-lift table	1	
Floor Scale	2	
CMS (Cargo Management System)	1	
RMS (Rack Management System)	1	
TRS (Truck Control System)	1	
Forklift	35	Spare 4
Tag and dolly	13	Spare 2
Hand Fork	22	

Source: JICA Study Team

Source: JICA Study Team

Figure 7-1 Example of MHS (other airport)

Source: JICA Study Team

Figure 7-2 Example of ETV (other airport)

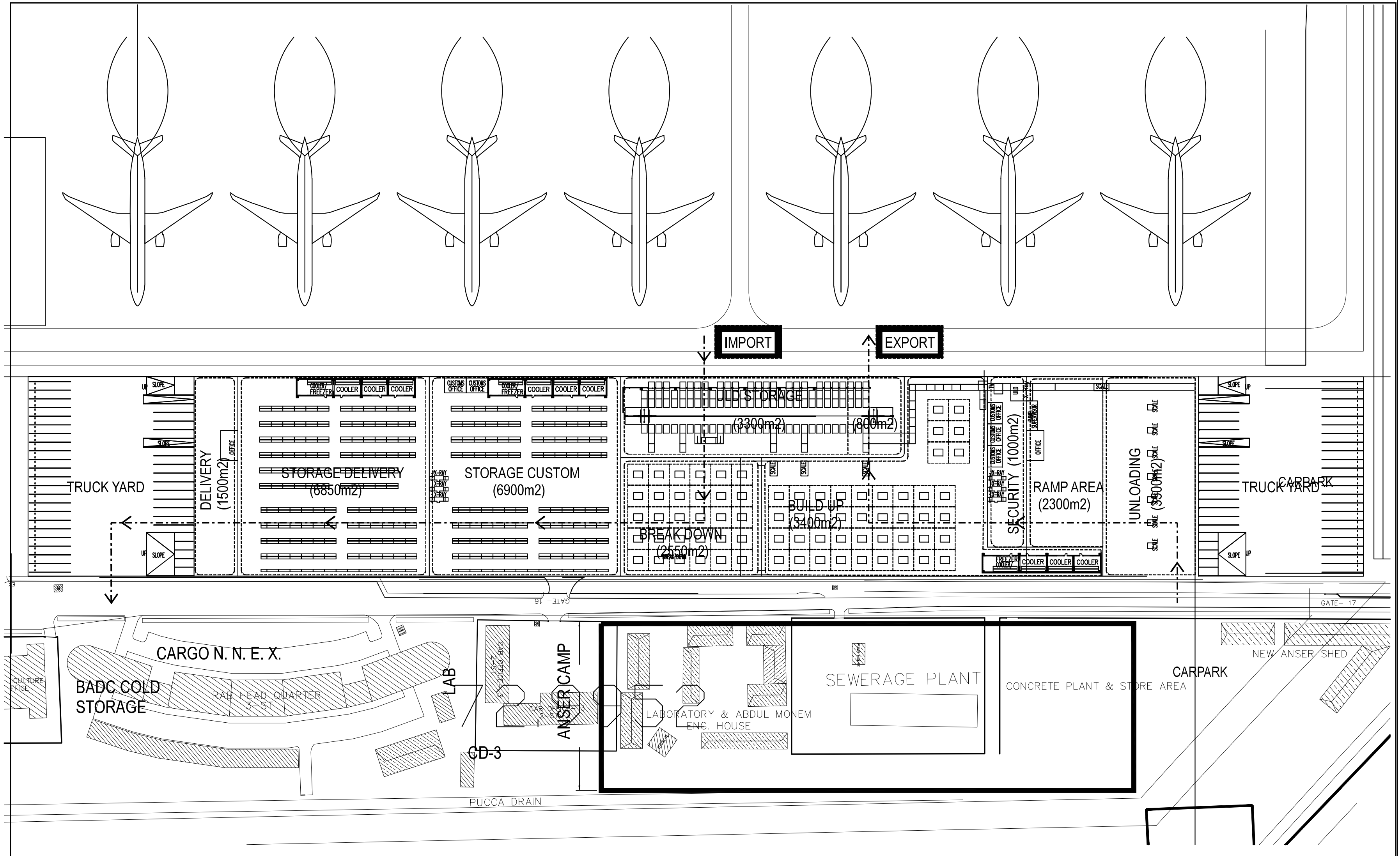
Source: JICA Study Team

Figure 7-3 Example of ASRS (other airport)

Source: JICA Study Team

Figure 7-4 Example of large inspection machine (other airport)

The layout for the detailed design and the confirmation of necessary equipment for both cases (Full automated and semi automated) will be carried out in the future.



ource: JICA Study Team

Figure 7-5 Draft Cargo Terminal Layout (Semi automated)

7.3 VVIP Terminal

The survey and interview about existing VVIP Terminal were implemented during the first meeting with CAAB. The new VVIP Terminal shall be designed as suitable for the VVIP based on the functions of the existing facility. CAAB will continue to be consulted on future development of proposed facilities.

In the meeting with CAAB held on 6th February, CAAB requested that barrier free design for handicapped or elderly passenger flow to be considered. Further discussion and study will be continued in the next stage.

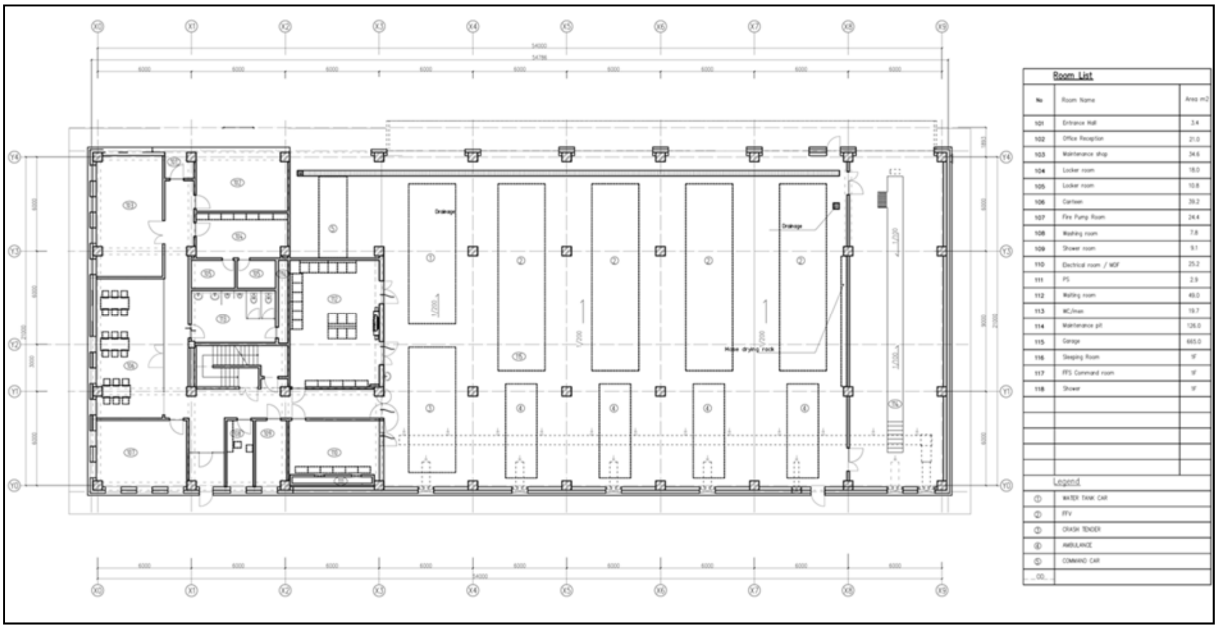
7.4 Fire Station

Based on the result of on-site confirmation, the facilities for the fire station with maximum numbers of with vehicle/equipment were set as shown below.

Table7-5 Plan of Fire Station

Item	Standard	Qt	Remark
FFV	9,000 L	1	
FFV	11,200 L	1	
FFV	9,000 L	2	Install in Feb 2017
Ambulance		4	
Command car		1	
Water tank car		1	
Crash tender		1	
Maintenance pit	Underground type	1	
Water hydrant		5	
Waiting room		1	
Control room		1	

Source: JICA Study Team



Source: JICA Study Team

Figure7-6 FFS Layout

7.5 Car Parking

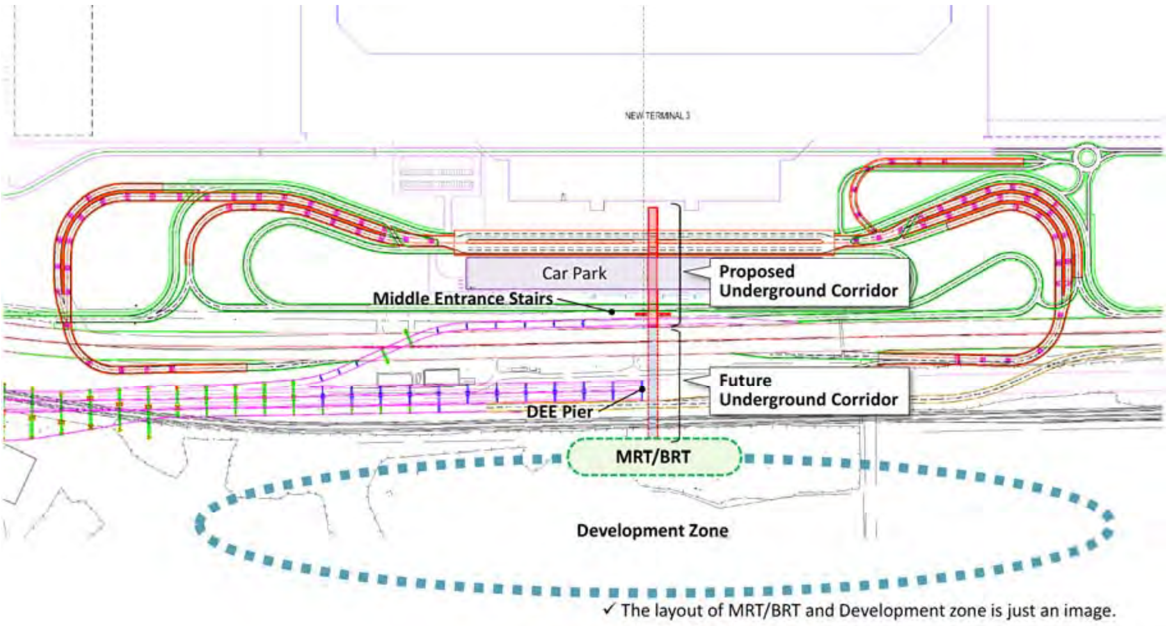
There are no indication of car parking system and details in the original drawings. The following item of design conditions and requirement shall be clarified. In the meeting held on 6th Feburuary 2017, JICA survey team explained about the summary of Car Parking Control System. The design will be developed further in the next stage.

- Car Parking Control System
- Security System in Car Parking
- Security Zoning as Airport Facility
- Demarcation of Scope of Work for Construction of Car Parking, Bridge (Elevated Road), and Terminal Building
- Requrement of Room in Car Parking
- Main Access from Car Parking to Terminal Building

7.6 Underground Pedestrian Corridor

(1) Corridor Layout

In front of Terminal 3, the new MRT/BRT station and other developments are under separate studied to ensure public traffic access. Although the layout of a new station plaza and a development plan are still undecided, the underground pedestrian corridor should be provided for airport users' convenience between Terminal 3 and the new station plaza. On the other hand, the new parking building is planned over the underground corridor. Therefore, the underground corridor take into account future development and should be constructed in the airport landside in advance. Along with the new terminal construction. In addition, the DEE pier is expected opposite the center of the Terminal 3 building. Thus, the layout of the underground corridor should be adjusted to avoid the DEE pier.



Source: JICA Study Team

Figure7-7Layout of Underground Pedestrian Corridor

(2) Interior Dimensions

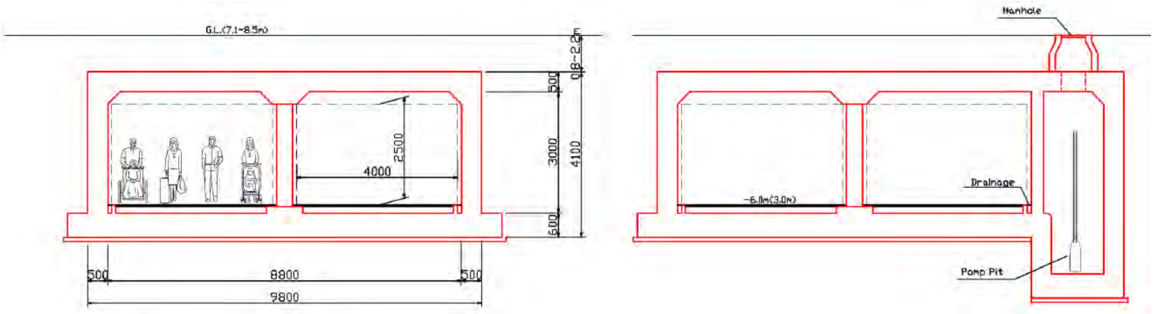
Working width should be planned with enough margin in consideration of future effective utilization.Vertical clearance, 2.8~3.0 m, should be ensured in consideration of some margin such as lighting and advertisement in addition to 2.5 m of pedestrian space. The passageway width is as follows, in case of the number of MRT users is assumed to be 30% of airport visitors in 2035.

Number of MRT users in 2035 : 75,500 per/day (JICA Study 2016)

In case of peak 10%,

Number of Pedestrian :	Q = 7,550 per/h	(126 per/min)
Pedestrian Density :	k = 0.3per/m^2	
Walk Speed :	v = 60 m/min	
Traffic Capacity :	q = k･v	= 18 人/min･m
Required Width :	w = Q / q	= 7.0 m (3.5m x 2)

For the effective width of one side, 4.0 m is recommended in consideration of person width and margin in addition to the above required width.



Source: JICA Study Team

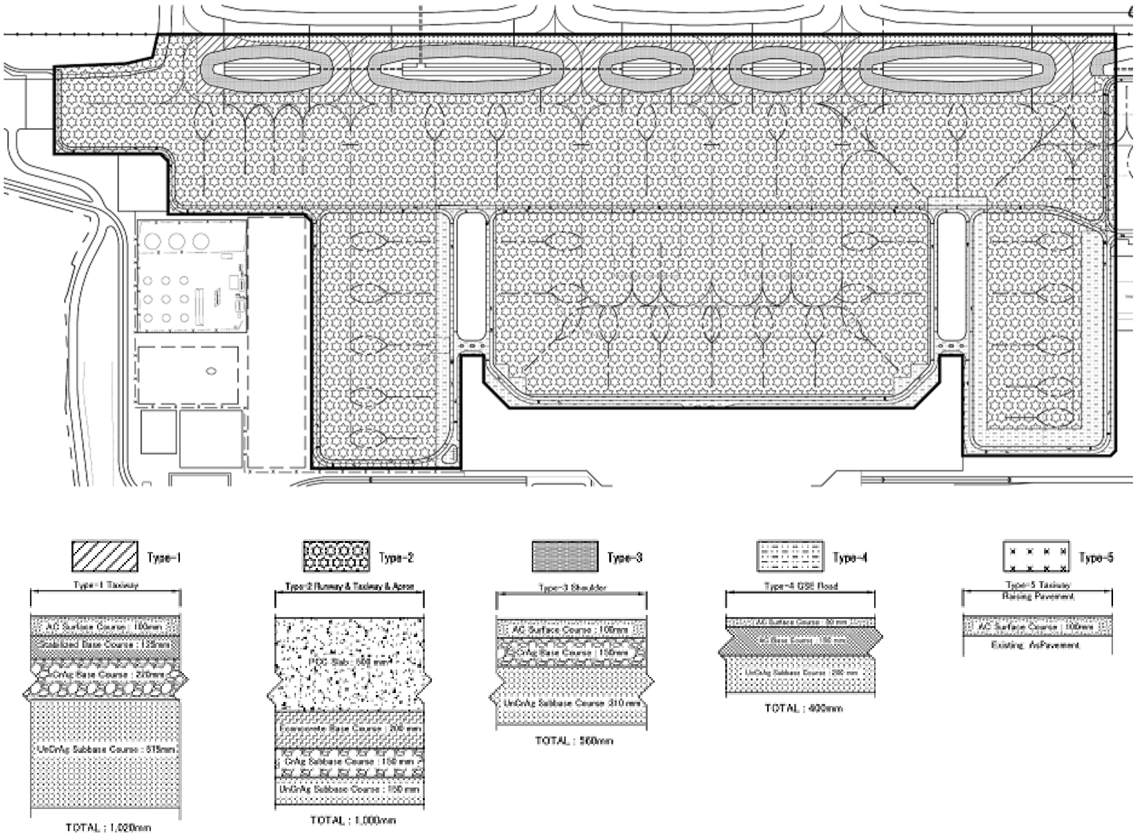
Figure 7-8 Cross Section of Underground Pedestrian Corridor

(3) Future Tasks

In the detailed design stage of this project, it is necessary to examine the design and location of the underground pedestrian corridor while adjusting with MRT line 1 project.

7.7 Apron

Pavement thickness is calculated by pavement program, FAA RFIELD v1.41 - Airport Pavement Design. The pavement thickness is different from the thickness in the master plan under the same design condition. In the detailed design, the pavement thickness should be recalculated.



Source: JICA Study Team

Figure 7-9 Pavement Type of Apron

7.8 Taxiway

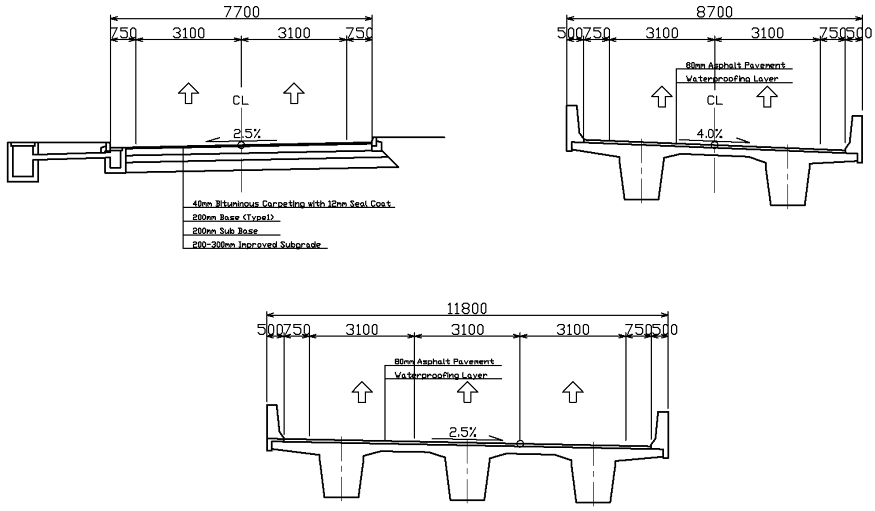
In the existing master plan, a trafic volume for pavement design of rapid exit taxiway and connecting taxiway is same as the runway pavement. It is possible to reduce the pavement thickness of connecting taxiway since the traffic volume of connecting taxiway may be reduced dependng on connecting location. In the detailed design stage of this project, it is necessary to recalculate the traffic volume and examine the pavement structure of the connecting taxiway taking into account the reviewed demand forecast results.

7.9 Internal Road and Bridge (Elevated Road)

(1) Cross Section

1) Access / Approach Road

The cross section of an access/approach road is shown below. In case of one-lane road, width of the carriageway including shoulder of more than 6 m should be provided for passing of an emergency vehicle.

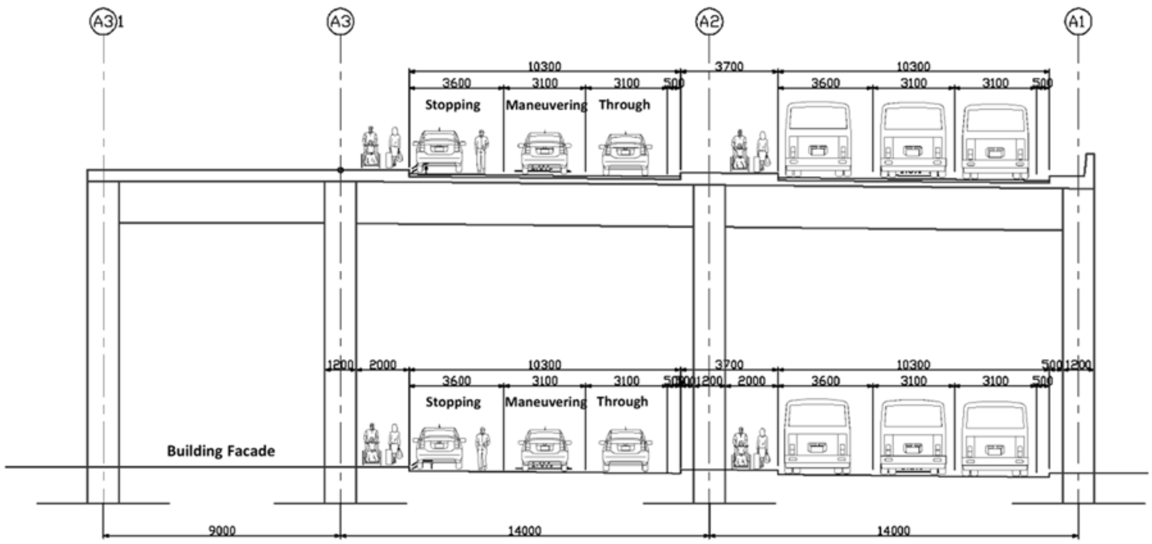


Source: JICA Study Team

Figure 7-10 Cross Section of Access / Approach Road

2) Curbside

Departure and arrival floors are each provided with two kerbsides for smooth traffic at peak hour. Each kerbside consists of three lanes for stopping, through traffic and maneuvering. In the stopping lane, wide width should be provided for stopping to let people get on and off and baggage handling. In a footway, width of more than 2 m should be provided in the resticted space around columns for passenger traffic and visibility.



Source: JICA Study Team

Figure 7-11 Cross Section of Curbside

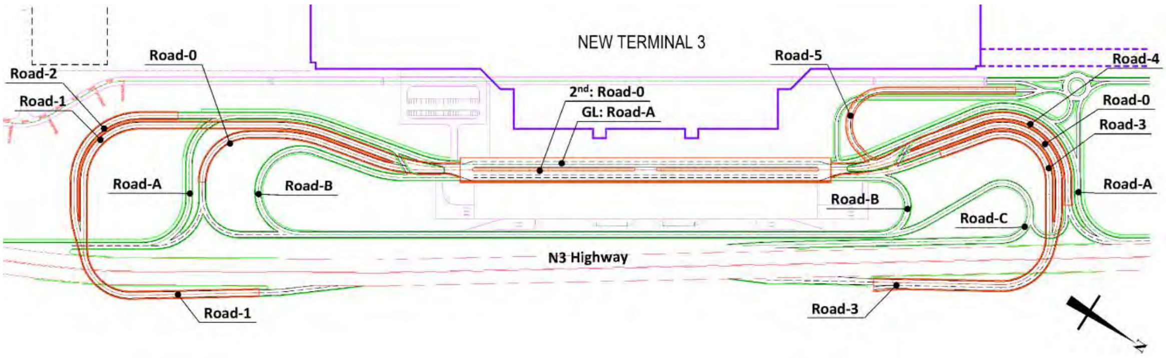
(2) Road Alignment Plannning

The access/approach road is constituted by nine roads from Road-0 to Road-5 and Road-A to Road-C.The road alignment should promote route continuity and harmony of horizontal and vertical alignment. It should be decided in consideration of smooth and safe traffic, facilities layout, and landscaping. Especially, since internal road has many diverging/merging sections, suitable visual guidance and diverging interval should be provided for drivers unfamiliar with layout. Each road and horizontal alignment are shown below.

Table 7-6 Access / Approach Road List

Road	Function	Summary
Road-0	Elevated Approach Way to Departure	Road-A > Departure >Road-3
Road-1	Entrance Access Way Elevated Approach Way to Departure	Entrance HW North > Cross HW> Departure
Road-2	Elevated Approach Way to Arrival	Road-1 >Road-A > Arrival
Road-3	ExitAccess way Elevated Approach Way from Arrival	Arrival> Cross HW> Exit HW South
Road-4	Elevated Approach Way from Departure	Departure >Road-0>Road-A
Road-5	Elevated Approach Way from Terminal 1 / Terminal 2	T1/T2 > Road-0
Road-A	Entrance / Exit Access Way Approach Way for Arrival	Entrance HW South > Arrival> Exit HW North
Road-B	Circulation Way	
Road-C	Entrance Access Way from DEE	Entrance DEE-Exit > Road-B

Source: JICA Study Team



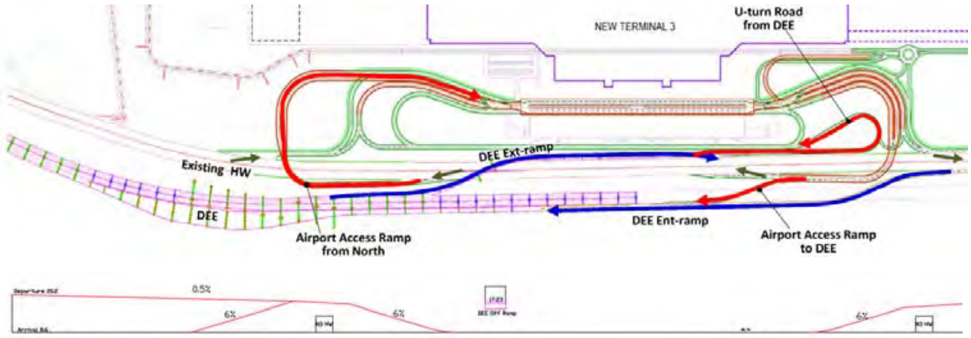
Source: JICA Study Team

Figure7-12 Access / Approach Road Layout

(3) Access with DEE

The entrance/exit ramp in Dhaka Elevated Expressway (DEE) is planned to be linked near to the existing airport. On the other hand, the entrance ramp from the north for Terminal 3 access interferes with the DEE exit ramp, and the exit ramp to the south interferes with the DEE entrance ramp. According to the master plan in 2015 and feasibility survey, a layout which shifts the DEE exit ramp to the south by 1 km and the entrance ramp to the north by 0.5 km is recommended. However, since the DEE project is already under construction, the replanning of the access method of Terminal 3 and DEE is required. Thus, examination of alternatives was carried out regarding the connection method with DEE.

As a result, the consultant proposed "Alt-2A:Shift Terminal 3 access ramp to the south and U-turn road" as for the connection method with DEE for traffic safety and economy.



Source: JICA Study Team

Figure7-13 Alt-2A (Connects by U-turn Road, Shift T3 Ent to South & Shift DEE Ent Ramp to North)

(4) Issues for the Detail Design

- Road alignment was planned based on new T3 terminal of the basic design 2015 in this survey. In a detail design, the benchmark coordinate and elevation should be adjusted with new T3 building, the existing road, and DEE.
- Horizontal alignment should be examined in the detail design to adjustment such as a transition curve and improvement of diverging / merging.
- Adjustment of vertical gradient to accommodate CAAB request for maximum 5% should be studied in the detail design.
- The layout of DEE entrance ramp should allow for maximum weaving length possible from the existing junction of T1 / T2.
- The northern section of DEE entrance ramp is not a DEE project but the DAEA (Dhaka Ashulia Elevated Expressway) project. In the detailed layout, adjustment with DAEA will be required.
- Bridge surface pavement should be studied including installation of the layer of leveling and waterproof in a detail design phase.

7.10 Water Treatment Plant

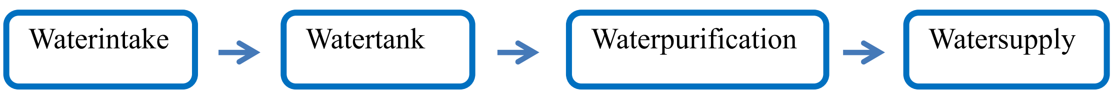
Water treatment plant does not calculate required supply water volume. The JICA Study Team arranged the following table and calculate the required supply water volume at the plant and plan facilities scale.

Table7-7 Required Supply Water Volume

Item	Qt	Water Use Ration	Water Volume(m^3)
Passenger	40,138	40ℓ/man	1,606
Pick up persons	21,822	40ℓ/man	873
Staff	3,738	100ℓ/man	374
No of resturant	4,385	40ℓ/meal	171
Other	2,191		1,682
Tptal	72,274		4,706

*Others include cooling tower make upwater, backwash water for filtration system in WTP, the make up water for the chemical feeder.

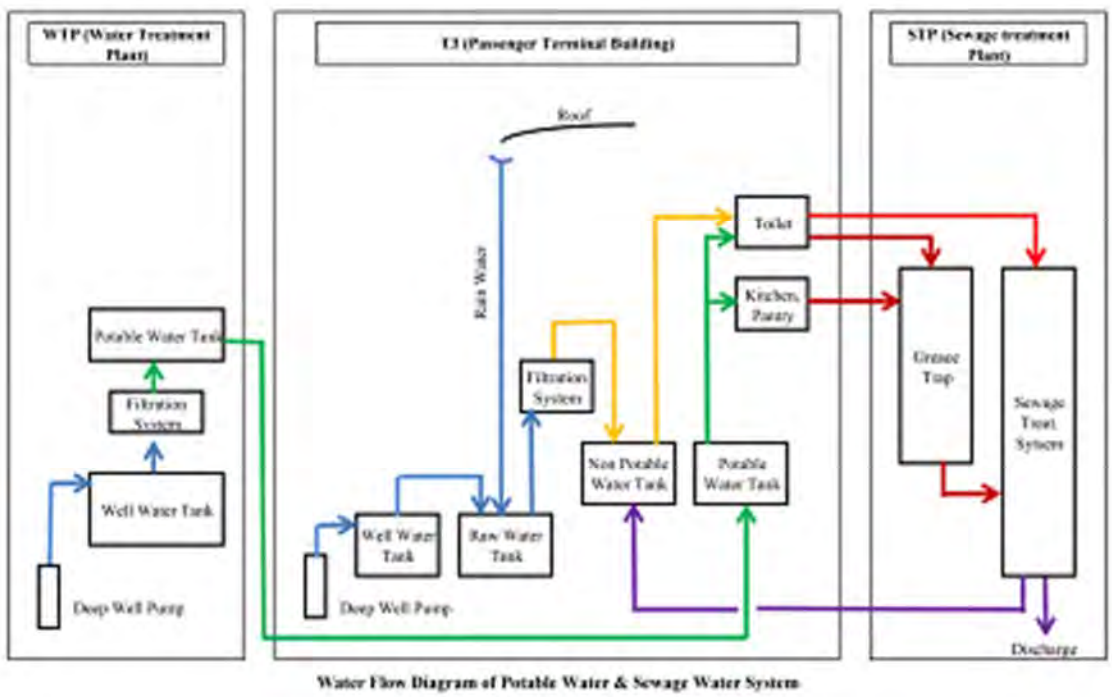
Source: JICA Study Team



Source: JICA Study Team

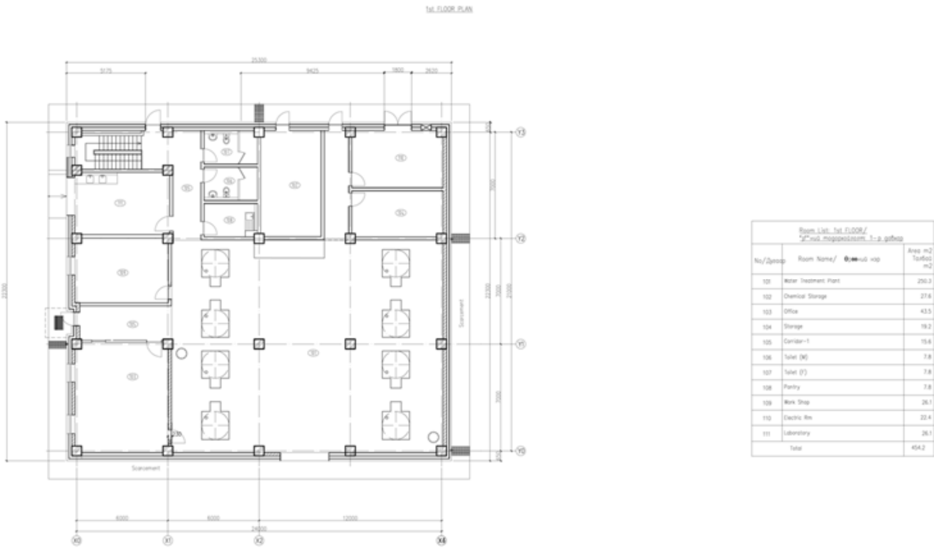
Figure7-14 WTP Flow Sheet

- Raw water is obtained from six deep well pumps as mentioned in the specifications of CPG.
- The storage water facilities are reserve deep well drawn water.
- The filtration facilities choose a filter device depending on raw water turbidity and do not install removal of iron and manganese device because there are few cases where iron content and manganese content is mixed with raw water.
- The filtered water undergoes chlorination to maintain a value of residual chlorine.
- The water supply facilities install water pump and piping system to the necessary building.



Source: JICA Study Team

Figure7-15 Water Flow Diagram



Source: JICA Study Team

Figure 7-16 Water Supply Equipment Layout

7.11 Sewage Treatment Plant

The sewage treatment plant is made based on the specifications in the basic design but considering the target processing material, there are many matters which need confirmation.

In the discussion with CAAB, the following matters are confirmed and assumed that the facilities will reflect these.

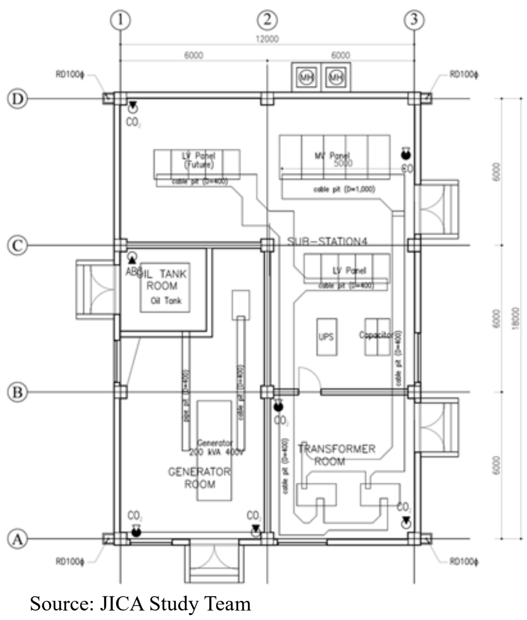
In addition, because the existing sewage treatment plant is reported to not operate smoothly, the sewage treatment plant for the whole airport was requested. However, it was decided to set the target facilities on the original scope because the request deviated from the conventional scope of JICA projects.

Since phosphorus and nitrogen are not prescribed as materials targeted under wastewater regulations, depending on the need, it is suggested to consider facilities which cope with these two materials in following recent trends in sewage treatment.

After confirming the existing sewage treatment plant from outside the facility, aeration processing space for the disposal of sludge was observed and a similar space will be secured for the new sewage treatment plant.

After the water supply capacity of the above was calculated, the necessary processing capacity was reduced for the make-up water or other water supply of the cooling tower for the air conditioning.

Based on the specifications of the CAAB, black water is the filthy water which is discharged from toilet, and grey water is wastage discharged from kitchen and canteen. Grey water shall be provided with oil and grease trap to remove oils and fats prior to connection to the septic tank facilities. The expansion will only handle grey water in the future.



Source: JICA Study Team

Figure7-17 STP Layout

Source: JICA Study Team

Figure7-18 Sewage Treatment Facilities Aeration Space (Existing Facilities)

7.12 Power Intake Station

(1) New power intake station

In this "Dhaka International Airport Expansion Project" plan, the expansion is planned with the new passenger terminal building, new cargo terminal building, and the VVIP building, so existing power receiving facilities and distribution lines do not have enough capacity.

Therefore, a new intake power station and HT distribution are to be installed.

The power station confirmed by CAAB to be planned to receive power supply from both ADA Power Station in the south side and CAAB Power Station in the north side, with an electric voltage of 11 kV.

In addition, in the meeting between CAAB and the Dhaka Power Supply Public Corporation, it wais confirmed that at least five years are required in the preparation of power station in the master plan of CAAB. This is a significant risk factor for planning of the construction schedule.

Therefore, reconfirmation by CAAB is requested, and it will be necessary to arrange countermeasures, such as temporary power supply, prior to commencement of construction if substation schedule does not meet the main construction schedule.

1) New Electric Equipment Capacity

Taking into consideration the plan of this "Dhaka International Airport Expansion Project" and future expansion plan, the total electric power capacity will be 57,520 kVA.Total power demand will be about 50,000 kVA (Intake power: minimum of 50,000 kVA required). Also, the generator is installed at each substation, and 100% backup excluding airconditioning, and refrigerator (chiller) demand is scheduled for power outage and accident. Total generator capacity is 64,000 kVA.

2) New Distribution System（HT Distribution Schematic Diagram）

The new power intake station assumes a two system retreat from an electric power company and plans four system pulls in the future so that it is possible for including it (future HT loop).

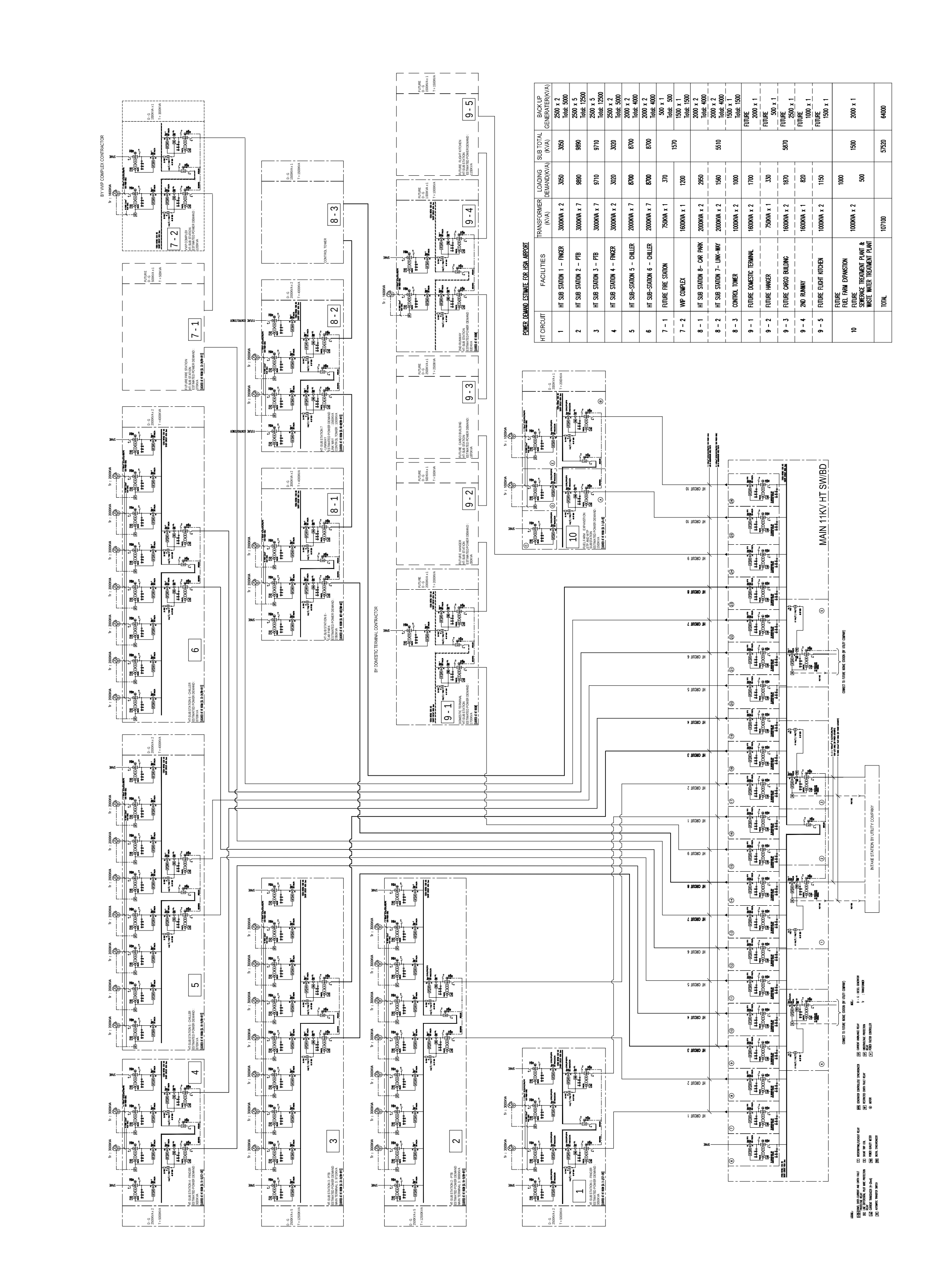


Figure 7-19 HT Distribution Schematic Diagram

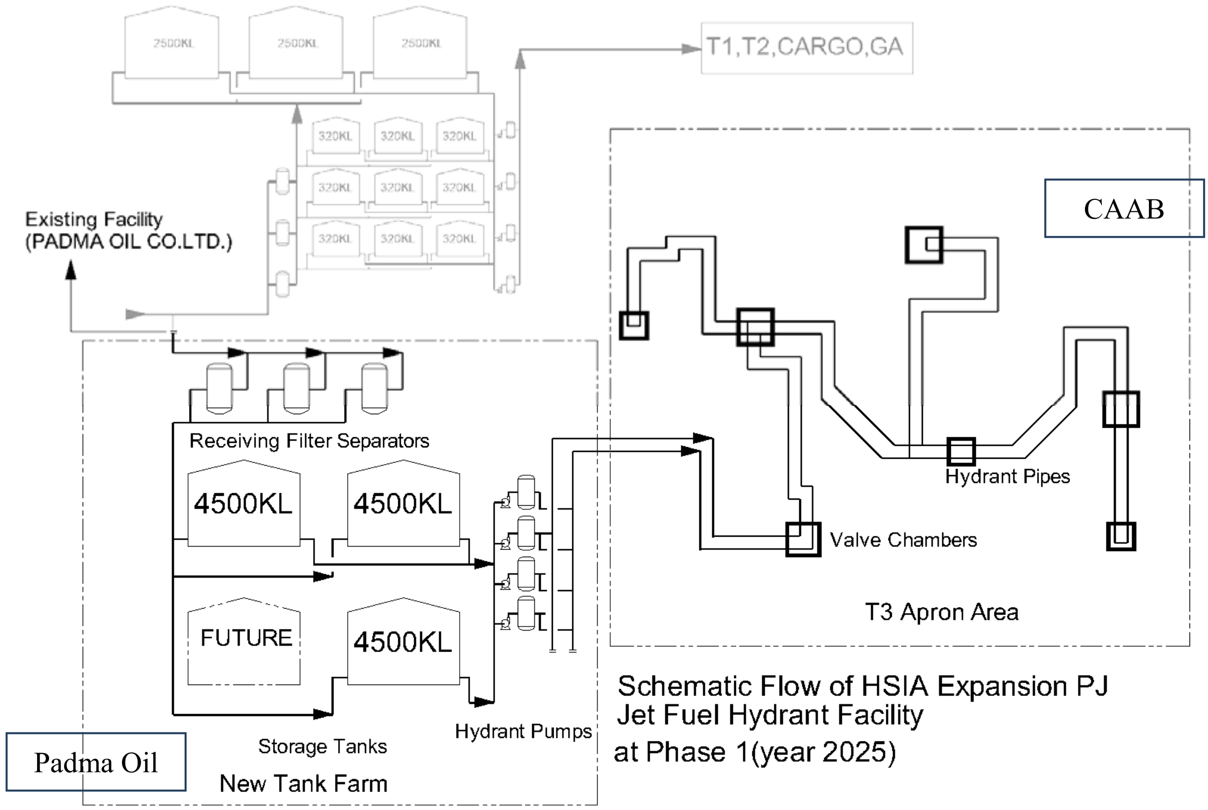
Source: JICA Study Team

7.13 Fuel Supply Facilities

The fuel depot and hydrant facility are all in one system as a fuel supply system and it cannot be segregated individually. Therefore, the implementation of fuel supply system (Fuel depot and hydrant facility) for Terminal 3 must be done all in one system.

Further discussion for the work demarcation of fuel supply facility at Terminal 3 with Padma Oil Co., Ltd. will be required. However, we understand that fuel depot facilities will be provided by Padma Oil Co., Ltd and hydrant facility will be provided by CAAB.

Figure 7-20 shows the Outline of Fuel Supply Facilities for Terminal 3.



Source: JICA Study Team

Figure 7-20 Outline of Fuel Supply Facilities

7.14 Communication Facility

In the HSIA Expansion Project Phase-1, significant extension, including the new terminal building, new cargo terminal, and VVIP terminal is scheduled. Therefore, the existing communication network will be utilized and the new communication network for expansion area will be newly built. The new network will be connected to the existing network to complete the whole built out network.

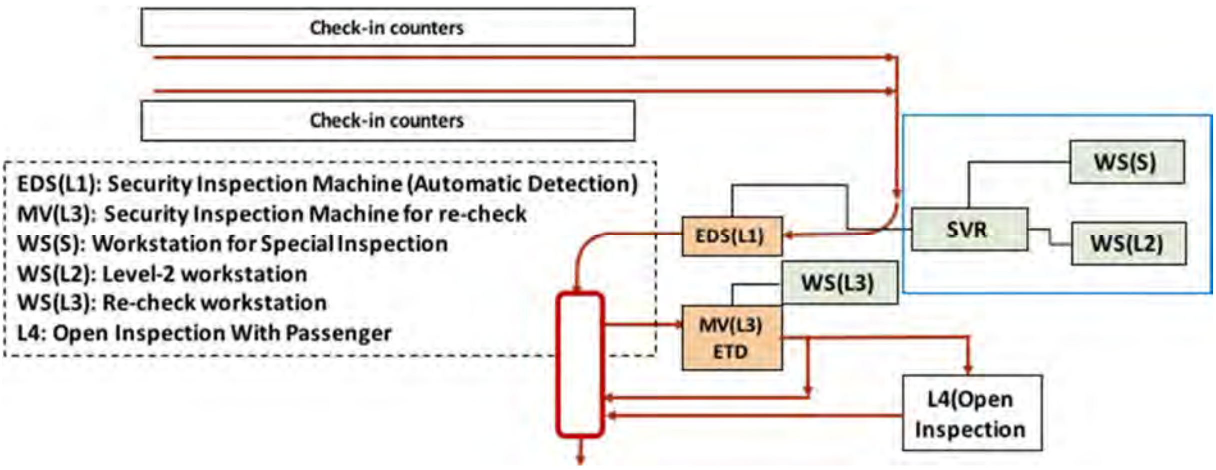
7.15 Security Equipment

The security equipment was discussed with security operator and CAAB. In the discussion, the following requests were confirmed from CAAB:

- HSB will follow the regulation of TSA and ECAC.
- HSB will comply with EU STD3 that will be operational at the time of Terminal3 opening
- HSB shall have a separate image inspection for handguns, etc. in addition to EDS evaluation functions on all baggage.
- The inspection of the carry-on is also based on regulation of TSA and ECAC.
- The regulation of ECAC in the carry-on will comply with the EU STD3 (C1 - C3) operation.
- The security check point will be provided with a smart security lane.
- In the inspection for passenger, will install ATI(MWD).
- The inspection machine of the customs excludes the installation of CAAB.

based on the above considerations HSB diagram can be shown as below:

Inspection	Special	Level-1	Level-2	Level-3 (Re-check)	Level-4
Method / Equipment	Image inspection by operator (Inspection room)	Automatic decision function	Image inspection by operator (Inspection room)	Image inspection by MV inspection machine and ETD(Re-check room)	Open inspection



Source: JICA Study Team

Figure7-21 HBS Inspection Flow

8. Study on Applicability of Japanese Technologies

The airports constructed by Japanese companies in the past 20 years and the Japanese technologies applied in these airports are listed.

There are various technical problems in each airport and a various Japanese advanced technologies are used to solve them. A condition considered to be a problem is listed in the column of "technical constrained conditions" and common problems in the Dhaka international Airport Expansion Project are airport construction under operation and soil improvement.

In addition to the issues with airport construction under operation and soil improvement at Dhaka International Airport Project, shortening of construction period is also required. Construction period is set until April 2021 for 37 months as the completion of the Terminal 3 building. However, there is congestion caused by different construction such as the huge scale of Terminal 3, apron construction at the front part of Terminal 3, and service roads including the elevated structure in Terminal 3 landside area. Therefore, it is necessary to adopt construction method that will contribute to the shortening of the construction period of Terminal 3 in order to smoothly implement the construction of Terminal 3, which is the main component of HSIA expansion.

Here, advanced technology is divided into two major categories, namely: construction method and material/equipment. Advanced technology in construction method is defined as the technology that must be adopted to solve a particular problem in this airport. At the tendering stage, it will be necessary to confirm the experience in the particular construction methods to secure construction quality.

On the other hand, the latest construction materials and equipment used in Japanese airports are technologies that work predominantly in terms of maintenance and operation such as reduction of the maintenance cost and improvement of image of the airport. However, they are not necessarily Japanese technology only, and there may be similar euqipment/materials which may be in use in other advanced countries. A contractor/supplier will select which country these things will come from at the bidding stage. Therefore,it is important that the specific characteristics are prescribed on the specifications.

The required technology is gathered for the following three items in the Dhaka International Airport Expansion Project as mentioned above:

- Construction under airport operation
- Construction method for shortening of construction period
- Soil improvement

Of these, construction under airport operation has already been carried out by CAAB such as apron expansion project from F taxiway to an existing export cargo terminal and asphalt overlay construction of the parallel taxiway. These constructions in the airport have been carried out according to Safety Management System (SMS) Manual based on the ICAO standards and airport construction under airport operation should not be necessarily considered as a Japanese advanced technology.

Therefore, for advanced technology in this airport, Screwed Steel Piling Method and soil improvement method are adopted for shortening the term of the works and soft ground countermeasure.

8.1 Screwed Steel Pile

8.1.1 Consideration for Shortening the Construction Period due to the Application of Screwed Steel Pile

It is difficult for local contractor to construct screwed steel pile because screwed steel pile is Japanese technology. According to interview with Japanese company, they can dispatch only seven parties at the moment. In view of the above, the JICA Study Team considers the mixed case of screwed steel pile and cast-in-place pile.

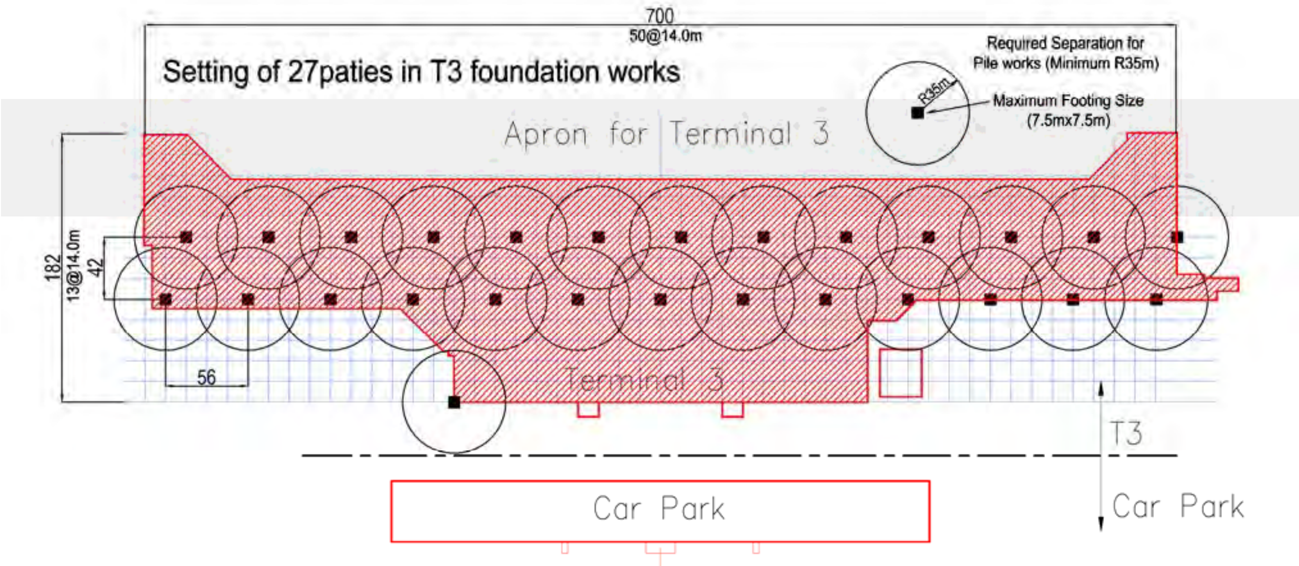
As a result, when the ratio of screwed steel pile and cast-in-place pile is 66:34, it is the most effective plan for shortening the construction period. In this case, the period can be shortened by about ten months. However, the construction cost will increase by JPY 4 billion. In the case where the ratio of screwed steel pile is 25%, the period can be shortened by about 100 days, and the construction cost will increase by JPY 1.5 billion. Figure 11.4 shows the relationship among the ratio of the screwed steel pile, the effectiveness of shortening the construction period, and the increase of the construction cost.

However, the above considerations might probably change since there is no detailed construction plan. Also, it is necessary to separate the structure of the building for different pile foundation since the elastic condition for each pile is different. Therefore, it is necessary to reconsider the structure of the building including the placement of expansion joint.

8.1.2 Applicability of Screwed Steel Pile to this Project

The applicability of screwed steel pile to this project is shown as follows:

- In the original design, pile foundation will be constructed by cast-in-place pile. It will become the critical path since it will take about 16 months. However, if it will be constructed by screwed steel pile, the construction period can be drastically shortened.
- Based on the result of a general study based on the boring investigation results of this study, it is revealed that the number of screwed steel pile for a single foundation will be reduced to 5 from 9 for cast-in-place pile. Furthermore, the construction period in case of screwed steel pile can be reduced to about 8 days from 14 days in comparison with the cast-in-place pile. However, the pile length of screwed steel pile is longer by approximately 7 m compared with the cast-in-place pile. But according to the interview with the Japanese companies, they can only dispatch seven parties. Thus, combination of screwed steel pile and cast-in-place pile will be used to shorten the construction period.
- Hereafter, it is necessary to confirm the structure and load of the building, hardness of the ground for each depth, and consideration of the separation of the building structure, among others. In the detailed design, it is necessary to design the separation of the building using expansion joint since there is no detailed drawing for expansion joint.
- As a result of the outline study, the construction period can be shortened by approximately ten months in case two thirds of all piles are screwed steel pile. However, the construction cost will increase by about JPY 4 billion. These considerations might still be changed during the detailed design and construction planning of the foundation and structure in the future.
- The construction area is very complicated since the footing at the center of Terminal 3 has 50 spans (1 span is 14 m); 2 parties per 4 spans will be placed in case of the installation of 27 parties. However, because the width required for the construction of screwed steel pile is about 10 m, it is necessary to ensure separation of about 35 m considering the drop of pile. In view of the above, the construction will be implemented using staggered placement.



Source: JICA Study Team

Figure8-1 Arrangement of the Screwed Steel Piles in Consideration of the Work Clearance

- As a method of further shortening the construction period, day and night constructions are considered feasible. The additional construction cost due to labor cost such as night allowance and the establishment of night lighting facilities is a small amount of the entire cost of construction. In this case, it is necessary to ensure more than twice the number of technicians and operators. Also, the construction period in case of cast-in-place pile with day and night constructions can be reduced to about eight months. This is almost the same construction period shortening effect using screwed steel pile.
- In order to apply the heterogeneous pile to the pile foundation in the same building, it is necessary to reconsider the structure of the building and the construction plan during the detailed design phase (6 months).

8.2 Soil Improvement

8.2.1 Soil Improvement Area

The purpose of the ground improvement is divided into subsidence measures, stabilization measures such as the increase in ground strength, and stabilization measures at the time of an earthquake. The soil improvement method of construction adapts to the most improved purpose and furthermore, it is necessary to choose the most economic method in consideration of the characteristic of soil layer of the existing ground and the facilities built above.

Gathering the above, the necessary area for soil improvement is assumed as follows:

Source: JICA Study Team

Figure 8-2Assumed Soil Improvement Area

8.2.2 Applicability of Soil Improvement

Consolidation settlement will occur in the new taxiway and Terminal 3 construction site after completion of construction since there is an existing regulating reservoir.

There is a possibility to deviate from the required gradient of the International Civil Aviation Organization (ICAO) standard (vertical and crossing gradient of taxiway is provided at less than 1.5%, apron is provided at less than 1.0%) by consolidation settlement. After the airport opens, it is likely to be a major problem in the next few years.

When liquefaction occurs, the pavement grade cannot satisfy the rated value or the pavement is more likely to be destroyed.

Based on the above, it is required to select the most economic and effective method of improving the soft soil.

9 Construction Planning

9.1 Procurement Situation

The local procurement situation for the procurement of materials for civil engineering facilities works and building facilities works, which shall be the main works in the construction of HSIA Expansion Project, are summarized below.

However, based on the applicable standards and specifications, special equipment and plant, such as baggage handling system, passenger boarding bridge, aeronautical navigation radio facility, and lighting facilities, will have to be imported.

9.2 Planning Condition

The following are the important points in the construction planning of the HSIA Expansion Project:

- The construction planning has taken into consideration the schedule of piling work.
- The onsite construction work as well as related planning would take into consideration the bad nature of the site soil.
- The timing of infrastructure connection, such as mechanical, electrical and fuel should be coordinated.

9.3 Study on Construction Works Progress

Working ratio is determined at 75.7% (1.32), as shown in Table 9-1, omitting rainy days as disability period and holidays.

Table 9-1 Calculation of Operating Rate

Year (days)	Work Inability Date			Working Days	Operating Rate	
	Rainfall Date	Holidays	Total			
365	77.5	11	88.5	276.5	75.7%	1.32

Source: JICA Study Team

Main work volume and working days are shown below.

Table 9-2 Working Period

Engineering Work	Classification	Quantity	Working Days (days)	Working Months (months)	Remark
Earthwork	Removal of Topsoil	760,000 m^3	270	12	
	Sand Filling in pond	425,000 m^3			
	Soil Improvement Work	200,000 m^3			
	EarthCut	—			
Pavement work	Taxiway	108,000 m^2			
	Apron	498,500 m^2	500	22	
	Facilities Road	1 Lot	520	23	
Drainage work	Main Drainage	1 Lot	630	28	
	Reservoir	1 Lot	770	34	
Miscellaneous work	Security Fence	1 Lot	200	9	

Source: JICA Study Team

The critical work of the project is the terminal building work. The total work period of this project including preparation work, construction work, and trial run is 37 months.

10 Project Implementation Schedule

(1) Conditions

1) Precondition

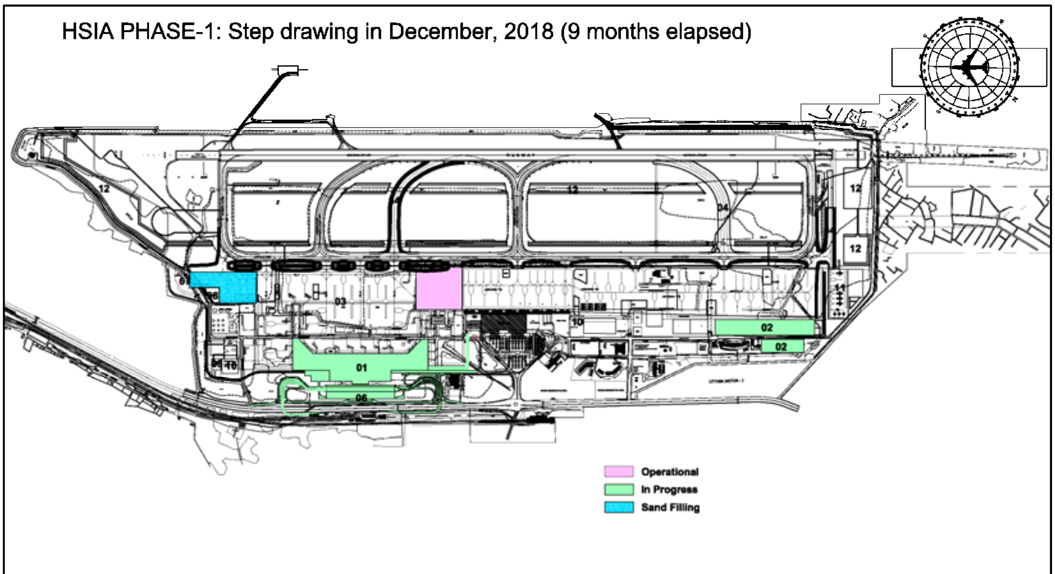
Based on the intention of the Bangladeshi government of early completion, the procurement procedure shall be of a minimum period.

- Consulting service will start in April 2017.
- The period of detailed design is shortened to six months by utilizing existing drawings as much as possible.
- Construction will start in April 2018 based on the above condition.
- Construction period for international terminal (Terminal 3) is 37 months.
- Construction period for apron is 34 months.

- At the time of the soft opening planned in January 2019, the service of the new VVIP building shall start.

2) Project Implementation Schedule

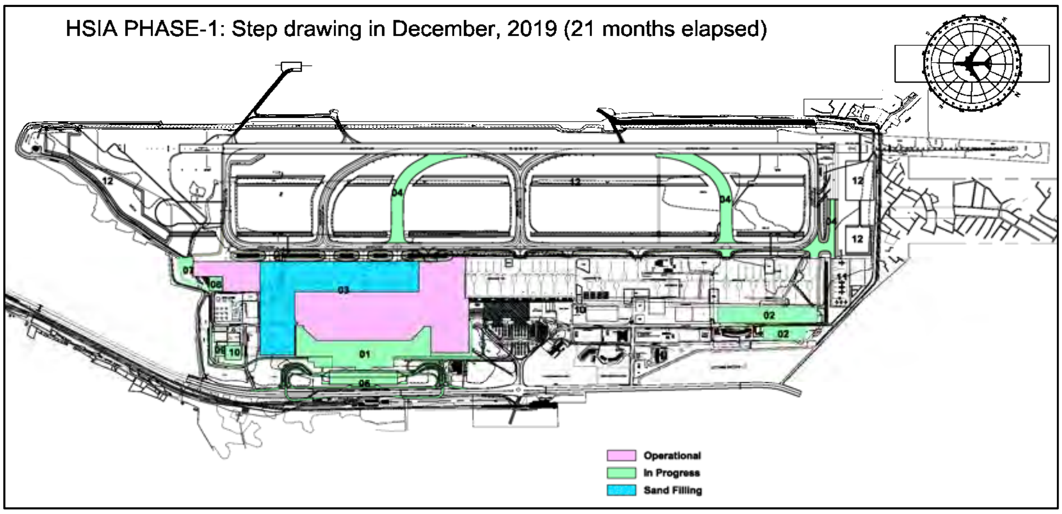
Project step drawing is shown in Figure 10-1 to Figure 10-4. Also, project implementation schedule is shown in Figure 10-5.



01	New International Terminal Building (Terminal 3)	07	VVIP Complex
02	New Cargo Complex	08	Rescue Fire Fighting Facility
03	Expansion of Apron (Including Fuel Hydrant)	09	Sewage Treatment Plant
04	Taxiways	10	Intake Power Plant
05	DVOR/DME	11	GA Apron
06	Road and Car Park	12	Improvement of Drainage Ditch

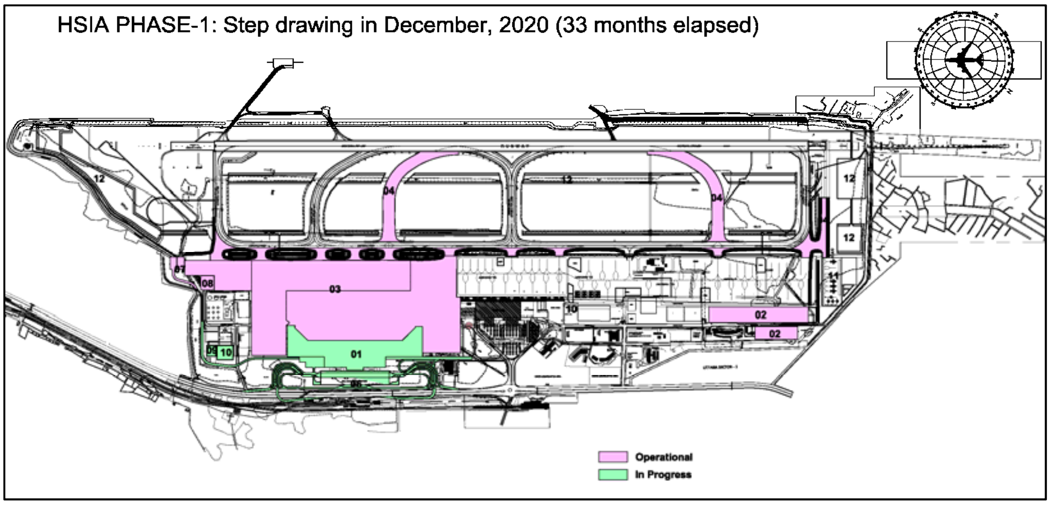
Source: JICA Study Team

Figure 10-1Step Drawing in December 2018 (9 months elapsed)



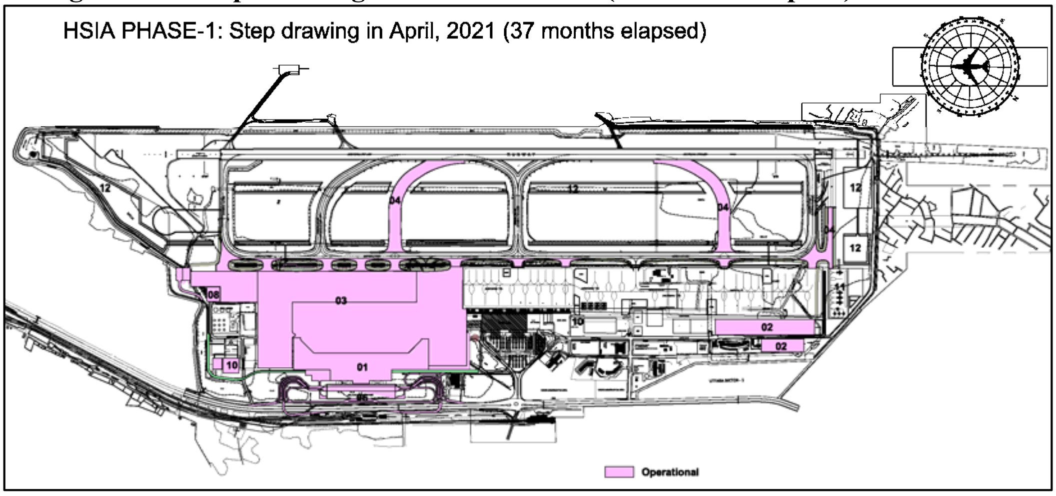
Source: JICA Study Team

Figure 10-2 Step Drawing in December 2019 (21 months elapsed)



Source: JICA Study Team

Figure 10-3 Step Drawing in December 2020 (33 months elapsed)

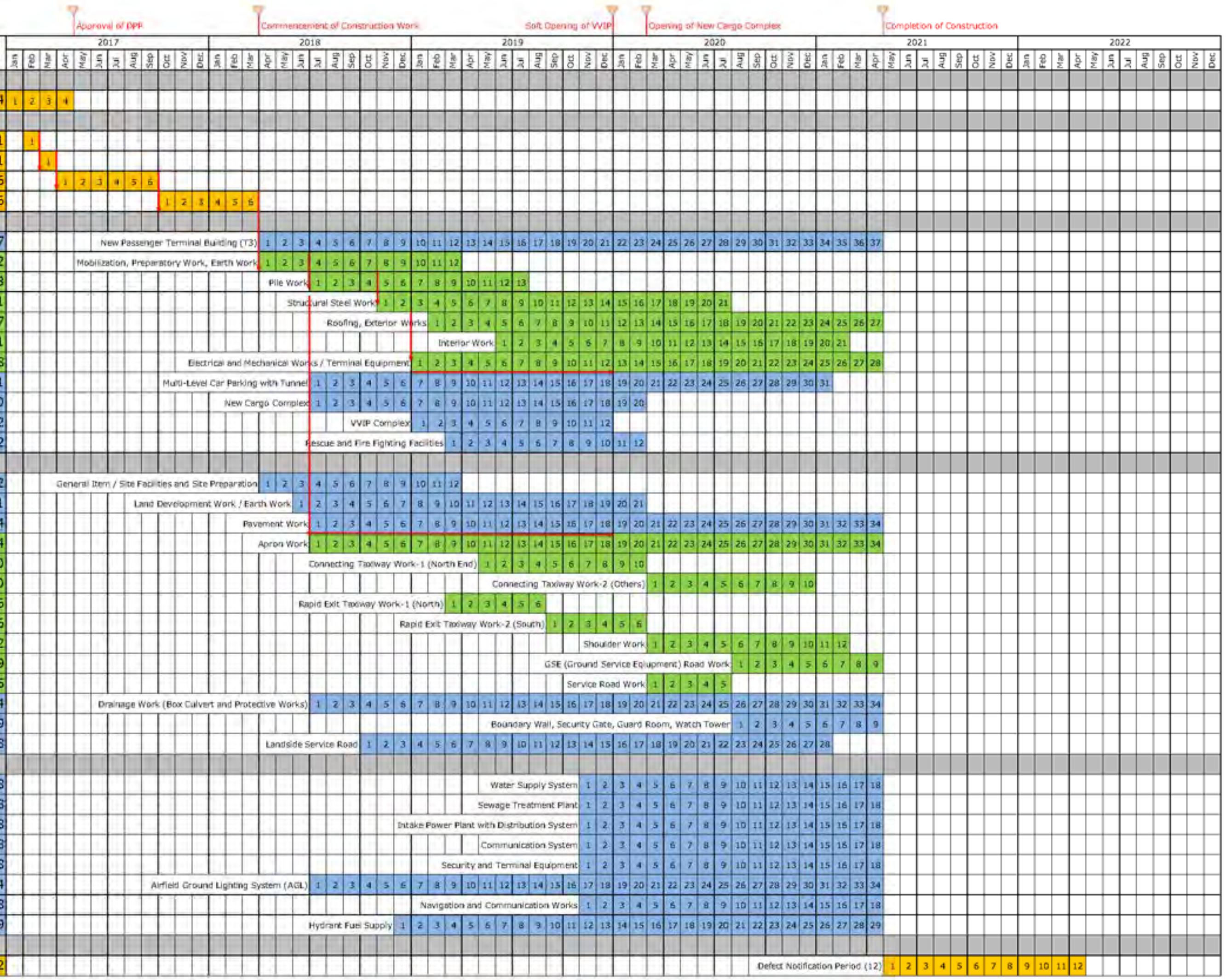


Source: JICA Study Team

Figure 10-4Step Drawing in April 2021 (37 months elapsed)

Table 10.5 Project Implementation Schedule

No.	Item	Month
	Project Preparation	
	DPP (Development Project Proposal)	4
	Engineering Service	
	Contract Negotiation, Purchase Committee Approval	1
	Contract Signing, JICA Concurrence, Performance Bond	1
1	Review of Existing Design	6
2	Tender Assistance	6
3	Building Work	
3	New Passenger Terminal Building (T3)	37
(1)	Mobilization, Preparatory Work, Earth Work	12
(2)	Pile Work	13
(3)	Structural Steel Work	21
(4)	Roofing, Exterior Works	27
(5)	Interior Work	21
(6)	Electrical and Mechanical Works / Terminal Equipment	28
3	Multi-Level Car Parking with Tunnel	31
3	New Cargo Complex	20
3	VVIP Complex	12
4	Rescue and Fire Fighting Facilities	12
4	Civil Work	
4	General Item / Site Facilities and Site Preparation	12
4	Land Development Work / Earth Work	21
4	Pavement Work	34
(1)	Apron Work	34
(2)	Connecting Taxiway Work-1 (North End)	10
(3)	Connecting Taxiway Work-2 (Others)	10
(4)	Rapid Exit Taxiway Work-1 (North)	6
(5)	Rapid Exit Taxiway Work-2 (South)	6
(6)	Shoulder Work	12
(7)	GSE (Ground Service Eqiupment) Road Work	9
(8)	Service Road Work	5
4	Drainage Work (Box Culvert and Protective Works)	34
5	Boundary Wall, Security Gate, Guard Room, Watch Tower	9
5	Landside Service Road with Elevates Road	28
5	Utility Work	
5	Water Supply System	18
5	Sewage Treatment Plant	18
5	Intake Power Plant with Distribution System	18
5	Communication System	18
6	Security and Terminal Equipment	18
6	Airfield Ground Lighting System (AGL)	34
6	Navigation and Communication Works	18
6	Hydrant Fuel Supply	29
6	After Construction	
6	Defect Notification Period (12)	12



Condition of Soft Opening: 1) Open of VVIP Complex

Source: JICA Study Team

11 Environmental Consideration

Based on the JICA Guidelines for environmental and social considerations (Hearinafter called JICA Guidelines), this Project is classified under Category B. This Project is an expansion project involving construction of new buildings, among others, within the current airport area. There is no land acquisition involved. There is no new runway construction or extension. Thus, expected impacts are site specific, are reversible, and normal mitigation measures can be applied.

For this Project, as it is classified as Category B project, environmental and social consideration studies require the IEE level including examination of the potential positive and negative environmental impacts, mitigation measures to avoid, minimize, mitigate or compensate for adverse impacts, as well as measures to promote positive impacts, if any such measures are available.

11.1 Proposed Project Components Subject to the Environmental and Social Consideration (ESC)

Proper environmental and social protection against any adverse impact from a development project is the key to the project's sustainability. To ensure that, environmental and social analysis and assessment is to be carried out, and if required, proper mitigation plan is to be prepared. The environmental and social examination under this Survey is aimed at analysis of environmental and social considerations base on both JICA guidelines Bangladesh regulations, confirming the current status of environmental and social assessment, and formulating further tasks to be carried out before the Project can enter into the implementation stage.

The physical components of the proposed Project subject to environmental and social considerations are as follows:

Table11-1 Details of Scope of Works (Phase - 1)

Works	Division	Facilities
Building	New Passenger Terminal Building (Terminal 3)	3 story building with area of approximately 220,000 m^2 including supply of related equipment capacity of 12.0 mppa
	New Cargo Complex	Area of approximately 42,200 m^2
	VVIP Complex	Area of approximately 5,000 m^2
	Rescue and Fire Fighting Facilities	
	Multi-Level Car Parking with Tunnel	Area of approximately 62,000 m^2
Civil	Parking Apron (Terminal 3 Area)	Approximately 520,000 m^2
	Taxiways (two rapid exit and one connecting taxiway for the runway 14 threshold)	Approximately 60,000 m^2
	Taxiways Landside Service Road with Elevated Road	9 connecting taxiways connecting to the T3 apron: approximately 35,000 m^2
	Improvement of Drainage System	
Utility	Water Supply System	
	Sewage Treatment Plant	Area of approximately 3,000 m^2
	Intake Power Plant with Distribution System	Area of approximately 7,000 m^2
	Hydrant Fuel Supply System	

Works	Division	Facilities
	Communication System	
	Security and Terminal Equipment	

Source: JICA Study Team

The following are the scope of analysis under this Survey:

1. To confirm baseline of environmental and social conditions;
2. To confirm environmental and social system of Bangladesh;
3. To prepare item scoping of EIA study;
4. To predict future environmental and social situation with this project;
5. To assess effect of this project and to execute comparative consideration of altenative plans;
6. To consider mitigation measures;
7. To prepare draft environmental management plan and draft environmental monitoring plan;
8. To clarify budjet, financial resource and implementing organization of EMP and EMoP and
9. To support stakeholders' consultations.

As the Project does not need any land acquisition and as all the Project-related construction and operation activities are expected to be confined within the HSIA area, no adverse social impact is expected. However, there are some former leaseholders, who still have facilities within the proposed work site and still occupying the land. Details of the issue are explained in Section 13.3.

11.2 Present Conditions of the Project Area

A detailed description of the environmental setting of the project area has been elaborated in the project IEE Report (August, 2016). A brief summary is given in this report.

11.3 Investigation of Existing Structures/Facilities at the Proposed Work Site (Within Current Landside)

The proposed location of the Terminal 3 building, its entrance facility, and new apron will occupy some portion within the current airside area and some portion within the current landside area. The structures/ facilities within the current airside area are well defined and CAAB has definite plan for their relocation. The Study Team investigated the existing structures/facilities located within the current landside portion earmarked for the proposed T3 terminal.

Five structures/facilities are identified during the investigation as marked in Table 11-2. Brief descriptions of each structure/facility are given below.

Table11-2 Structures/Facilities at the Site

Number	Location	Facilities	Main Building
①	Location 1	CAAB's Central Engineering, Maintenance and Stores Unit (CEMSU) compound	Administrative building, one workshop, one warehouse, two smaller stores
②	Location 2	Airport Armed Police Battalion	The Airport Police for their barrack and office
③	Location 3	Flying Club Complex	Proposed six-storey building. Construction is now suspended, and there is no business activities going on.
④	Location 4	Civil Aviation Training Center (CATC) of CAAB	Male hostel, female hostel, and diving area
⑤	Location 5	A subsidiary of Bengal Group	Five-storey building, a semi-pacca prayer area, a restaurant, a semi-pacca car garage, and some storage sheds

Source: JICA Study Team

For the implementation of the Project, all these facilities/ buildings/ structures mentioned above must be removed. Facilities at Location #1 are owned by CAAB; thus their relocation can be done with CAAB internal arrangements. Similarly, all the facilities at Location #4 are owned and operated by CAAB, thus their relocation can be managed easily by CAAB. Though the facilities at Location #2 are used by Police, the facilities are owned by CAAB. The policemen are staying there "at the request" of CAAB, and CAAB is "paying" for their duty and arranging accommodation. CAAB has already finished accommodation arrangement and request Police to move to new location. So there are no social issues.

On the one hand, facilities at Locations #3 and #5 are occupied by private entity. As lease tenures have been expired for both the cases, technically there is no bar on CAAB to re-possess the land. After the issue of the verdict, these area will be vacated in accordance with government law.

11.4 Legal and Administrative Framework

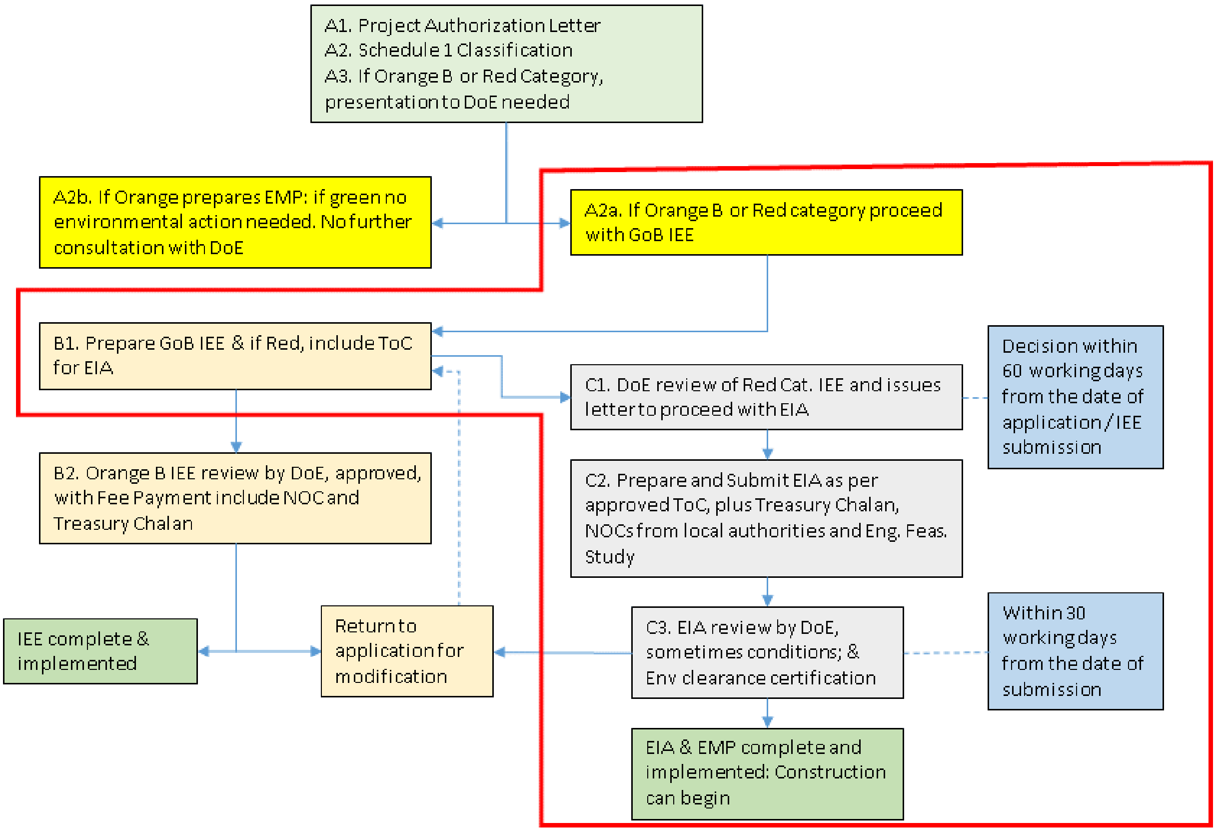
11.4.1 Environmental Policy and Regulation of GoB

For the protection, conservation, and management of the biophysical (natural) and social environment from damaging development pressures, if any, the Government of Bangladesh has developed a legal framework, including laws, regulations, decrees, and standards addressing environmental and social safeguards. These legislations also provide the principal mechanism for assessing and mitigating the environmental impacts of projects, both existing and proposed. The relevant national legislative, regulatory, and policy requirements are given in this report.

11.4.2 Application Procedure of Environmental Clearance

As explained above, any proposed project must obtain an ECC from the DOE before its implementation. The clearance process varies depending on the project classification.

Flow diagram for the environmental clearance procedure is shown below (as this airport expansion project falls under Red Category, only red colour marked steps need to be followed).



Source: Adopted from the Environmental Guidelines (DOE, 1997)

Figure 11-1 Diagram for DOE Environmental Assessment Process

11.4.3 Policy Gap between the Government and JICA

As explained in the previous sections, this Project is classified as Category B as per JICA guidelines requiring only IEE level environmental assessment. On the other hand, this Project is classified as Red Category as per ECR 1997 requiring EIA level of environmental assessment. For this particular Project, there is difference in categorization between GOB and JICA regulation. However, JICA guidelines also mentions that if an EIA procedure has been conducted to satisfy national requirement, JICA may refer to the EIA report, but this is not a mandatory requirement.

The Gap between the government law and JICA Guidelines are shown in this report.

11.4.4 International Civil Aviation Organization (ICAO) Recommended Practices

It may be noted that airport noise is exempted in the Bangladesh Noise regulation of 2006. Since this Project will be funded by JICA, proper noise management is required, and this Project should follow ICAO guidelines for noise.

International design code, manual, standards, and guidelines that are relevant to the proposed project include the following: International Civil Aviation Organization (ICAO), International Air Transport Association (IATA), and U.S. Federal Aviation Administration (FAA). The relevant documents and their relevance to the Project are given below:

Table 11-3 Outline of the international standard

Guidelines	Relevance to this Project
Annex 16 to the Convention on International Civil Aviation, Volume I: Aircraft Noise, Sixth Edition, July 2011	Gives the maximum allowable noise levels depending on aircraft types, at lateral point, approach point and flyby measurement point.
ICAO Doc. 9184 - Airport Planning Manual, Part 2: Land Use and Environmental Control, 2nd Edition, 2002	Airport and runway noise and its remedial measures
FAA Advisory Circular 150/5020-1-Noise Control and Compatibility Planning for Airports, 1983	Noise measurement methods, preparation of noise contour, prediction of noise exposure, and airport noise control planning

Source: The Study Team

11.5 Alternative Study

Since it is expected that the passenger of HSIA will be exceed the capacity of the existing facilities, the countermeasures of this issue had considered. The Plan-0 will obstruct the economic development for rising up from Least Development Countries. The Plan-1 is able to meet the expected demand after 2030, but the benefit per cost is low. And the negative effect to environment and social is large. Plan-2 is able to meet the expected demand until 2030, the benefit per cost is high and the negative impact to socio environmental aspect is small. Therefore, the Plan-2 is selected on this project. On the Plan-3, the cost is high and the negative impact to socio environmental aspect is significant and tne plan-2 will be acceptable until 2030.

11.6 Scoping

The project was reviewed in light of the JICA Guideline for environmental and social considerations. The scoping result is summarized in this report.

11.7 Result of Environmental and Social Consideration Survey

The result of survey and prediction for environmental and social consideration is shown in this report.

11.8 The assessment of project effect for environmental and social conditions

The assessment of project effect for environmental and social conditions is shown in this report. The negative impact of this project is considered small.

11.9 Mitigation Measures

It is needed to consider mitigation measures for avoiding or reducing environmental and social impact regardless the scale of the impact. The study on mitigation measures is conducted with consideration of technological feasibility and legislative system. The result of study is shown following table.

Table 11-4 Mitigation Measures

No.	Environmental Items	EMP	Implementing agency	Responsible Agency	Rough cost estimation (Million JPY)
Construction					
1.	Air pollution	• Water sprinkling for preventing resuspende soil • Cleaning activity of inside hauling road and entrance of the airport • Using of low air pollutant emission type machinery for construction	Contractor	CAAB	166
2.	Water Pollution	• Using wastewater treatment such as sedimentation tank for discharge to the canals	Contractor	CAAB	40
3.	Solid waste	• Segregation and sorting of the waste for appropriate reusing and recycling	Contractor	CAAB	Included in site management cost
4.	Soil contamination	• Securing that contaminated soil will be isolated from clean soil.	Contractor	CAAB	Depending on the quantity of contaminated soil
5.	Noise/Vibration	• Using of low noise type machinery for construction	Contractor	CAAB	1,511
6.	Exisiting social infrastructuresand services	• Installation of inside hauling road for reducing imact to outside road.	Contractor	CAAB	90
7.	Local conflicts of interest	• Nogotiating for relocatin	CAAB	CAAB	—
8.	Landscape	• Cleanup activity in construction site for impact mitigation of scenery to the airport users and residents	Contractor		Included in site management cost
9.	Infectious disease such as HIV/AIDS	• Complying with craus of HIV/AIDS prevention measures.	Contractor	CAAB	Included in site management cost
10.	Working Environment (includes work safety)	• Installing Personal Protective Equipment (PPE), hearing protection for workers on demolition of concrete.	Contractor	CAAB	20
11.	Accidents	• Preparing traffic management plan and road safety plan for prevebnting road accident around the airport.	Contractor	CAAB	Included in site management cost
Operation					
1.	Air pollution	• Installing multi storey car parking with adequate parking number for reduction of gas emission from waiting cars.	CAAB	CAAB	6,243
2.	Water Pollution	• Installing wastewater treatment facility for complying with the standards mentioned in Schedule 10 of the ECR 1997 for inland water discharge	CAAB	CAAB	199
3.	Solid waste	• Proper collection and disposing all internally generated solid waste	CAAB	CAAB	—
4.	Soil contamination	• Installing Oil separator for drainage in oil farm	CAAB	CAAB	15
5.	Noise/Vibration	• Establishing complaint section for issue of airport activity including aircraft noise	CAAB	CAAB	—

No.	Environmental Items	EMP	Implementing agency	Responsible Agency	Rough cost estimation (Million JPY)
6.	Exisiting social infrastructuresand services	• Installing road infrastructure for smooth traffic and human movement near airport.	CAAB	CAAB	6,786
7.	Accidents	• Installing road infrastructure for smooth traffic and human movement near airport.	CAAB	CAAB	
8.	Global Warming	• implementing energy reduction equipment for lighting or air conditioning.	CAAB	CAAB	1,290

Source: JICA Study Team

11.10 Environmental Monitoring Plan

The environmental monitoring plan during construction and operation is shown in this report.

11.11 Next Activities Required for Obtaining ECC

As stated earlier, the DOE first step clearance (which is the site clearance) together with the approval of IEE and EIA TOR has been obtained. It may be noted here that as per JICA guidelines (2010), as this Project is of Category B, IEE approval by DOE can fulfil minimum JICA requirement. However, as this Project is classified as Red category as per Bangladesh law, EIA approval by DOE is required before the start of construction activities.

Based on the approved EIA TOR, the EIA document is to be prepared. The EIA document must include EMP, Environmental Monitoring Plan (EMoP), EMP implementation budget, and EMP implementation arrangement, in addition to expected impacts and their remedial measures. The EIA document should also include result of public consultant meetings/ information disclosure meetings should be conducted.

The Report is to be submitted to DOE for its approval leading to the issuance of ECC. It is rather difficult to estimate the time required for such approval process.,it can be assumed that two months will be required for EIA approval. A tentative timeline is given below.

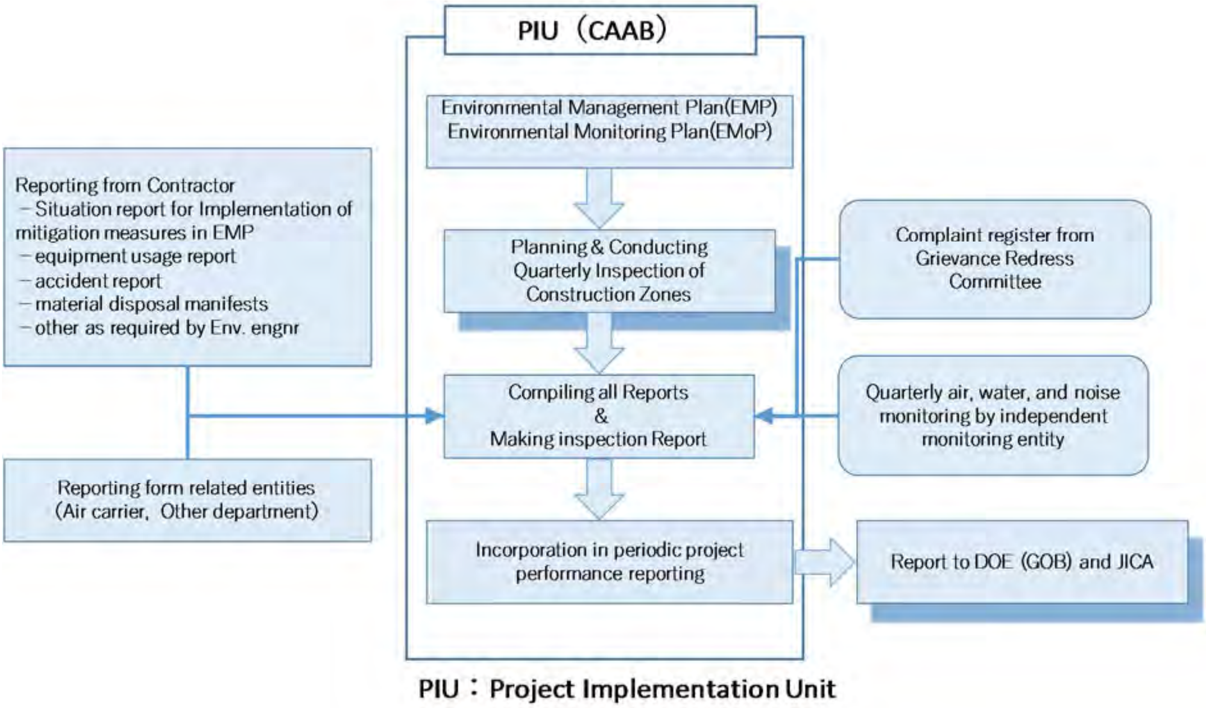
Table 11-5 Tentative Timeline

Activity	Q2, 16	Q3, 16	Q4, 16	Q1, 17	Q2, 17
IEE Approval / EIA TOR Approval by DOE					
EIA Preparation by CAAB					
EIA Approval/ ECC Issuance by DOE					

Source: JICA Study Team

11.12 JICA Environmental Checklist, Environmental Management Plan, Monitoring Plan

JICA Environmental Checklist, Environmantal management plan, Environmental monitoring plan and Environmental monitoring form are show in Annex. The frameworks of Environmental monitoring is shown below figure.



Source: JICA Study Team

Figure11-2 Tentative Environmental Monitoring Framework

11.13 Stakeholder's Meeting

During the IEE study, 6 stakeholder meetings were held. In the meeting, it was confirmaed that there is no opponents to this project and cooperation with this project during the construction. There were various constructive opinions concerning this project in the meeting.

12 Project Cost Estimate

(1) Total Project Cost

The total project cost amounts to JPY 191.971 billion, which is composed of JPY 93.516 billion under the foreign currency (FC) portion and JPY 71.344 billion under the local currency (LC) portion. The eligible portion amounts to JPY 154.764 billion, which is composed of JPY 89.423 billion under FC and JPY 47.348 billion under LC (with a loan ratio of 81.31%). The remaining JPY 37.207 billion will be borne by the executing agency.

Table 12-1 and Table 12-2 show the financial plan and annual fund requirement of the project while Table 12-3 shows the breakdown of funds.

Table12.1 Financial Plan

(Unit: JPY in millions)

Procurement	Cost
Eligible Portion (Draft)	154,764
Non-eligible Portion	37,207
Total	191,971

Source: JICA Study Team

Table12.2 Annual Financial Plan

Year	Total	Eligible Portion (Draft)	Non-eligible Portion
2017	2,496	1,712	783
2018	58,153	47,515	10,638
2019	45,278	36,797	8,481
2020	47,504	38,508	8,997
2021	27,129	21,632	5,498
2022	11,411	8,601	2,810
Total	191,971	154,764	37,207

Source: JICA Study Team

Table12.3 Breakdown of Fund

Item		Fund Total		
		Foreign	Local	Total
A .Eligible Portion		89,423	47,348	154,764
Ⅰ)	Procurement/Construction	85,484	46,492	149,643
	A.Building Work	57,595	17,922	82,327
	B. Civil Work	10,527	15,933	32,515
	C. Utility Work	10,265	1,314	12,078
	Dispute Board	64	0	64
	Price Escalation	2,962	9,109	15,533
	Physical Contingency	4,071	2,214	7,126
Ⅱ)	Consulting Service	3,940	856	5,121
	Consulting Service	3,672	698	4,636
	Price Escalation	80	117	242
	Physical Contingency	188	41	244
B. Non-eligible Portion		0	23,995	33,114
c	Administration Cost	0	224	310
d	VAT (Contractor and Consultant)	0	3,346	4,618
e	Import Tax	0	12,389	17,097
f	Corporate Tax	0	0	0

Item		Fund Total		
		Foreign	Local	Total
g	Income Tax (Contractor)	0	7,591	10,475
h	Income Tax (Consultant)	0	445	615
C. Interest during Construction		3,776	0	3,776
	Contractor	3,774	0	3,774
	Consultant	2	0	2
D. Front End Fee		317	0	317
E. JICA Finance Portion (A)		89,423	47,348	154,764
G. GOB Finance Portion (B+C+D)		4,093	23,996	37,207

Source: JICA Study Team

(2) Construction Cost

The breakdown of the construction cost is summarized below.

Table12-4 Breakdown of the Construction Cost

Item	Unit	Quantity	Unit Rate		Amount (Million)		Total (Million)
			Foreign	Local	Foreign	Local	
			USD	BDT	JPY	BDT	JPY
A:Building Work	**set**	**1**			**57,595**	**17,922**	**82,327**
1.New Passenger Terminal Building (Terminal 3)	set	1			48,819	15,191	69,783
1.1 New Passenger Terminal Building including Terminal Equipment and Security Equipment (Terminal 3)	m²	226,000	1,953	65,761	47,762	14,862	68,272
1.2 Additional Cost for Footing with Screwed Steel Pile	set	150	65,107	2,192	1,057	329	1,511
2.Multi-level Car Parking with Tunnel	m²	62,000	651	21,920	4,368	1,359	6,243
3.New Cargo Complex	m²	41,200	651	21,920	2,902	903	4,148
4.VVIP Complex	m²	5,900	1,953	65,761	1,247	388	1,782
5.Rescue and Fire Fighting Station and Equipment	m²	1,840	1,302	43,841	259	81	371
B:Civil Work	**set**	**1**			**10,5278**	**15,933**	**32,515**
1.General	set	1			636	1,108	2,165
1.1 Site Facilities and Site Preparation	set	1	5,845,257	846,516,191	632	847	1,801
1.2 Security Cost	set	1	40,820	260,989,300	4	261	364
2.Land Development Work /Earth Works	set	1			2,518	2,545	6,031
2.1 Land Development Work/Earth Works	set	1	11,206,304	2,019,513,806	1,213	2,020	4,001
2.2 Soil Improvement	m	350,000	34	1,500	1,305	525	2.030
3.Pavement Works	set	1			4,441	7,396	14,647
3.1 Apron Works	m²	498,500	57	10,196	3,052	5,083	10,067
3.2 Connecting Taxiway Works-1 (North End)	m²	24,000	57	10,196	147	245	485
3.3 Connecting Taxiway Works-2 (Others)	m²	42,500	57	10,196	260	433	858

Item	Unit	Quantity	Unit Rate		Amount (Million)		Total (Million)
			Foreign	Local	Foreign	Local	
			USD	BDT	JPY	BDT	JPY
3.4 Rapid Exit Taxiway Works-1 (North)	m^2	22,000	57	10,196	135	224	444
3.5 Rapid Exit Taxiway Works-2 (South)	m^2	19,500	57	10,196	119	199	394
3.6 Shoulder Works	m^2	105,800	36	6,541	416	692	1,371
3.7 GSE Road Works	m^2	83,800	34	6,205	312	520	1,030
3.8 Service Road Works	m^2	33,000	19	3,469	69	114	226
4.Drainage Works (Box Culvert and Protective Works)	set	1	5,978,544	1,077,407,094	647	1,077	2,133
5.Boundary Wall, Security Gate, Guard Room, Watch Tower	set	1	2,108,644	380,003,609	228	380	752
6.Landside Service Road witth Elevated Road	set	1	19,015,459	3,426,819,578	2,057	3,427	6,786
C:Utility Work	**set**	**1**			**10,265**	**1,314**	**12,078**
1.Water Supply System	set	1	946,277	13,108,696	102	13	120
2.Sewage Treatment Plant	set	1	1,560,651	21,619,565	169	22	199
3.Intake Power Plant with Distribution System	set	1	34,461,429	477,391,304	3,729	477	4,387
4.Security and Terminal Equipment (Cargo)	set	1	20,479,128	283,695,652	2,216	284	2,608
5.Airfield Ground Lighting System (AGL)	set	1	16,242,067	225,000,000	1,757	225	2,068
6.Hydrant Fuel System	set	1	21,185,305	293,478,261	2,292	293	2,696
Total					**78,387**	**35,169**	**126,920**

Source: JICA Study Team

13 Implementation Organization of the Project

13.1 Implementing Agency

The implementing agency for the terminal expansion project will be the Civil Aviation Authority, Bangladesh (CAAB), which will be responsible for the design, procurement, and construction of the project. CAAB shall establish the Project Implementation Unit (PIU) for this project, which will be an independent organization with delegated authority and specific functions.

13.2 Evaluation and Recommendations on the Implementing Agency (Required Staffing, Human Resource Development)

The staff required for PIU to carry out the implementation of the Japanese yen loan project will be selected from the CAAB staff with previous experience of airport development projects. In addition to DSIA, since CAAB is responsible for operation and management and development of international airports in Chittagong and Sylhet and five other domestic airports, experience of construction projects is abundant. There are no difficulties envisioned in the implementation of the project since the PIU will be appropriately established and manned mainly by experienced CAAB staff. However, the scale of the proposed Terminal 3 is extremely large and also the first passenger terminal with capacity of ten million passengers, which exceeds the annual handling capacity of the existing terminal building for

CAAB. Moreover, the construction period is only three years from commencement of construction to commencment of operations requiring highly difficult construction management.

Furthermore, security management over the whole large construction site must also be firmly addressed following the terrorist attack of July 2016.

Therefore, it will be necessary to employ staff who have the capability to manage large projects in short construction schedules and are also capable of cooperation with the security management entity. At the same time, it will also be necessary to train CAAB staff in order to acquire capabilities to carry out similar difficult projects. Therefore, on-the-job training (OJT) programs must be implemented for CAAB staff as well as appropriate off-the-job training as required.

14 Maintenance and Operation Organization

14.1 Confirmation of Maintenance and Operation Organization

The operations, maintenance, and administration of airports in Bangladesh at present are under the jurisdiction of CAAB. The maintenance of runways, taxiways, aprons, landing strips, radio navigation facilities, and navigation aids are also their responsibility. The ground handling services are operated by Biman Bangladesh Airline and cargo handling is operated by Biman Cargo.

Table-14-1 Organization of Operations and Management at HSIA

Category of Operation	Responsible entity	notes
Operation of passenger terminal	CAAB	
Operation of cargo terminal	Biman Cargo	
Safety management	CAAB	
Fire fighting and emergency services	CAAB	
Disaster prevention	CAAB	
Security Services (security inspections, police)	CAAB, airlines, Bangladesh Police (Airport Armed Police), Bangladesh Ansar & VDP	
Facility Management & Maintenance	CAAB	
Ground Handling Services	Biman Bangladesh Airline	
Immigration/Emigration/Quanrantine	Bangladesh Police, Bnagladesh Customs, Department of Agricultural Extension	
Air Traffic Control Services	CAAB	

Source: JICA Study Team

This system is expected to remain during the construction period and after commencement of operations. The project encompasses not only the expansion of the airport facilities, but also includes the continued operations of the existing terminal during construction. Therefore, the existing maintenance operations must also be continued same as before.

14.2 Confirmation of Scope, Organization and Staffing of Maintenance and Operation Organization

Among the current maintenance and operations under the jurisdiction of CAAB, such as the maintenance and operation of basic facilities, air traffic control facilities (ATC), radio navigation (Navaid) facilities, and aerodrome lighting facilities, ATC and Navaid are currently scheduled to be upgraded under Bangladesh Government funding. However, the objective is to improve performance and replace outdated equipment with no increase in installation numbers and the upgrades are not expected to significantly increase the service volume and the present organization and number of staffs are expected to be maintained.

The commencement of operations at Terminal 3 is scheduled for February 2021. The T3 facilities for services not operated by CAAB, such as immigration and emigration, customs and quarantine are expected to remain under the same organizations as at current terminals whose staff will operate the equivalent facilities at T3 for the time being after the commencement of operations. Although the organization and staffing after 2021 have not been finalized at present, the number of staffs will be required to be increased in accordance with the increase in floor area.

The present CAAB maintenance staff for the international airport are approximately 500 in number, excluding the security staff of ANSAR and Armed Police. Th number of staff is planned to increase to about 950, with approximately 450 out of the planned increase of 700 being assigned to HSIA.

Since CAAB has appropriately managed the operations of the passenger terminal up until now, it is expected that CAAB will continue its appropriate airport operations, maintenance, and administrations after commencement of services at Terminal 3.

15 Financialand Economic Evaluation, and Monitoring Indicators

15.1 Financial Analysis

The financial analysis of the proposed Dhaka International Airport Expansion Project was carried out by comparing the costs and revenues between the 'with project' and 'without project' cases. Based on the assumptions below, the cash flow of an 'incremental' case was prepared in order to measure the net financial impact of implementing the proposed project. The financial internal rate of return (FIRR) of the incremental case was calculated to evaluate the feasibility of the proposed project.

The FIRR was calculated at 6.2%, higher than the target of 1.983%. Therefore, the proposed project is financially feasible.

15.2 Economic Analysis

Economic analysis of the proposed project was carried out in this section by comparing the economic costs and benefits on the incremental case. The project's economic internal rate of return (EIRR) was calculated based on the cash flow of the incremental case to evaluate the net economic impact by the proposed project on the national economy.

The EIRR was determined at 22.5%, above the target of 12%. Therefore, the proposed project is economically feasible.

15.3 Sensitivity Analysis

Table 15-1 below summarizes the results of the sensitivity test of the project FIRR and EIRR to key variables, i.e., investment cost and passenger traffic.

Table 15-1 Sensitivity Test

	Project FIRR (%)	Project EIRR (%)
Target Rate	1.983	12.000
0. Base	6.225	22.511
1. Investment Costs (+30%)	3.924	19.121
2. International Passengers (-30%)	5.077	19.347
3. Domestic Passengers (-30%)	6.215	22.297
4. Total Passengers (-30%)	5.067	19.132
5. Investment Costs (+30%) and Total Passengers (-30%)	2.938	16.255

Source: JICA Study Team

The FIRR and EIRR are higher than the respective target rates of 1.983% and 12.000% under all cases.

15.4 Conclusion

The project FIRR and EIRR were calculated at 6.2%, and 22.5%, respectively, achieving the respective targets of 1.983%, and 12.000%. The sensitivity analysis also showed higher FIRR and EIRR than the targets even on the case of +30% investment costs and -30% total passengers.

From the above discussion, it was concluded that the proposed project would bring sufficient net benefits to both HSIA and the Bangladeshi economy.

15.5 Operation and Effect Indicators

Passenger traffic is generally considered as both operation and effect indicators for airport development projects. The quantitative indicators are follows. Target year of the quantitative indicators is 2023, two years after project completion.

- Traffic volume
- The annual revenue of HSIA

Qualitative effect indicators in 2023, two years after the completion of the Project, were considered in the following items:

- Upgrade of Service Levels
- Enhancement of capacity and function as a gateway airport

16 Points to Consider for Project Implementation

Following items are studied for Project implementation.

- Consultant services
- Measures for safety construction
- Safety measures in security such as terrorism
- Coordination with airport operator
- Measures against HIV
- Demolition and shifting of existing structure around Terminal 3 area
- Building permit
- Evasion of military use

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ABBREVIATIONS

ACM	Aircraft Movement
ADB	Asian Development Bank
AGL	Aeronautical Ground Lighting
AIP	Aeronautical Information Publication
ALS	Approach Lighting System
APTA	Asia Pacific Trade Agreement
ASDA	Accelerate Stop Distance Available
ASRS	Automatic Storage Rack System
ASYCUDA	Automated System for Customs Data
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATM	Air Traffic Management
ATS	Air Traffic Service
B/C	Benefit / Cost
BATMUP	Bangladesh Air Traffic Management Upgrade Project
BBA	Bangladesh Bridge Authority
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDT	Bangladesh Taka
BHS	Baggage Handling System
BIFFL	Bangladesh Infrastructure Finance Fund Limited
BIMSTEC	Bengal Initiatives for Multi-sectoral Technical and Economic Cooperation
BNBC	Bangladesh National Building Code
BOT	Build Operate Transfer
BR	Bangladesh Railways
BRT	Bus Rapid Transit
BSMIA	Banglabandhu Sheikh Mujib International Airport
BUET	Bangladesh University of Engineering & Technology
BWDB	Bangladesh Water Development Board
CA	Concession Agreement
CAAB	Civil Aviation Authority, Bangladesh
CAT	Category
CATC	Civil Aviation Training Center
CCEA	Cabinet Committee on Economic Affairs
CCR	Constant Current Regulator
CEMSU	Central Engineering, Maintenance and Stores Unit
CNG	Compressed Natural Gas
CPG	CPG Corporation Pte. Ltd.
CPTU	Central Procurement Technical Unit
CRCCI	China Railway Construction Corporation International
DDC	Design Development Consultant
DEE	Dhaka Elevated Expressway
DESCO	Dhaka Electric Supply Company Limited
DFR	Draft Final Report
DOE	Department of Environment

DPP	Development Project Program
DSA	Debt Sustainability Analysis
DSF	Debt Sustainability Framework
DTCA	Dhaka Transport Coordination Agency
E/M	Electro Mechanical
ECA	Environment Conservation Act
ECC	Environmental Clearance Certificate
ECF	Extended Credit Facility
ECR	Environment Conservation Rules
EDS	Explosive Detection System
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
ERD	Economic Relations Division
F/S	Feasibility Study
FAA	Federal Aviation Administration
FDEE	First Dhaka Elevated Expressway Company Limited
FGD	Focus Group Discussion
FIR	Flight Information Region
FOD	Foreign Object Damage, or Foreign Object Debris
FY	Fiscal Year
GA	General Aviation
GDP	Gross Domestic Product
GDSUTP	Greater Dhaka Sustainable Urban Transport Project
GNSS	Global Navigation Satellite System
GoB	Government of Bangladesh
GRDP	Gross Regional Domestic Product
GSE	Ground Service Equipment
H. S. code	Harmonized Commodity Description and Coding System Code
HSIA	Hazrat Shahjalal International Airport
IAB	Institute of Architects Bangladesh
IEB	Institute of Engineers Bangladesh
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICB	International Competitive Bidding
IDCOL	Infrastructure Development Company Limited
IEE	Initial Environmental Examination
IFB	Invitation for Bid
IFC	International Finance Corporation
ILS	Instrumental Landing System
IMED	Implementation Monitoring and Evaluation Division
IMF	International Monetary Fund
IRR	Internal Rate of Return
ITD	Italian Thai Development Public Company Limited
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JPY	Japan Yen

LCC	Location Clearance Certificate
LDC	Least Developed Country
LGED	Local Government Engineering Department
M&E	Mechanical and Electrical
MHS	Material Handling System
MIST	Military Institute of Science and Technology
MoCAT	the Ministry of Civil Aviation and Tourism
MOEF	Ministry of Environment and Forest
mppa	Million Passenger Per Annum
MPEMR	Ministry of Power, Energy and Mineral Resources
MRT	Mass Rapid Transit
MYT-Plan	Myanmar National Transport Master Plan
NAPA	National Adaptation Programme of Action
NAVAID	Navigational Aids
NBSAP	National Biodiversity Strategy and Action Plan
NCS	National Conservation Strategy
NEMAP	National Environmental Management Action Plan
NOC	No Objection Certificate
NPV	Net Present Value
OD survey	Origin Destination survey
ODA	Official Development Assistance
OECF	Overseas Economic Cooperation Fund
PAX	Passenger
PCN	Pavement Classification Number
PCU	Passenger Car Unit
PDR	Peak Day Ratio
PHR	Peak Hour Ratio
PMBMA	Public Moneys and Budget Management Act
PMR	Peak Month Ratio
PPA	Public Procurement Act
PPP	Public-Private Partnership
PPR	Public Procurement Rules
PSR/SSR	Primary and Secondary Surveillance Radar
PTB	Passenger Terminal Building
PWD	Public Works Department
R/W	Runway
RCC	Reinforced Concrete Column
REHAB	Real Estate & Housing Association of Bangladesh
RFFS	Rescue and Fire Fighting Services
RFP	Request for Proposal
RFQ	Request for Quotation
RHD	Roads and Highways Department
RSP	RSP Architects Planners & Engineers
RSTP	the Revision and Updating of the Strategic Transport Plan
SAA	SAA Architect
SAFTA	South Asian Free Trade Area

SAIA	Shah Amanat International Airport
SATO	Station of Air Traffic Office
SBR	Sequencing Batch Reactor
SOB	Survey of Bangladesh
SPT	Standard Penetration Test
STD	Standard Tender Documents
STP	Strategic Transportation Plan
T/W	Taxi Way
T1	Terminal 1
T2	Terminal 2
T3	Terminal 3
TAF	Technical Assistance Financing
TODA	Take Off Distance Available
TOR	Terms of Reference
TORA	Takeoff Run Available
UNCTAD	United Nations Conference on Trade and Development
ULD	Unit Load Device
USAID	United States Agency for International Development
UTM	Universal Transverse Mercator
VAT	Value Added Tax
VGF	Viability Gap Financing
VOT	Value of Time
VVIP	Very Very Important Person
WASA	Water Supply and Sewerage Authority
WB	World Bank
WWTP	Waste Water Treatment Plant

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CHAPTER 1 INTRODUCTION

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Chapter 1 INTRODUCTION

1.1 Background of the Study

In recent years, Bangladesh's economy has experienced an average annual growth rate of more than 6%. Against this background, the aviation demand in Bangladesh has been increased rapidly at an average pace approaching 10%. The Dhaka International Airport or the Hazrat Shahjalal International Airport (HSIA) handles nearly 70% of all domestic and international flights in Bangladesh and plays an important role as infrastructure supporting the rapid growth of economic activity.

The HSIA was planned for a capacity of 8 million passengers annually. However, based on the data collection survey conducted in April 2016, the number of passengers for 2015 was approximately 6.5 million per annum (mppa) (international: 5.57 mppa, domestic: 0.91 mppa) and the passenger handling capacity of the passenger terminal building (PTB) is expected to be saturated by 2019. In order to respond to this situation, the Government of Bangladesh (hereinafter referred to as “GoB”) is considering the construction of a new international passenger terminal, the refurbishment of the cargo terminal and the construction of peripheral infrastructure including the approach road to the National Highway. The construction of the new international passenger terminal and the construction of peripheral infrastructure in particular are expected to be implementedas one of fast-track projects, having been prioritized as important projects in the Seventh Five-Year Development Plan by GoB. Furthermore, HSIA is located approximately 17 km north of central Dhaka and there are plans to make the approach to HSIA into a multimodal hub connected with urban railways and expressways planned for the future.

The Japan International Cooperation Agency (JICA) has been conducting a data collection survey for this project since April 2016. It has been confirmed that there is an immense amount of reference materials including the design drawings for civil and architectural works, which requires detailed review prior to the implementation of the project. The GoB has requested the early commencement of the project for completion by the end of 2019. In addition, the importance of the project was mutually confirmed in the Japan-Bangladesh Summit Meeting held on May 28, 2016.

The improvement of the navigation aid system and airport terminal security at HSIA has been implemented under the Japanese grant aid scheme project entitled “The Project for Improvement of Airport Safety and Security Systems” (2014), which is expected to secure safety of aircraft guidance to destination airports and landings and improve responses to aircraft accidents and acts of terrorism. In order to respond to the future increase in demand and to secure convenience and safety, it is urgently necessary to implement the mid-term expansion projects for HSIA. Acting on this background, GoB has requested JICA to implement the study on the expansion projects of HSIA with the intention to secure future yen loans.

1.2 Objective of the Project

The objective of the project is to meet future demand of air transportation and to ensure international standard of safety, security and facilitation by expanding airport terminal facilities and developing related infrastructure at the Hazrat Shahjalal International Airport in Dhaka, thereby contributing further economic growth in Bangladesh.

1.3 Objective of the Study

The objective of the present study is to conduct the necessary surveys to review the rationale of the project for implementation under Japanese government loan. It includes the objectives of the project, general composition, project finances, implementation schedule, implementation method (procurement and construction), organization for project implementation, organization for operation and maintenance, and environmental and social considerations based on the existing Master Plan (M/P) for expansion of HSIA

1.4 Location of the Project

The location of HSIA is shown in Figure 1.1.

Source: JICA Study Team

Figure 1-1 Location Map of HSIA

1.5 Components of the Project

- Construction of the following facilities at HSIA:
  - International PTB (Terminal 3),
  - New cargo terminal building (complex),
  - Expansion of apron,
  - Construction of new taxiways (including rapid exit taxiway),
  - Procurement of equipment for communication system, aeronautical light, airport security systems,
  - Internal roads in airport and parking facilities, and
  - Utility facilities.
- Assistance for improvement of operations at passenger/cargo terminal
- Strengthening of security organization for HSIA as a whole

1.6 Counterpart Agencies of the Recipient Country

The counterpart agencies are the Civil Aviation Authority, Bangladesh (CAAB) and the Ministry of Civil Aviation and Tourism (MoCAT).

1.6.1 Ministry of Civil Aviation and Tourism (MoCAT)

The main responsibilities of MoCAT are to provide highly reliable and organized aviation services for the smooth operation of air traffic in Bangladesh, and to contribute to the development of the economy of Bangladesh through development of tourism.

1.6.2 Civil Aviation Authority, Bangladesh (CAAB)

The CAAB is the sole regulatory organization for all aviation related matters in Bangladesh. In addition, it is responsible for providing air traffic control (ATC) services, securing fast and efficient flow of aviation traffic within the Bangladesh Flight Information Region (FIR), as well as the responsible agency for maintaining facilities including airports and navigation aid systems.

(1) Organization of CAAB and HSIA

The CAAB is in charge of operations and maintenance of all airports in Bangladesh, employing approximately 3,700 personnel. Within this organization, the section responsible for the operation and planning at HSIA is the Board Member in charge of operations and planning, one of the three under the Chairman, under whom the Director in Charge of HSIA is placed (refer to Figure 1.2).

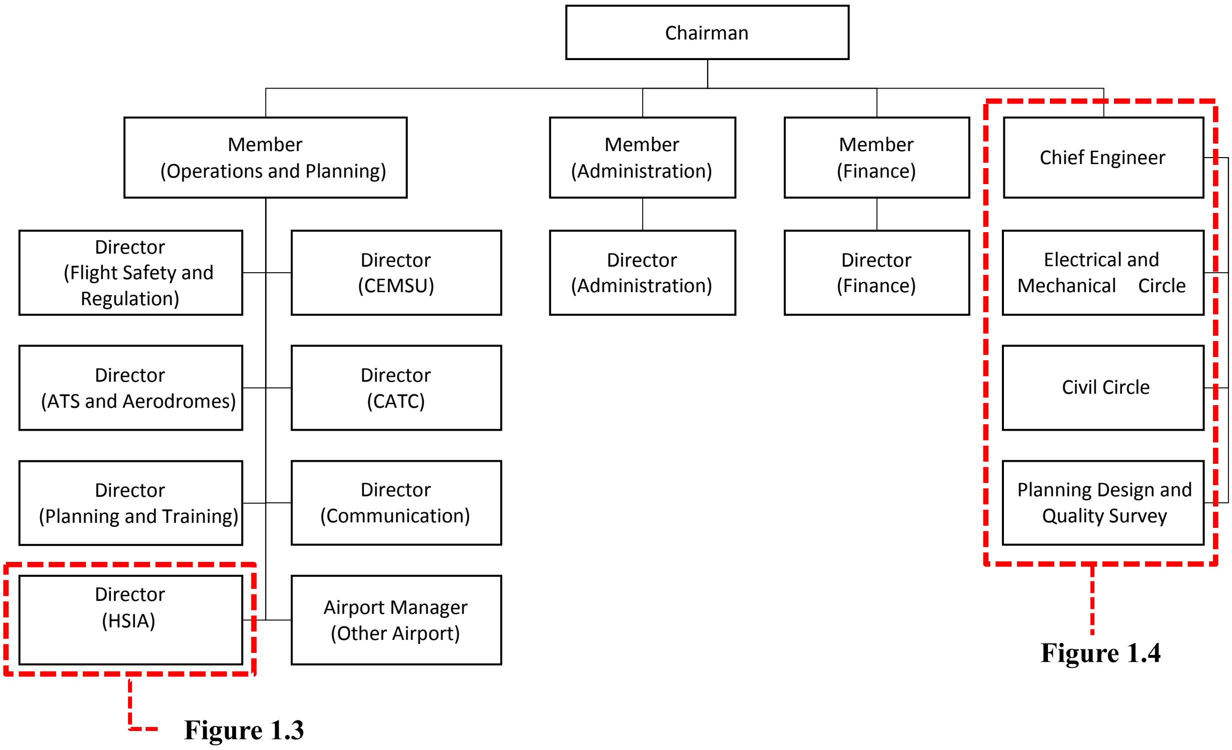
Planning and design of expansion at HSIA is carried out by individual Project Directors (Superintending Engineers) for each department under the Chief Engineer.

Furthermore, the present operational organization at HSIA belongs to the Operation and Planning Group and is composed of four departments for Deputy Airport Manager (Airport Operation), Station Air Traffic Officer, Station Communication Sector, and Security Section and Anti-Hijacking (refer to Figure 1.3).

Normal facility maintenance (cleaning, lighting, and mechanical building systems) is carried out by two teams: Civil Division 1 and Electrical and Mechanical Division 1 (refer to Figure 1.4).

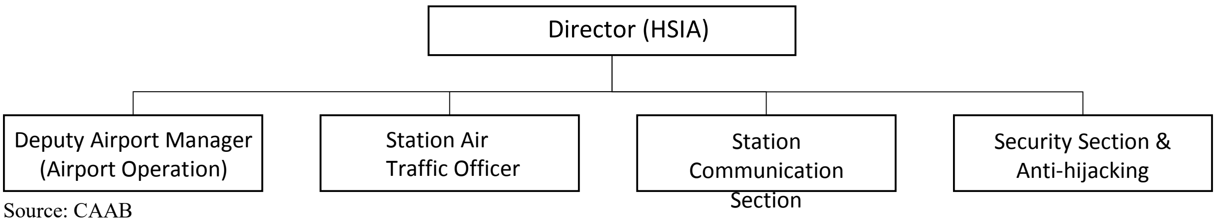
The Electrical and Mechanical Division 2 (Dhaka Area Excluding HSIA) is responsible for planning and maintenance of runways and airside facilities.

The operation of the commercial facilities is carried out by the Budget and Revenue Team in the Finance Group.



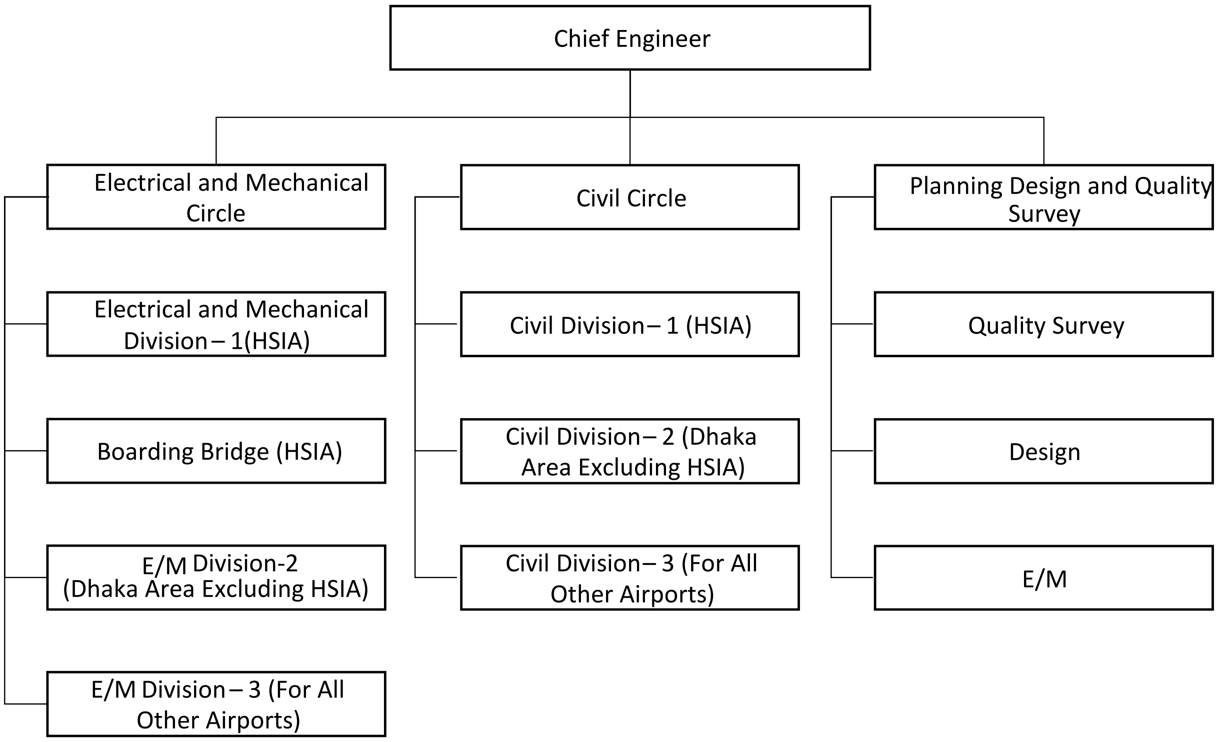
Source: CAAB

Figure 1-2 CAAB Organizational Structure



Source: CAAB

Figure 1-3 HSIA Organizational Structure



Source: CAAB

Figure 1-4 CAAB Engineering Organizational Structure

CHAPTER 2 SOCIAL AND ECONOMIC CONDITION

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Chapter 2 SOCIAL AND ECONOMIC CONDITION

This chapter discusses the social and economic conditions of the project area following the results of "Data Collection Survey of Expansion of International Airport in Dhaka, December 2016, JICA" (hereinafter referred to as "Data Collection Survey"), with some descriptions updated.

2.1 General Outline

Bangladesh is one of the poorest countries in Asia with a population of approximately 160 million people. According to the International Monetary Fund (IMF), Bangladesh's nominal gross domestic product (GDP) in 2013 was USD 161.3 billion, and the nominal GDP per capita was USD 1,030 (World Economic Outlook Database, April 2016). It is categorized as a least developed country (LDC) based on the standards of the United Nations.

Bangladesh has an eminently fertile land nurtured through the flooding of the Padoma River, the Jamuna River, and the Meghna River, and has been referred to as "the Golden Bengal". From the fact that the country has an enormous population and workforce, the economic potential is high; however, under the influence of natural disasters such as floods and cyclones, the development of its industries are delayed

Furthermore, even though Bangladesh has received technical and financial assistance over a long period, the country still faces challenges of economic and social development due to these natural disasters, excessive population, undeveloped infrastructure, and political confusion. However, they have shown a continuous steady economic growth after 2006 and are expected to achieve a nominal GDP per person of USD 1,900 in 2020 and to shift from LDC to middle-income country by 2021.

2.2 Basic Socioeconomic Indicator

Bangladesh's basic socioeconomic indicators are shown in Table 2-1.

Table 2-1 Basic Socioeconomic Indicators

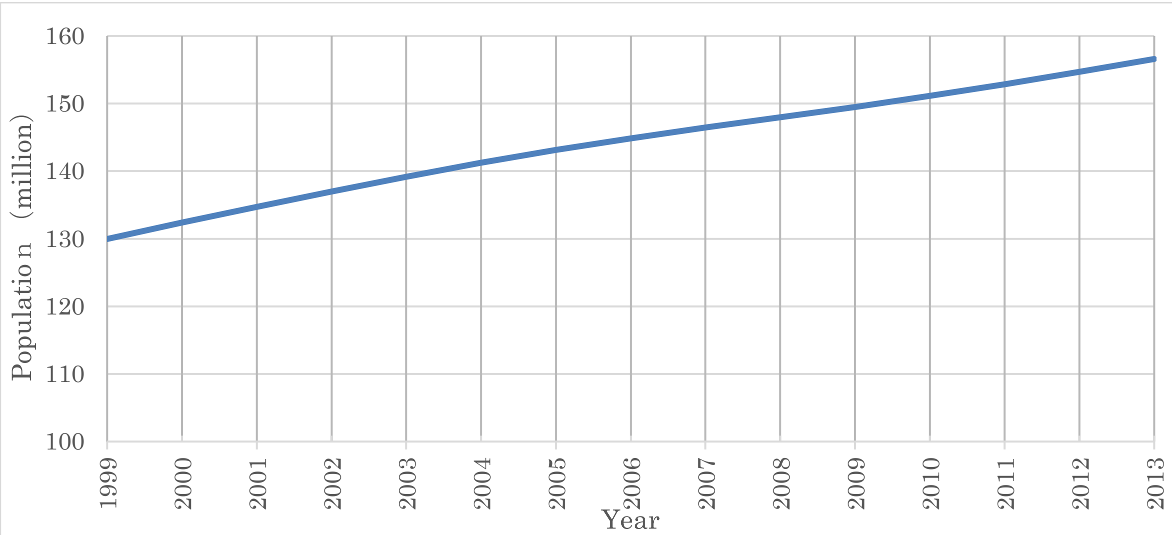
Indicator	2012	2013	2014
Real GDP Growth Rate	6.26%	6.04%	6.31% (Estimation)
Current GDP	USD 141.71 billion	USD 161.30 billion	USD 184.00 billion (Estimation)
Current GDP per Capita	USD 916.03	USD 1,030.03	USD 1,163 (Estimation)
Consumer Price Growth Rate	6.23%	7.54%	7.01%
Unemployment Rate	6.52%	6.01%	6.06%

Source: World Economic Outlook Database, April 2016
Source (Unemployment Rate): Institute of Developing Economies, Japan External Trade Organization

2.3 Indicators

2.3.1 Population

The population was 159,400,000 (Bangladeshi Statistics Bureau, October 2015), and the average annual growth rate of population was 1.37% (Bangladeshi Statistics Bureau, March 2011). The annual rate of population growth was 3.4% immediately after independence (1975) and population explosion became a social problem. However, the government has continuously and strongly promoted population control from 1992 to reduce the rate of population growth. Accordingly, the rate of population growth has shown decrease to 2.06% (2007 estimation) and 1.37% (2011 estimation) which is one of the lowest levels of population growth rate in Asia, in recent years.

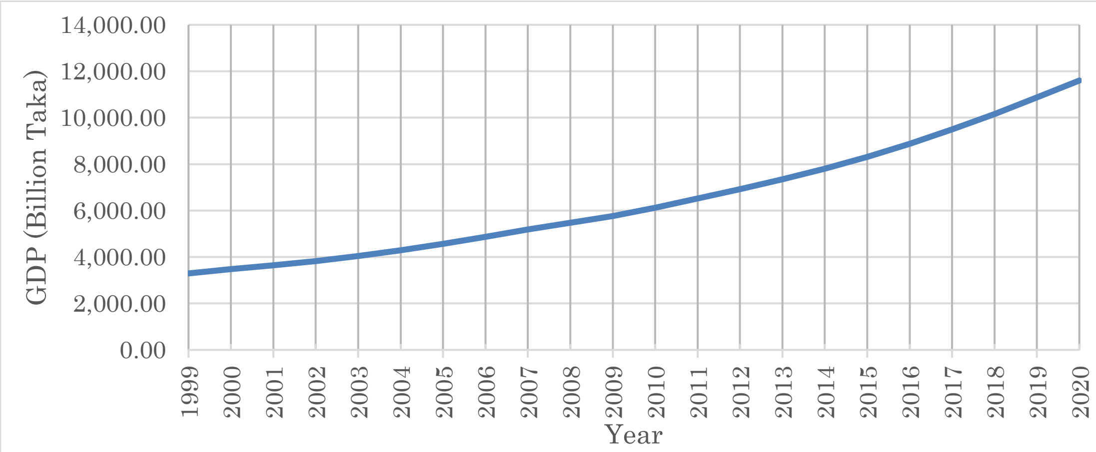


Source: IMF, World Economic Outlook Database, April 2016

Figure 2-1 Population

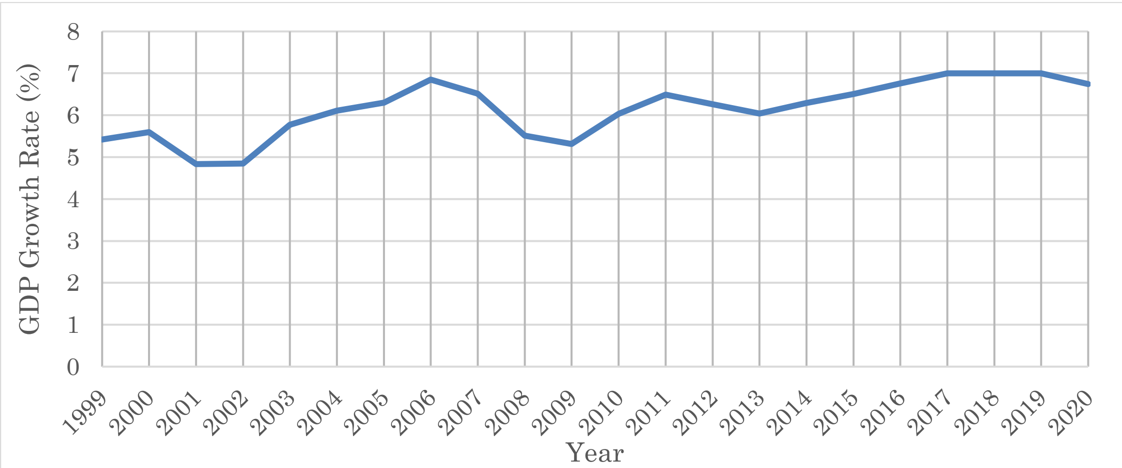
2.3.2 Gross Domestic Product

The economy of Bangladesh has been growing continuously for the past 20 years. According to the statistics of IMF, the growth rate of real GDP has been maintained at 5%-7% for the past 20 years. Its growth rate in the 2013 financial year (from July 2013 to June 2014) was 6.04%, and the total sum of real GDP reached BDT 7,342 billion. Continuous economic growth is supported by the stability of apparel products export and remittances from overseas workers, and the stable growth of agriculture.Meanwhile, diversification of industry and improvement of the energy industry including electric power supply and transportation facilities will be needed for sustainable development in the future.



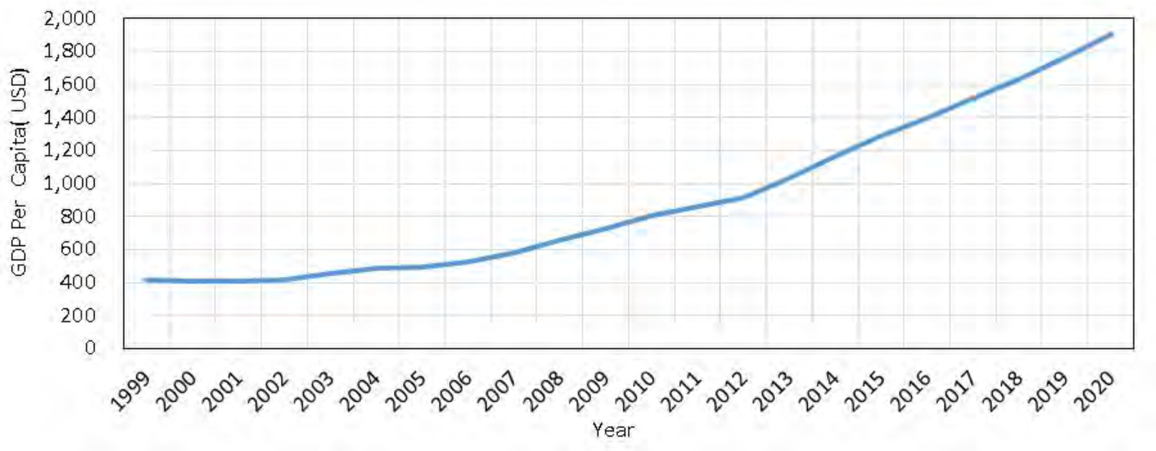
Source: IMF, World Economic Outlook Database, April 2016

Figure 2-2 Trend of Constant GDP



Source: IMF, World Economic Outlook Database, April 2016

Figure 2-3 Trend of Constant GDP Growth Rate



Source: IMF, World Economic Outlook Database, April 2016

Figure 2-4 Trend of Current GDP per Capita

2.3.3 Export and Import

The trade balance of Bangladesh shows a chronic payment deficit.

The main export items are textiles such as cotton, knit, jute, and home textile. On the other hand, the main import items are oil products, raw materials such as fibre, raw cotton, steel including machines, and transportation equipment.

The development of the textile industry was triggered in the 1970's by investments from Korea and Hong Kong where textiles production had begun to slump. In recent years, with the rise of labour cost in China, the low labour cost in Bangladesh has attracted attention and textiles export have increased. 80% of the export of Bangladesh is accounted for by textiles, and major garment industries have moved into Bangladesh as a China+1manufacturing country. Items to support the export industry, such as raw fibre materials, oil, machinery and steel, account for the majority of imported goods.

Table 2-2 Trade Balance (USD in millions)

Year	Export	Import	Balance
2001	6,419	8,430	-2,011
2002	5,929	7,697	-1,768
2003	6,492	8,707	-2,215
2004	7,521	9,840	-2,319
2005	8,573	11,870	-3,297
2006	10,412	13,301	-2,889
2007	12,053	15,511	-3,458
2008	14,151	19,481	-5,330
2009	15,581	20,291	-4,710
2010	16,233	21,388	-5,155
2011	22,592	30,336	-7,744
2012	23,989	33,309	-9,320
2013	26,566	33,576	-7,010

Source: Annual Report 2012-2013, Bangladesh Bank

Table 2-3 Main Export Items (2013 Provisional Value)

Main Export Item (Commodity)	Amount (USD in millions)
Fabric product	11,039
Knit product	10,475
Jute product	800
Home textile	791
Farm output product	535
Frozen food	543
Footwear	419
Leather, hides product	399
Industrial products	367
Straight jute	229
Others	1,337
Total	27,027

Source: Annual Report 2012-2013, Bangladesh Bank

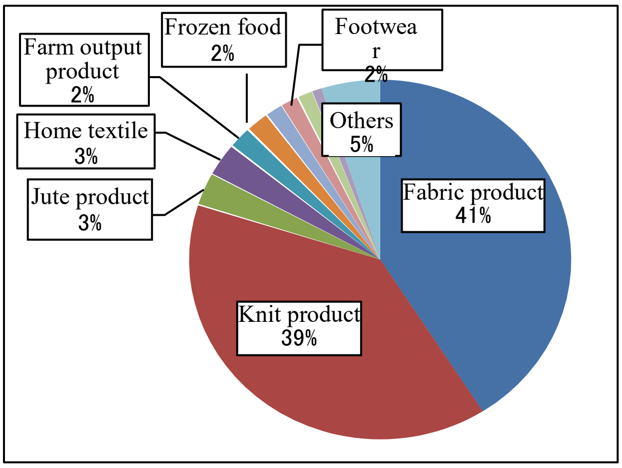


Figure 2-5 Main Export Items (2013 Provisional Value)

Table 2-4 Main Import Items (2013 Provisional Value)

Main Import Item (Commodity)	Amount (USD in millions)
Oil products	3,642
Fiber	3,273
Raw cotton	2,005
Steel	1,836
Capital goods such as machine and transportation equipment	1,835
Edible oil	1,402
Plastic rubber	1,366
Cotton yarn	1,356
Chemicals	1,302
Oil	1,102
Manure	1,188
Cereals	726
Others	12,543
Total (FOB)	33,576

Source: Annual Report 2012-2013, Bangladesh Bank

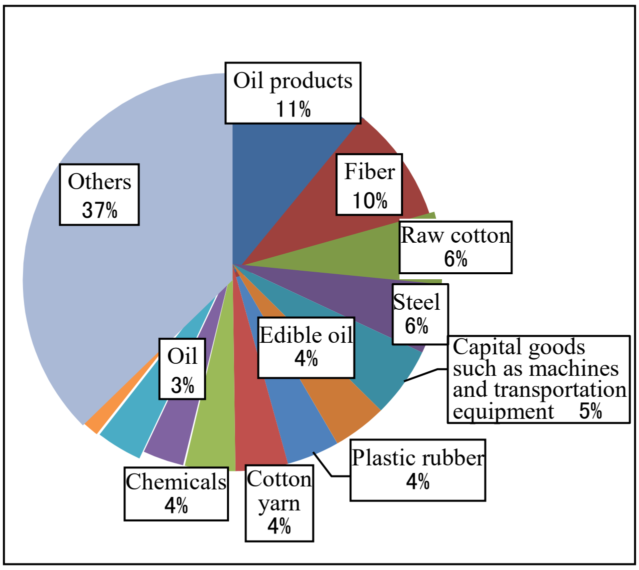


Figure 2-6 Main Import Items (2013 Provisional Value)

2.3.4 Inbound and Outbound Travelers

Bangladesh has some attractive tourist places including world heritage sites. However, integrated infrastructure such as transportation, accommodation, and advertisement for tourism has not yet been developed. According to the data of the Bangladesh Tourism Board, the annual number of foreign visitors after 2000 is approximately 250,000 people as shown in Table 2-5.

Table 2-5 Change of Foreign Visitors

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	199,211	207,199	207,246	244,509	271,270	207,662	200,311	289,110	467,332	267,107
% Change	15.3	4.01	0.02	17.98	10.94	-23.45	-3.54	44.33	61.65	-42.84

Source: Website of Bangladesh Tourism Board

The tourism and business visit accounted for 95% of all foreign visitors, followed by religion purpose in 2009. On the other hand, the departure for "service" which seems to be for overseas migrant workers, accounted for more than 45% of all departures followed by departure for tourism.

Table 2-6 Tourist by Purpose (2009)

Item	Tourism	Business	Office	Study	Religion	Service	Other	Total
Inbound Tourist	122,899	111,569	3,895	6,475	8,983	0	13,286	267,107
%	46.01%	41.77%	1.46%	2.42%	3.36%	0%	4.97%	100.00%
Outbound Tourist	483,074	102,144	1,951	29,850	23,606	1,059,300	554,653	2,254,578
%	21.43%	4.53%	0.09%	1.32%	1.05%	46.98%	24.60%	100.00%

Source: Website of Bangladesh Tourism Board

2.4 Airports in Bangladesh

As shown in Figure 2-7, there are three international airports in Bangladesh, namely, Dhaka (HSIA), Chittagong, and Sylhet. The target airport of this study is HSIA.

In addition, there are ten domestic airports in Bangladesh. In particular, five airports, namely, Jossore, Cox's-Bazar, Barisal, Rajshahi, and Saidpur, have regularly scheduled flights and the number of passengers are relatively high compared with other domestic airports. The number of passengers within the past seven years is shown in Table 2-7.

Source: JICA Study Team

Figure 2-7 Airports in Bangladesh

Table 2-7 Passengers in Major Domestic Airports

Airport		2009	2010	2011	2012	2013	2014	2015
Dhaka	International	3,657,449	4,194,385	4,561,771	4,984,315	5,231,581	5,398,945	5,568,934
	Domestic	596,617	523,133	527,950	589,108	648,019	685,198	912,644
	Total	4,254,066	4,717,518	5,089,721	5,573,423	5,879,600	6,084,143	6,481,578
Chittagong	International	370,917	447,393	542,052	596,630	572,275	666,986	718,265
	Domestic	185,345	242,893	321,486	307,389	356,725	397,014	NA
	Total	556,262	690,286	863,538	904,019	929,000	1,064,000	NA
Sylhet	International	NA	NA	136,293	138,530	140,880	168,421	NA
	Domestic	NA	NA	43,707	71,470	75,120	79,579	NA
	Total	160,000	191,000	180,000	210,000	216,000	248,000	207,701
Jossore	Domestic	52,489	50,005	83,379	81,255	104,536	108,001	114,200
Cox-Bazar	Domestic	25,000	35,000	57,998	63,837	66,424	87,001	136,051
Barisal	Domestic	0	0	0	0	3,269	2,926	13,872
Rajshahi	Domestic	0	0	734	3,105	3,754	4,162	16,459
Saidpur	Domestic	0	0	1,255	7,660	15,145	26,535	68,456

Source: CAAB

CHAPTER 3 PRESENT CONDITIONS AND ISSUES RELATED TO HSIA

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Chapter 3 PRESENT CONDITIONS AND ISSUES OF HSIA

3.1 Airport Operation and Management

The existing HSIA landside facilities are shown in Figure 3-1.

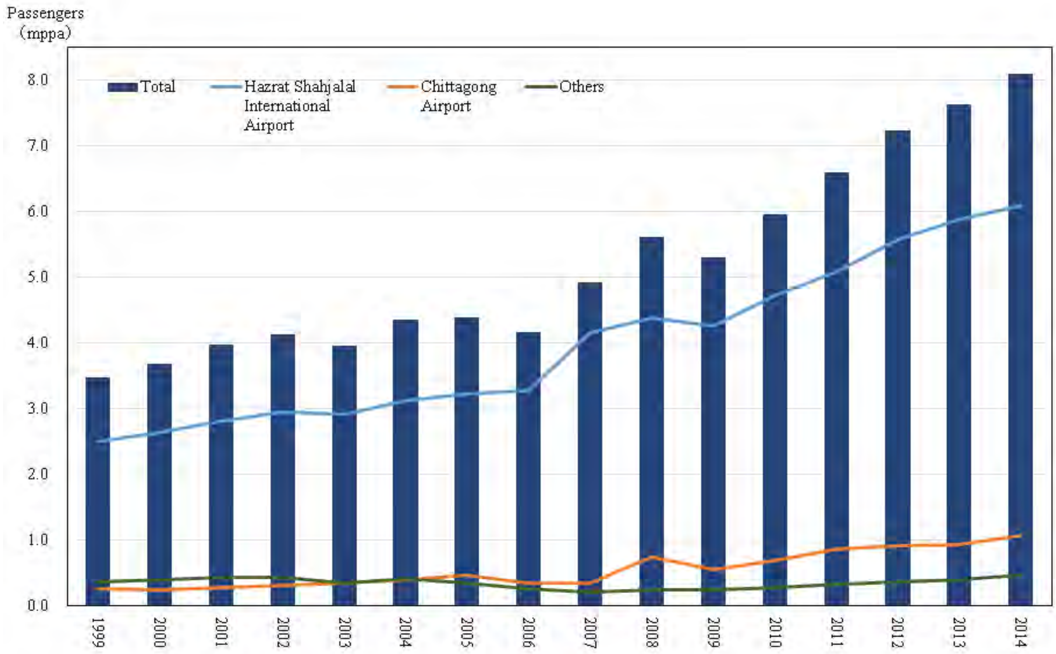
Source: CAAB Master Plan and Feasibility Study

Figure 3-1 Existing HSIA Landside Facilities

3.1.1 Number of Passengers

The number of passengers nationwide and at HSIA was increased in 2007 and 2008, but decreased by about 100,000 passengers in 2009 due to the "Lehman shock" as shown in Table 3-1 and Figure 3-3. After 2010, it continues to grow again by roughly 6% in line with economic growth.

Furthermore, the average annual growth rate of air passengers at HSIA from 1999 to 2015 was 6.17%. However, it rose to 7.88% after 2006 with increasing demand in recent years.



Source: JICA Study Team

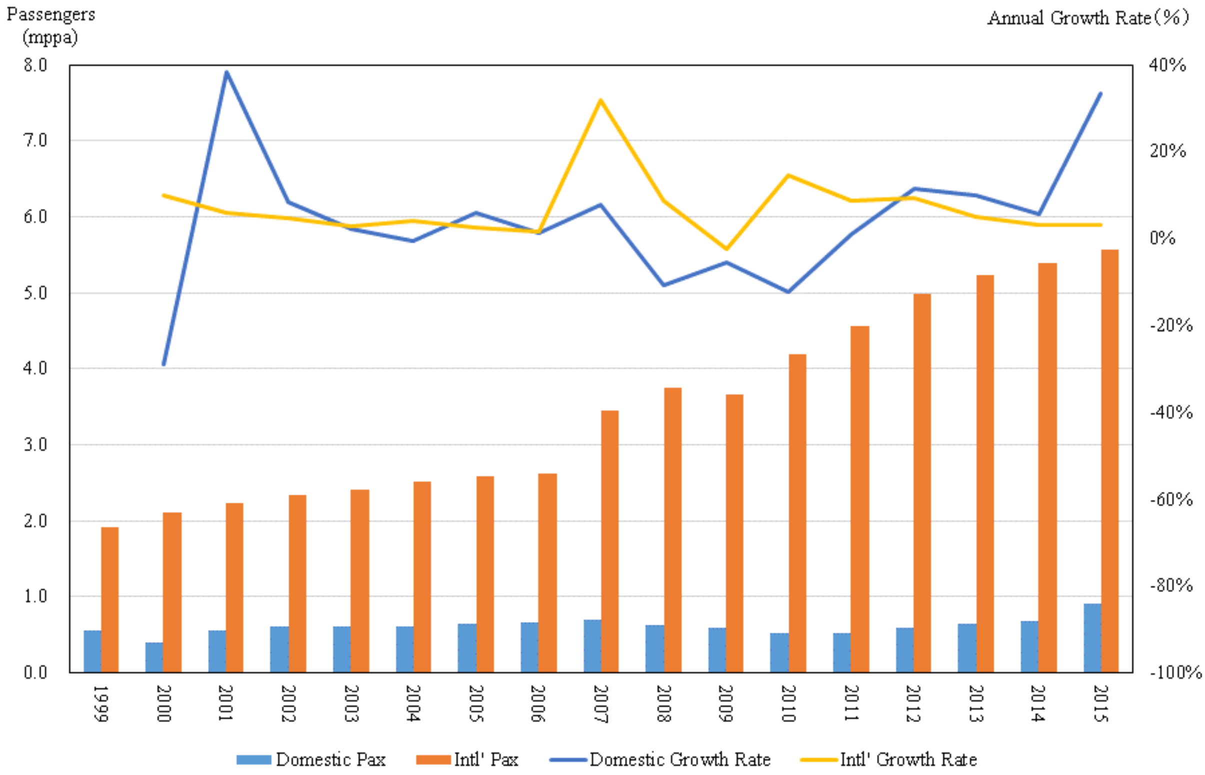
Figure 3-2 Demand of Passengers in Bangladesh

Although the ratio of passengers on international flights was 77.2% in 1999, it became around 90% after 2011. On the other hand, the number of domestic flights passengers has been stable between 1999 to 2009, recording around 700,000 passengers nationwide in 2007. It dropped to 520,000 passengers in 2010 after which a steady increase has been recorded, even though demand remains small. The average annual growth of the number of air passengers from 2010 to 2015 was 5.84%.

Table 3-1 Number of Passengers in HSIA (Unit: million passengers)

Year	Domestic Passenger	International Passenger	Total	International Passenger Ratio
1999	0.566	1.923	2.489	77.24%
2000	0.403	2.112	2.515	83.98%
2001	0.557	2.240	2.796	80.09%
2002	0.603	2.346	2.949	79.56%
2003	0.616	2.414	3.030	79.66%
2004	0.612	2.516	3.128	80.43%
2005	0.648	2.580	3.228	79.93%
2006	0.657	2.619	3.276	79.95%
2007	0.708	3.450	4.158	82.97%
2008	0.631	3.749	4.380	85.59%
2009	0.597	3.657	4.254	85.97%
2010	0.523	4.194	4.717	88.91%
2011	0.528	4.562	5.090	89.63%
2012	0.589	4.984	5.573	89.43%
2013	0.648	5.232	5.880	88.98%
2014	0.685	5.399	6.084	88.74%
2015	0.913	5.569	6.482	85.91%

Source: JICA Study Team



Source: JICA Study Team

Figure 3-3 Transition of HSIA Passengers

3.1.2 Cargo Volumes

The volume of import cargo at HSIA has been increased by 9% on average between 2011 and 2015, while export cargo has grown more rapidly by 14% during the same period. The volumes of export and import cargoes in 2015 were 200,560 tons and 84,379 ton, respectively.

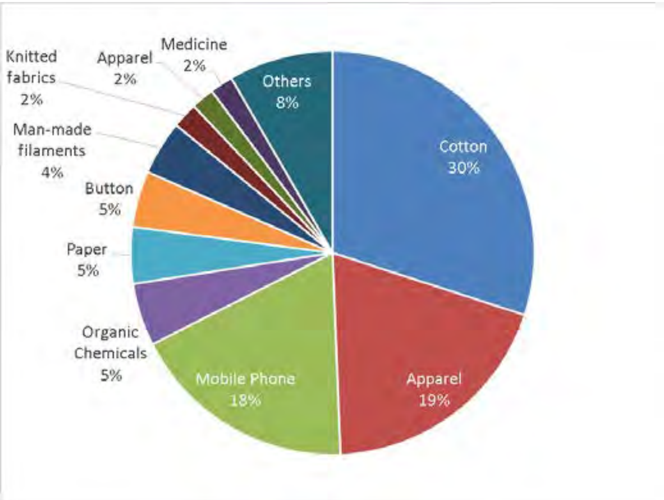
According to the data from the Custom House at HSIA[1], import for home consumption accounted for 10,385 tons between July 2015 and April 2016. Mobile phones recorded the largest volume with 5,816 tons, followed by chemical products (1,608 tons). Most of the import and re-export products (goods brought in bond) during the same period were mainly used for the apparel industry, which include clothing accessories (5,429 tons), cotton and denim (9,608 tons), and dyed woven fabrics (1,389 tons). Together with home consumption and goods for bond area, cotton, apparel, and mobile phones were the main imported goods in HSIA, which consist of around 67% of total imported goods (Figure 3-4).

In terms of export, apparel goods recorded 1,216,072 tons between July 2015 and April 2016, followed by fresh foods such as crabs and eels (34,120 tons) and vegetables (6,961 tons). Compared with the Biman Bangladesh Airlines' data for 2015, there was a huge increase of export of apparel goods at HSIA, while the volume of perishable exports remained at the same level. Currently, around 97% of export cargoes are apparel products, as shown in Figure 3-5.

The largest volume of imported cargo originated from Hong Kong and China, followed by India,

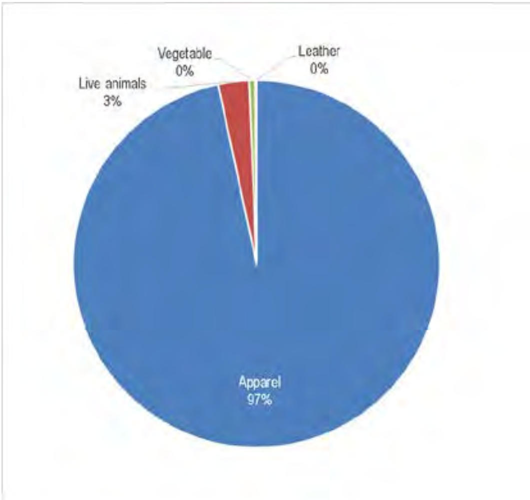
[1] The import data from the Custom House includes IM4 (for home consumption) and IM7 (goods for bond area), and does not include other categories such as IM5 (temporary import) that are very little in volume.

Pakistan, and Taiwan. Most of the imported goods from Hong Kong and China were primary materials for the garment industry. Mobile phones were largely imported from China and Korea, while chemical and pharmaceutical products were imported from Europe. Japan is ranked 14th in terms of imported cargo, accounting for 1,020 tons. In contrast to the imported cargo that were mainly from Asia, export cargo were mainly destined for Europe, in which Germany has the largest volume, standing at 648,825 tons, followed by the United Kingdom (444,654 tons), and Spain (81,729 tons). Most of the exported goods for Europe were apparel goods, followed by leather goods; while perishable goods were largely exported to the Middle East. Japan is the 9th export destination, accounting for 4,261 tons between July 2015 and April 2016.



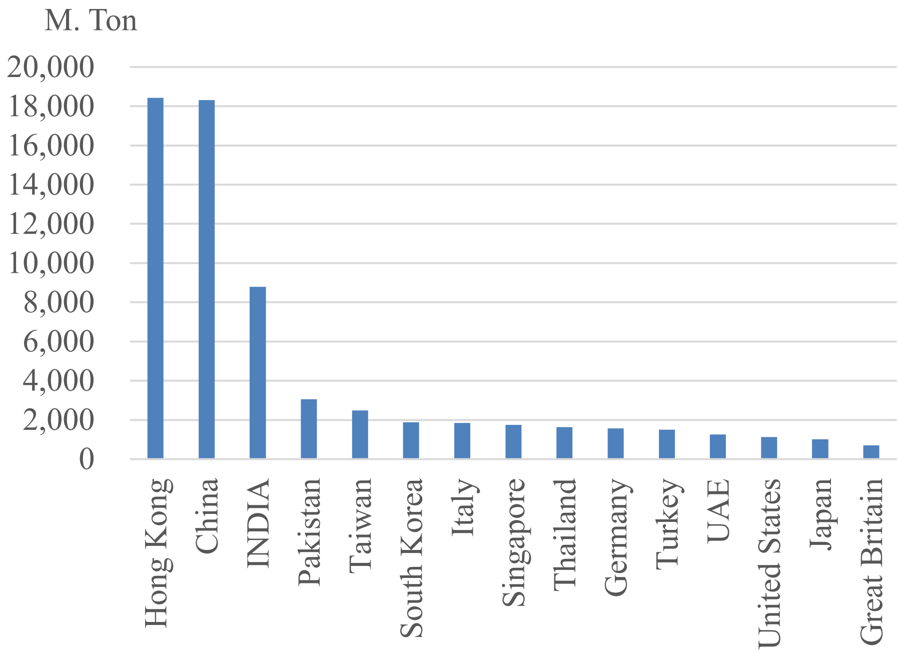
Source: Data from the Custom House

Figure 3-4 Composition of Import Commodities at HSIA Between July 2015 and April 2016



Source: Data from the Custom House

Figure 3-5 Export Commodities at HSIA Between July 2015 and April 2016



Source: Data from the Custom House

Figure 3-6 Imports by Country at HSIA between July 2015 and April 2016

3.2 Basic Facilities

3.2.1 Runway and Taxiway

The airport consists of a single runway (14/32), 46 m wide and 3,200 m long, with shoulders (8 m). About 90 m is secured for the runway end safety area (RESA) at both ends. The runway is equipped with CAT I instrument approaches. The declared distances are shown in Table 3-2.

Table 3-2 Runway Declared Distances of HSIA

Runway Designator	Take off Run Available (TORA) (m)	Take off Distance Available (TODA) (m)	Accelerate-Stop Distance Available (ASDA) (m)	Landing Distance Available (LDA) (m)
14	3,200	3,625	3,475	3,200
32	3,200	3,500	3,345	3,200

Source: AIP

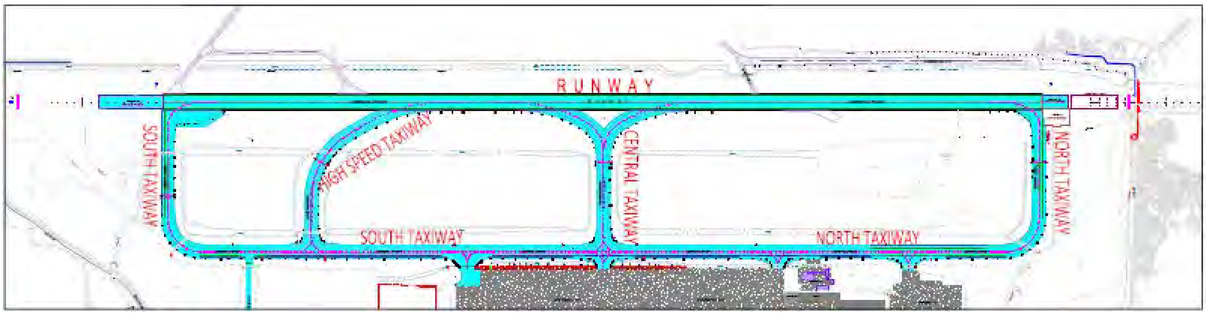
A part of the dual taxiway at the end of Runway 14 is being constructed. The runway will be extended to 3,290 m after completion of construction. A military airfield is located on the western side of the runway is connected by four taxiways to the runway. The runway and ATC are shared with the military. A taxiway is provided parallel to the runway, and a number of runway exits are available at the ends and in the middle of the runway. One rapid exit taxiway is provided for the landing direction of Runway 14. The entire runway was rehabilitated with an asphalt overlay of 180 mm in 2012 and the taxiway surface was rehabilitated by cut-out and repaving with 38 mm asphalt overlay for the taxing lanes of the main gear of large aircraft in 2015. These works raised the carrying capacities of the runway and taxiways to accommodate the heavy weight of large aircraft. The pavement classification number (PCN) of the runway and taxiways is now 116 as shown in Table 3-3.

Table 3-3 Runway and Taxiway Physical Characteristics

	Width	Surface	Strength (PCN)
Runway	46 m	Flexible pavement (asphalt)	PCN 116/F/C/W/T
Taxiway	23 m	Flexible pavement (asphalt)	PCN 116/F/C/W/T

Source: AIP

The layout and pavement of the HSIA runway and taxiway are shown in Figure 3-1 and Figure 3-4 respectively.



Source: CAAB

Figure 3-7 Runway and Taxiway Layout

Runway North Taxiway

South Taxiway Central Taxiway

Source: JICA Study Team

Figure 3-8 Runway and Taxiway Surface

3.2.2 Apron

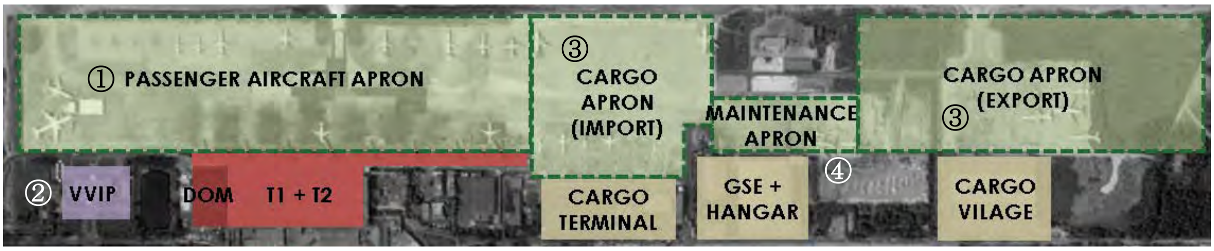
The existing apron areas are allocated as shown below:

① Passenger apron for scheduled service (nine stands, eight of which are boarding bridges),

② VVIP apron,

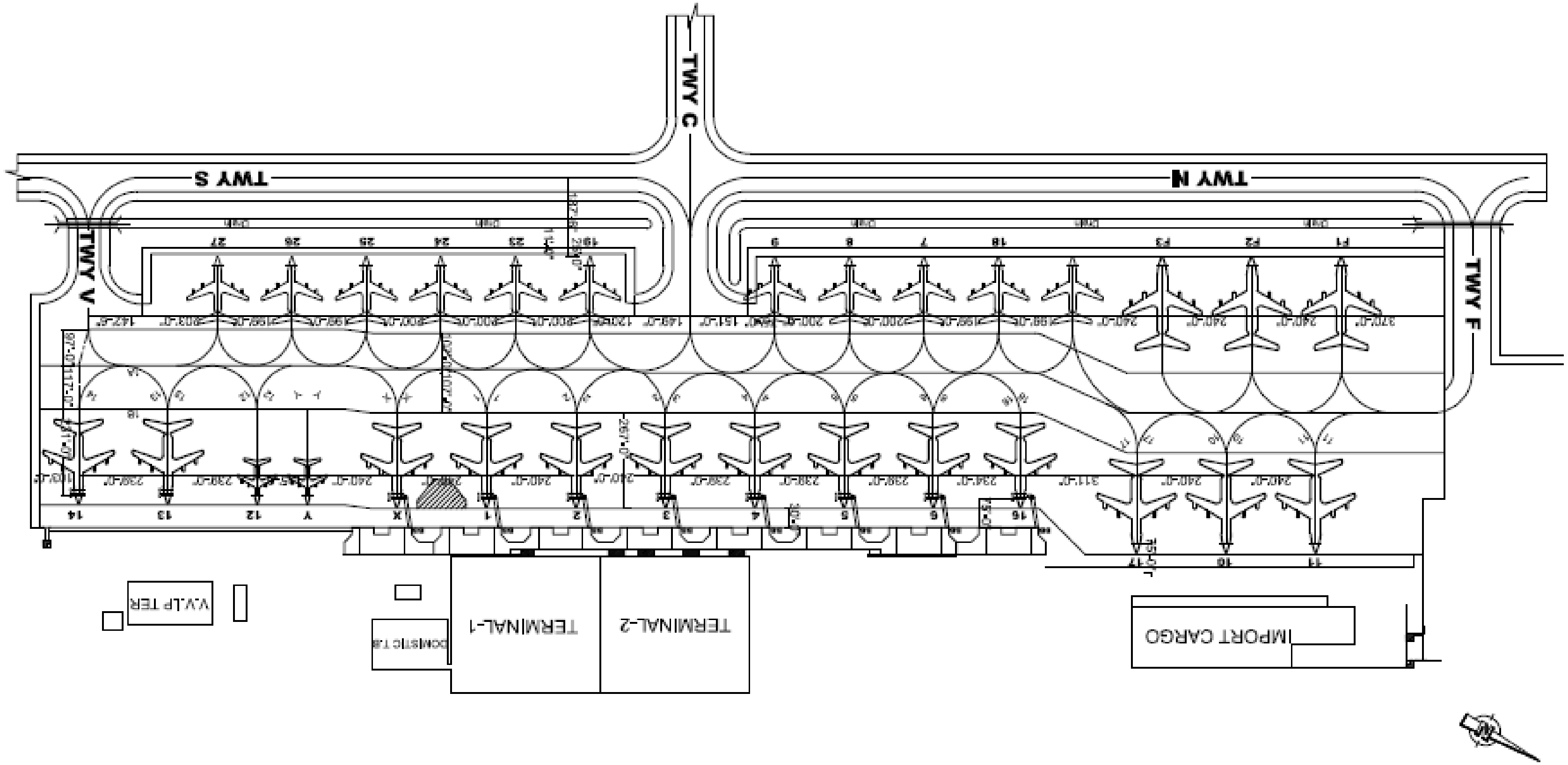
③ Cargo aprons (separate import and export aprons), and

④ Maintenance apron.



Source: CAAB

Figure 3-9 Apron Layout



Source: CAAB

Figure 3-10 Apron Stands and Marking Layout

Table 3-4 Existing Apron Stand Number

No.	Stand Number		Apron Type	Code	Remarks
	Present	Plan			
1	X	Bay 4	Passenger	E	Temporary Boarding Bridge
2	Y	Bay 3	Passenger	E	Combined with 12
3	1	Bay 5	Passenger	E	Boarding Bridge
4	2	Bay 6	Passenger	E	Boarding Bridge
5	3	Bay 7	Passenger	E	Boarding Bridge
6	4	Bay 8	Passenger	E	Boarding Bridge
7	5	Bay 9	Passenger	E	Boarding Bridge
8	6	Bay 10	Passenger	E	Boarding Bridge
9	7	Bay 20	Passenger	D	Boarding Bridge
10	8	Bay 21	Passenger	D	Non Scheduled
11	9	Bay 22	Passenger	D	“
12	10	Bay 13	Cargo	E	“
13	11	Bay 14	Cargo	E	
14	12	Bay 3	Passenger	E	Combined with Y
15	13	Bay 2	VVIP	E	
16	14	Bay 1	VVIP	E	
17	16	Bay 11	Passenger	E	
18	17	Bay 12	Cargo	E	Boarding Bridge
19	18	Bay 19	Passenger	D	
20	19	Bay 23	Passenger	D	Non Scheduled
21	23	Bay 24	Passenger	D	“
22	24	Bay 25	Passenger	D	“
23	25	Bay 26	Passenger	D	“
24	26	Bay 27	Passenger	D	“
25	27	Bay 28	Passenger	D	“
26	P1	Bay15	Passenger	E	“
27	P2	Bay 16	Passenger	E	“
28	P3	Bay 17	Passenger	E	“
29	Between 18 and P3	Bay 18	Passenger	D	“
30	Between 27 and T/W V	Bay 29	Passenger	D	“

Source: CAAB

The passenger apron pavement is showing many cracks and CAAB is planning improvement of the apron in the self-funded airport expansion plan currently under consideration. The characteristics of the apron pavement are shown in Table 3-5 and the condition of the passenger apron pavement is shown in Table 3-11.

Table 3-5 Apron Pavement Physical Characteristics

Surface	Strength (PCN)
Rigid pavement (concrete)	PCN 70/R/B/W/T

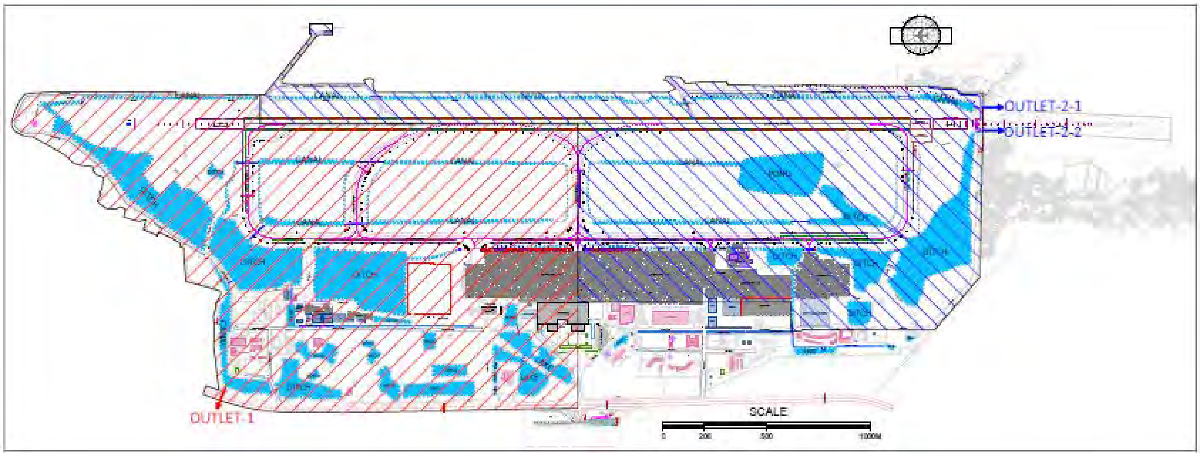
Source: AIP

Source: JICA Study Team

Figure 3-11 Passenger Apron Surface

3.2.3 Drainage System

The existing surface water drainage system in the airport is divided into two drainage zones, north and south. The drainage flow follows the lower areas, through retention ponds and drainage ditches in each zone and is discharged separately from the southeastern and northwestern corners of the airport area. Also, the airport area is an isolated zone avoiding entry of drainage from the outside. The existing drainage system is shown in Figure 3-12 and Table 3-13.



Source: JICA Study Team

Figure 3-12 Existing Drainage System

Existing Pond

Existing Culvert

Existing Open Channel

Existing Ditch with Grating

Drainage at the Southeastern Corner

Drainage in the Northwestern Corner

Source: JICA Study Team

Figure 3-13 Existing Drainage

3.3 Existing Landside Facilities

3.3.1 Current Condition of Passenger and Cargo Terminal

The existing terminal facilities of HSIA are the single storey domestic passenger terminal, two connected 3-storey international passenger terminals, two separate single-storey cargo terminal buildings for import and export, one VVIP passenger terminal, utilities and fuel supply facilities, and administration/management building. The auxillary facilities are located independently inside the airport area.

The floor areas of the HSIA passenger terminal and cargo terminal are shown in Table 3-6. The existing passenger terminal is shown as "T1and T2 Terminal", but are actually a single connected terminal and have a combined floor area of about 73,400 m^2.

Table 3-6 Existing Facilities and Floor Area in HSIA

Facilities	Floor Area
T1 and T2 Terminal	73,400 m^2
Domestic	2,200 m^2
Cargo (export)	12,800 m^2
Cargo (import)	15,000 m^2 (160,000 ft^2)

Source: CAAB Master Plan and Feasibility Study

The arrival/departure area is a double deck system for international departures and arrivals. Access to the departure kerbside is open to both well-wishers and drop-off vehicles. However, in common with many airports in Asia, vehicular access to the arrival kerbside is limited by a security check. Therefore, the areas outside the security fence surrounding the controlled area, including the parking space, are all extremely crowded with both people and traffic.

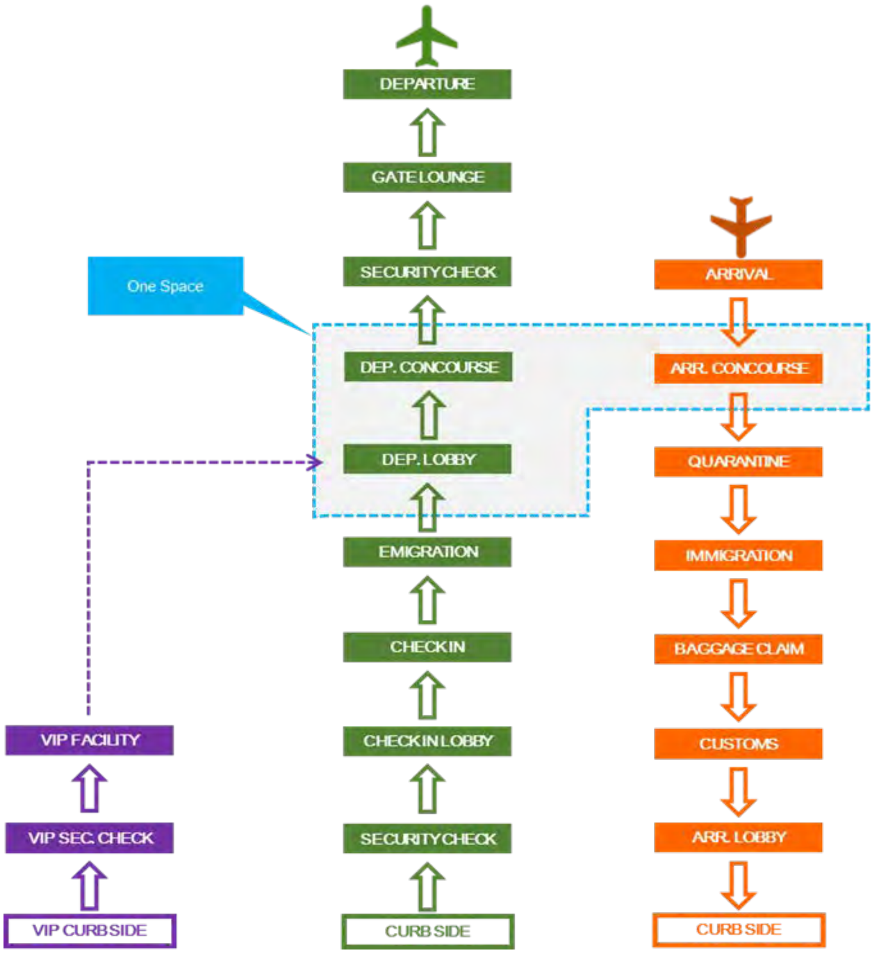
Facility planning and passenger flow of the passenger terminals are described below.

3.3.2 International Passenger Terminal Facilities

(1) Existing International Passenger Terminal Departure and Arrival Flow

The departure and arrival flow for international passengers are shown in Figure 3-14. The points of note concerning the passenger flows are described as follows:

- Departure and arrival passengers share the same airside concourse space, which are a later extension to the terminal building;
- Due to the mixing of departure and arrival passengers in this space, departing passengers must undergo security check immediately before entering the boarding area;
- One X-ray scanner and customs officers are stationed for baggage check and scanning of arriving passengers; and
- VVIP facilities are available on the northwest side of the international passenger terminal with access road and independent parking lot.



Source: JICA Study Team

Figure 3-14 Existing International Passenger Terminal Departure and Arrival Flows

(2) International Departure Passenger Facilities

International departure passenger facilities are shown in Figure 3-15. The points of note about the international departure passenger facilities are described below:

- ✈ There is a baggage check and ticket confirmation upon entering the departure lobby. People who accompany departure passengers can also enter the departure lobby by purchasing an entry ticket and registering basic data.
- ✈ For security reason, glass partitions are set up inside the departure lobby, separating the check-in counter from the entrance, and to make sure only passengers with valid passports and tickets can approach check-in counters. Since the departure lobby is separated into two spaces by the partition, the area in front of the check-in counters is tight and narrow.
- ✈ Duty free shops are found inside the concession area, but do not seem to attract many buyers. The articles on sale are limited and the retail concept needs to be re-examined
- ✈ Because of the gate security issue, departure passengers have to spend their time waiting inside the concession area, and then proceed to boarding and security check shortly before boarding time.

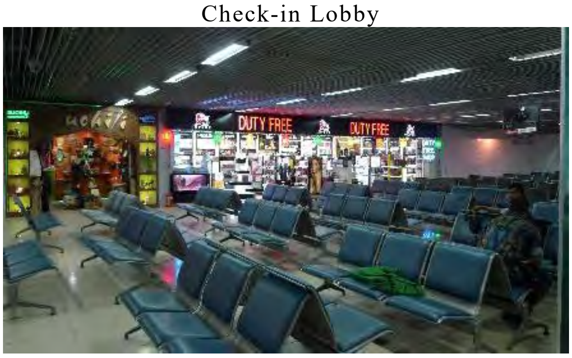
- Departure/arrival concourse was extended in 2003; the concourse space is quite wide, but the security check in front of the boarding gates creates long queue in this space.
- The gate lounges function more as a queuing space for boarding rather than waiting space for passengers.
- The security checks are authorized by CAAB, and the embarkation process is authorized by the Immigration Police, Special Branch Bangladesh Police.

Departure Kerbside

Security Check at the Entrance of Terminal Building

Check-in Lobby

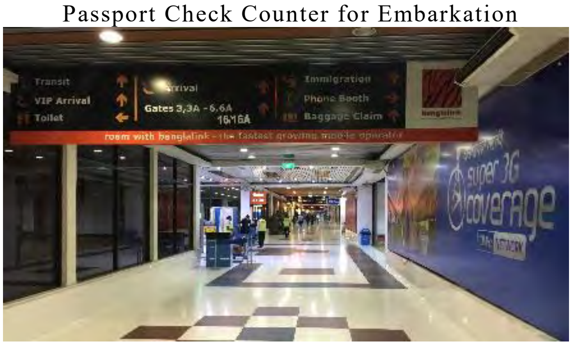
Passengers Line Up for Check-in Process



Departure Concession Area

Passport Check Counter for Embarkation

Queue in front of Boarding Gates for Security Check



Departure/Arrival Concourse

Source: JICA Study Team

Figure 3-15 Existing International Departure Passenger Facilities

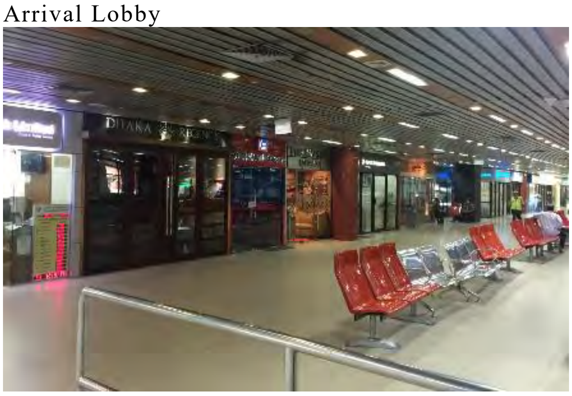
(3) International Arrival Passenger Facilities

The international arrival passenger facilities are shown in Figure 3-16. Some points of note about the international arrival passenger facilities are described below:

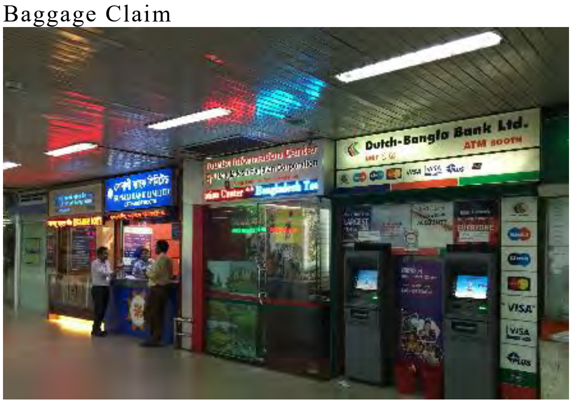
- The concourse is shared by departure and arrival passengers.
- The immigration processing time for arrival foreign passengers takes twice the average processing time in Japan, which is about 80 seconds.
- With a length of about 20 m, the space is big enough for queuing during passport checking.
- Another security point is placed after the arrival immigration counters to ensure all arrival passengers have completed passport checks before going to the baggage claim area.
- Baggage claim area is placed on both the left and right sides of the immigration processing area. With a width of about 60 m, the baggage claim space can adequately service passenger demand even during peak hours.
- Even though the arrival lobby is not spacious, it is not crowded since entry is controlled.
- Customs counters and one x-ray machine are provided in the customs area.
- There is also a police security point placed in the terminal exits in anticipation of people who may attempt re-entry to the terminal.
- Families or relatives who come to pick up passengers need to purchase tickets for entering the terminal building.
- General public without entry ticket must wait outside the airport security fences.

Arrival Lobby

Baggage Claim



Arrival Lobby



Money Changer at the Arrival Lobby

Source: JICA Study Team

Figure 3-16 Existing International Arrival Passenger Facilities

(4) International Passenger Terminal (T1 and T2)

The current Terminal 1 and Terminal 2 were built more than 20 years ago. Ceilings, lightings, and interiors are antiquated and in need of renovations. Some renovation works to improve the comfort of the toilets are being implemented.

An important issue of the current terminal is gate security. Based on the current operation system, security facilities and personnel need to be placed at every boarding gate. The bulk of passengers arrive at the boarding gates for the security check within the same short timeframe, causing long queues and some flight delays.

Another issue is the arrival facilities. Passport check for arrival passengers takes too long. Unstaffed booths were observed during congested periods and the error frequency for passenger data input to the system seems to be too high due to lack of familiarity with operations by the immigration staff.

Existing Terminal 1 and Terminal 2 Exterior

Check-in Counter for International Passengers

Source: JICA Study Team

Figure 3-17 Existing International Terminal

3.3.3 Domestic Passenger Terminal Facilities

(1) Present Situation

Domestic passenger terminal facilities are shown in Figure 3-18. Some points of note about the domestic passenger terminal facilities are described below:

- The domestic passenger terminal T1 is linked to the international terminal from the southeast side. An indoor corridor is placed to link the domestic terminal with the international arrival lobby on the ground floor.
- The domestic terminal is a flat roofed, single storey building. Airline check-in counters are placed in two locations inside the domestic terminal.
- After finishing the check-in process, passengers need to wait inside the departure lobby until the shuttle bus arrives to transport them to the aircraft.
- Arrival passengers are also transported by bus to the landside. They can approach the kerbside and share the same lobby with the departure passengers.
- For those who transfer to international flights or vice versa, there is a security system in the corridor linking to the international terminal.

Departure / Arrival Lobby

Departure / Arrival Shuttle Bus

Check-in Counter

Terminal Connection Corridor with Security Check Facility

Source: JICA Study Team

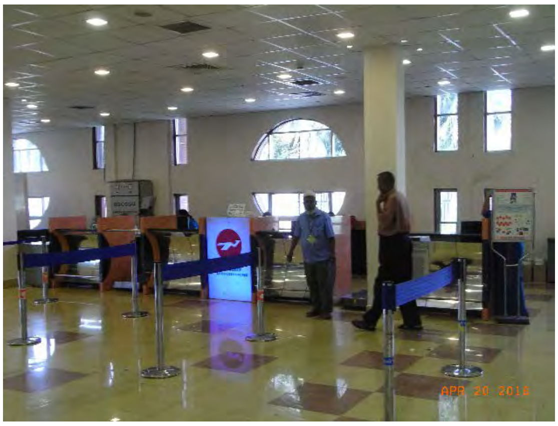
Figure 3-18 Existing Domestic Passenger Terminal Facilities

(2) Issues

1) Issues in Domestic Passenger Terminal

The domestic passenger terminal is a single-storey building with flat roof. It is a simple facility without baggage conveyors and all flights placed on remote stands. The check-in counters are placed in two areas, frontally in the lobby and to the side of the terminal. The interior spaces of the terminal space are spacious with high ceilings, but marked by cracks in the floor and dirty walls. The present conditions of the terminal are shown in Figure 3-19.


Domestic Flight Check-in Counter


Domestic Flight Check-in Counter

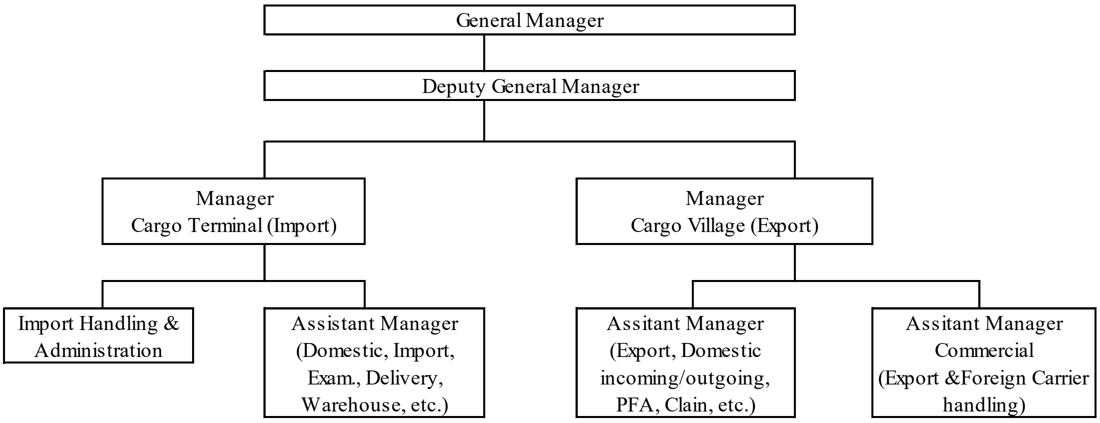
Source: JICA Study Team

Figure 3-19 Existing Domestic Terminal

3.3.4 Cargo Terminal Facilities

(1) Management

The cargo terminal of HSIA has been operated by Biman Cargo since 1972 when CAAB approved Biman Cargo as the sole ground handler to handle cargo services in Bangladesh. Figure 3-20 shows the organizational chart of the cargo terminal. The cargo terminal is headed by a general manager, who is assisted by a deputy general manager. There are two managers in-charge of export and import, who are assisted by assistant managers as shown in Figure 3-20. Currently, Biman Cargo has 110 employees but it plans to increase staffing to 355.



Source: Biman Cargo

Figure 3-20 Current Organizational Structure of Cargo Terminal at HSIA

The Civil Aviation Rules 1984 provides the rules related to airport transport services and safe transportation of dangerous goods. A license to operate air transport services shall be authorized by the chairman of CAAB and air transport fares are regulated by CAAB. Biman Cargo prepared the Cargo Operation Manual in 2013, which provides the information necessary for cargo handling, documentation, automation, loading and storing, and import procedures. The automated system for cargo handling and documentation was once introduced at the cargo terminal, but it was not functioning as expected. Currently, the documents are handled manually in the import cargo building and cargo are identified and processed on the basis of airway bill. The cargo are not classified by Harmonized System (HS) Code, but by two categories of 1) perishable cargo and 2) dry cargo. There is no separation between import for home consumption and import for bond area.

The Custom House under the National Board of Revenue is responsible for collecting import duties at HSIA. Recently, the Custom House introduced an automated system for custom data, called the Automated System for Customs Data (ASYCUDA) World, which was introduced in December 2013 for export goods and in May 2014 for import goods. The automated system has been supported by the United Nations Conference on Trade and Development (UNCTAD). UNCTAD provided training courses for operating the automated system in Malaysia. There are two payment methods for clearing customs, namely: 1) pre-paid system and 2) e-payment through bank. The Custom House handles around 4,000 imported goods per day, which include courier services. The import section for home consumption consists of six sections, and is very congested with clearance agents as shown in Figure 3-21. More than 90% of imported goods for home consumption were cleared within four days, 50% of which were cleared within one day. Around 75% of imported goods for bonded area (import + re-export), were cleared on the same day. The number of courier traffic has been increasing rapidly, and there are currently 33 courier agents at HSIA.

Direct Trade Data Input Room for Automated System at the Custom House

Import Section at the Custom House

Source: JICA Study Team

Figure 3-21 Existing Custom House

(2) Present Situation

Even though institutional framework such as the cargo management manual mentioned above are in place, the airside of the import cargo terminal is very crowded. The photographs in Figure 3-22 show that many parcels of import cargo are not carried into the cargo terminal building.

One cause of this problem is that the service hours for handling of imported cargo are limited to 9:00 – 17:00. Therefore, many irregular inspections take place outside. Since the cargo left outside are not properly supervised, some imported items are taken out inappropriately; leading to even more confusion.

The imported cargo which are fortunately carried into the cargo terminal is delivered to the shipper if the ledger sheet and cargo are matched; however, a process which is reported to take at least four days. There is almost no signage inside the terminal to direct the proper movement of the imported cargo, resulting in a confused circulation of handling staff and cargo. The floor is also littered with collapsed freight leaving only space sufficient for a wheelbarrow to pass when the passage lanes for dollys are excluded.

Some cargo racks have been installed in a part of the warehouse, but the work was suspended during installation and it has not been used yet. Forklifts are also in short supply and there is no space for vehicles to freely approach the racks to load/unload and move cargo on pallets.

There appears to have been some previous attempts to rectify the situation, but the handling staff cannot be stabilized (it has been reported that they are mostly day workers), making it difficult to train the staff. This in turn requires reliance on verbal instructions and makes operations far from efficient. It has also been reported that many of the handlers cannot correctly read and understand the labels attached to the cargo. It is considered essential to address the issue of improving the capability of the handlers and to train the staff to a sufficiently high level for the handling procedures and volumes expected after installation of the new equipment/facilities while developing an appropriate organization for cargo operation and management in time for the commencement of operations at the new cargo terminal.

Since in general, the number and letter combinations used to identify freight are not familiar to the cargo handlers, introduction of easily recognizable pictures and colours are believed to be required, as well as a means to reward by volume worked (increase in wages).

The education and training of staff members and management of handlers that reflects the reality in Bangladesh, coordinated with the introduction of appropriate equipment will be required to raise the efficiency of cargo handling to a level equal to that of ordinary airports in neighbouring countries

What is immediately apparent, both inside and outside the terminal building, is that orderly maintenance and cleaning are not being carried out and unnecessary goods, garbage, and damaged equipment are left abandoned. This condition is apparent throughout the airport, but this situation presents a candidate area where application of Japanese technical guidance and training would be appropriate.

The requirement for x-ray scanning of all items, requiring even small parcels to be individually passed through the large x-ray machine, is considered to be a bottleneck in export procedures. Continuing the same procedure in the future will require doubling the number of scanning equipment.

Export is serviced on a 24-hour basis and the procedures themselves are simple, so that the situation is better than imports, but it will be essential to eliminate excessive procedures and to improve working conditions similar to that for imports.

At present, trucks are overflowing the parking area. One reason is due to the traffic regulations that restrict daytime movement of large trucks causing the daytime movement of export cargo to be restricted to small trucks.

Both terminal buildings suffer from insufficient interior lighting and must be improved. A well-lit working environment will help to reduce mistakes and accidents.

The inability of handling capacity to keep up with the increased import volumes is another cause for the unkempt mess of import cargo. Other causes are the lack of an automated handling system and lack of efficient categorization. According to records, cargo whose owners could not be identified due to lack of efficient categorization was recorded to be 1,000 tons for the month of January 2016 alone. Already, airside space is saturated with insufficient space for storage of cargo. Interior spaces are also crowded with insufficient passage space (see Figure 3.22). The multilevel shelf space is also insufficient and is inaccessible to forklifts.

CAAB is aware that the current organization is also problematic for the export and import of air cargo to and from the United States and EU. CAAB is considering separating these operations from the Asian and Middle Eastern cargo to enable stricter management. However, compliance with Western standards is a fundamental requirement for international cargo, which is quite inferior under present circumstances. It is extremely important to introduce necessary facilities and focus on operation management.

Cargoes Stored Outside the Cargo Building

Congested Cargoes at the Airside

Warehouse in the Cargo Building

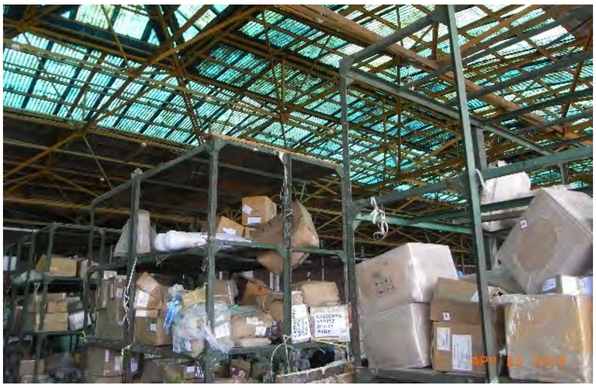
Source: JICA Study Team

Figure 3-22 Existing Cargo Building

(3) Issues at the Import Cargo Terminal

The import cargo terminal is quite small. There is a canopy area in front of the terminal building for temporary storage of imported cargo, but the space is not properly managed. Conditions do not allow for cargo to be properly handled and stored, frequently resulting in damage or disfigurement. The cargo terminal is operated solely by Biman Cargo. Although the terminal suffers from very limited space and debilitated facilities, the deterioration of the management and operations of the cargo terminal is also quite serious. Some cargo take almost one week to pass through customs which normally should take only one or two days, creating a major issue for air cargo with its need for speed. The present conditions at the import cargo terminal are shown in Figure 3-23.

Cargo are not properly sorted or handled



Interior of Import Cargo Terminal

Source: JICA Study Team.

Figure 3-23 Existing Import Cargo Terminal

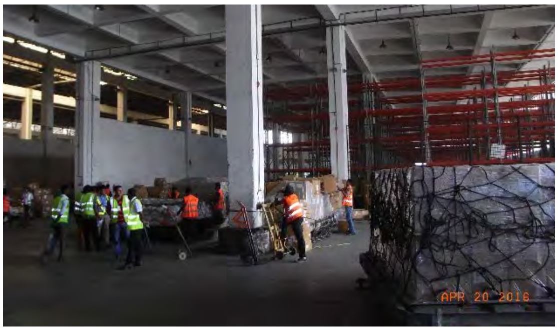
(4) Issues at the Export Cargo Terminal

The export cargo terminal is more spacious than the import cargo terminal.

The handling cargo exported from Bangladesh was prohibited by countries such as UK, Australia, and Germany due to the weak security scanning process. To improve the situation, new security screening equipment has been setup based on research by an UK airport security consultant, but waiting for inspections can be long and is considered a bottleneck at present.

Roller conveyors are available after the security scanning process and cargo are placed on dollys and lined up for uploading into the aircraft. The installation of cargo racks is also progressing to optimize space utilization inside the terminal area.

All cargo are moved inside the terminal from the gable side of the terminal where the security scanning facilities are placed due to the restrictions on the landside area. Cargo passing the security process are divided into categories and temporarily placed inside the terminal. Most operations are completed by workers by hand and the handling is rough and chaotic, mainly due to the lack of modern equipment. The export procedures follow a cargo handling manual prepared by Biman Cargo. Current conditions of the export cargo terminal are shown in Figure 3-24.



Interior Space of Export Cargo Terminal

Cargo Security Scan in Process

Source: JICA Study Team

Figure 3-24 Existing Export Cargo Terminal

3.3.5 VVIP Facilities

The VVIP passenger terminal is located at the southeast side of the airport area. There is an independent access for the VVIP terminal, which is connected directly to the main road outside the airport area. The VVIP terminal is fenced in and has a large garden.

VVIP Terminal Entrance Access Road

VVIP Terminal

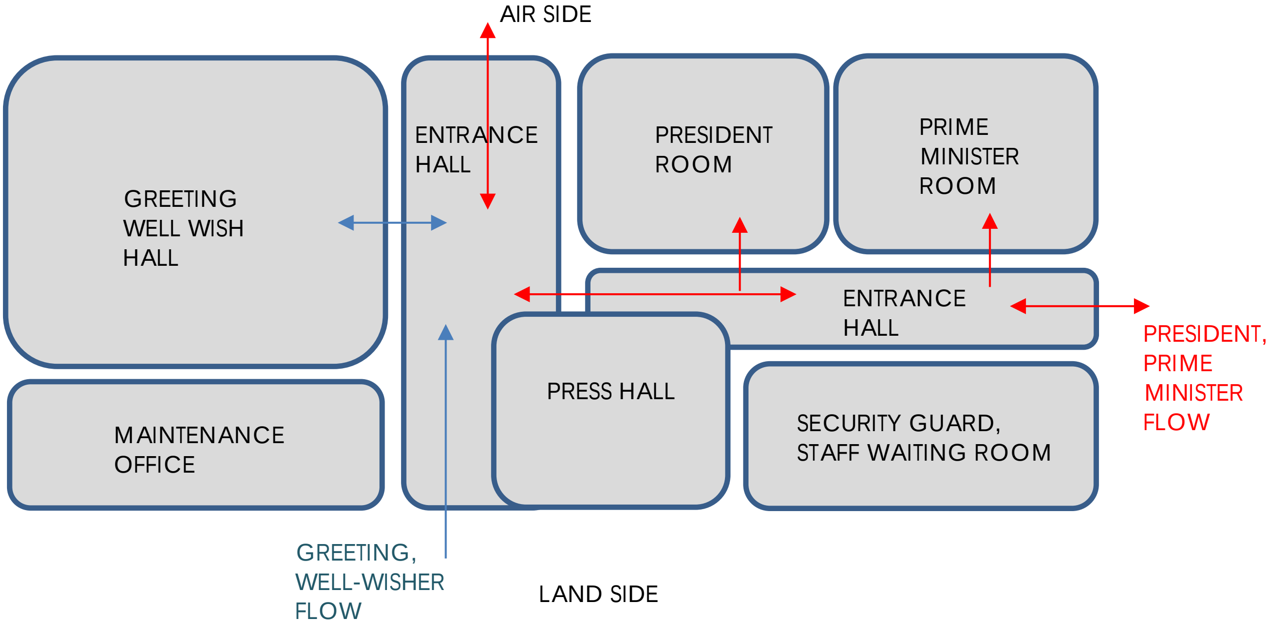
Source: JICA Study Team

Figure 3-25 Existing VVIP Facilities

(1) The current usage and layout of the existing VVIP building are shown below (refer to attached drawings and photographs).

- ✈ The permitted users are the President and the Prime Minister.

- There is a reception hall for well-wishers and greeters. Receptions are held here, although few in number.
- There is a press hall.
- There is a waiting room for staff of the President/Prime Minister and security guards.
- The day room on the first floor for the President and the Prime Minister are seldom used at present. However, a similar room should be provided in the new VVIP pavilion.
- There is no cooking conducted within the VVIP and catering services are used. Pantry space with functions for warming and preparation are provided.
- The actual time spent in the existing VVIP pavilion by VVIP is short. There is almost no use by visiting dignitaries.
  (Photographs attached)



Source: JICA Study Team

Figure 3-26 Layout of the Existing Ground Floor, Flow Chart

Entrance on the Apron Side

Greeters/Well-wishers Hall (Ground floor)

Source: JICA Study Team

Figure 3-27 VVIP Facilities (1)


Prime Minister's Room (Ground floor) (1)


Prime Minister's Room (Ground floor) (2)


President's Room (Ground floor)


Day Room (First floor)


Entrance for the President and Prime Minister


Press Room (Ground floor)

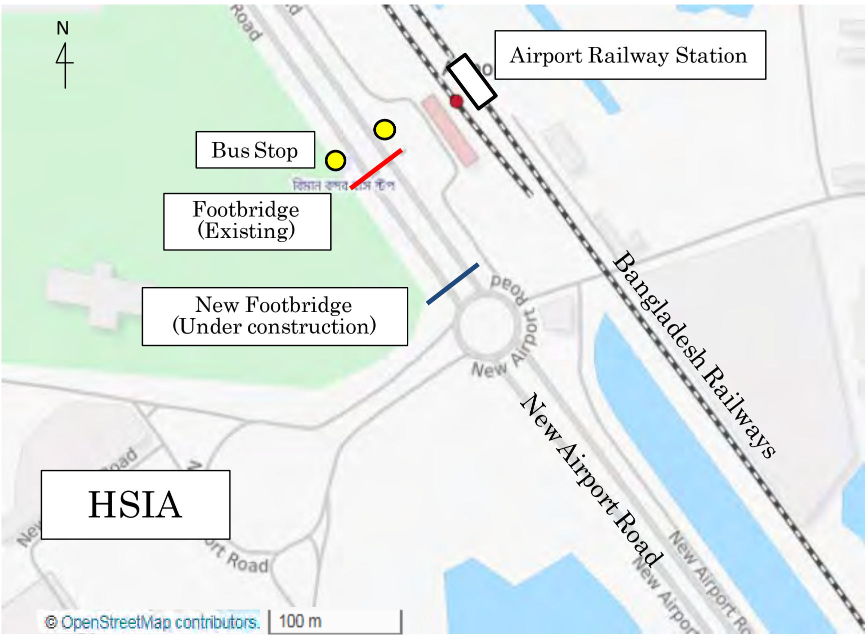
Source: JICA Study Team

Figure 3-28 VVIP Facilities (2)

3.3.6 Landside Access Road

(1) Current Condition of the Airport Access Road

The existing New Airport Road is the main access road to HSIA with four lanes on each side. The airport roundabout is located in front of HSIA and there are no traffic signals at the intersection. All traffic passes through the airport roundabout to enter HSIA. There is a median strip and pavement on the New Airport Road is well maintained. Physical devices such as speed bumps are not installed on the New Airport Road around the airport roundabout. Flyover and underpass to access HSIA are not developed at present.



Source: JICA Study Team

Figure 3-29 Current Location Map of the Airport Access Road and Surrounding Facilities

A bus stop is located 160 m north of the roundabout and many passengers board and disembark there. The pedestrian sidewalk is reduced to provide bus bays; however, passengers are sometimes forced to board or get off in the road mainly because of the following reasons: a) avoiding puddles especially during the rainy season, b) using the space for queuing, and c) the area is occupied by other vehicles (Figure 3-30). These behaviours obstruct the traffic flow and cause traffic congestion at the airport roundabout.

Source: JICA Study Team

Figure 3-30 Current Traffic Condition around the Bus Stop (Northbound)

Southbound bus passengers alight opposite to HSIA since traffic drives on the left in Bangladesh. The footbridge installed 130 m north of the airport roundabout (Figure 3-31), should be used to access HSIA. However, few pedestrians use the footbridge due to the distance, preferring to cross the road directly in front of HSIA, a zone without traffic signals. This behaviour is also another cause of traffic congestion in this area. A new footbridge is under construction near the roundabout (Figure 3-32).

Source: JICA Study Team

Figure 3-31 Existing Footbridge (in the North)

Source: JICA Study Team

Figure 3-32 New Footbridge Under Construction (South of the Existing Footbridge)

The Bangladesh Railways (BR) operates alongside the New Airport Road. The Airport Railway Station is located on the side opposite to HSIA. According to the interview with BR staff, the user numbers for Airport Railway Station is the largest among all stations in Dhaka City, and major users are the residents of Uttara and Mirpur. Railway users also use the footbridge or cross the road in the zone without traffic signals similar to the bus users. Users of the station often take buses, compressed natural gas (CNG) vehicles, or pick up their private cars to leave the railway station. Furthermore, the New Airport Road, which connects downtown Dhaka with north and northwest parts of the city, is a major artery with heavy traffic by private cars and buses unrelated to HSIA, causing heavy congestion in the vicinity.

(2) Issues of Airport Access Road

Traffic congestion on the New Airport Road is aggravated by the excessive dependence on road traffic throughout the whole area of Dhaka. Significant problems of the airport access road are: (i) reduced road capacity (ii) disorderly crossing by pedestrians no traffic signal zone and (iii) convergence of airport users and non-airport users. The causes and issues are summarized in Table 3-7.

Table 3-7 Summary of Causes and Issues

Problems	Causes	Issues
(i) Reduction of the road capacity	・Location of the bus stop ・Flooding of the road especially during the rainy season ・On-street parking	・Consideration of proper bus stop location ・Maintenance of drainage systerm ・Control of on-street parking
(ii) Disorderly crossing by pedestrians in no traffic signal zone	・Location and inconvenience of the footbridge ・Shortcut preferred due to big and heavy luggage to carry	・Installation of new footbridge nearby (under construction) ・Direct connection to HSIA from bus stop (footpath) and BR station
(iii) Convergence of airport users and non-airport users	・Proximity to residential areas	・Development of dedicated bus stop and railway station for airport users.

Problems	Causes	Issues
	・Location and number of bus stops and BR station	・Development of new public transport system

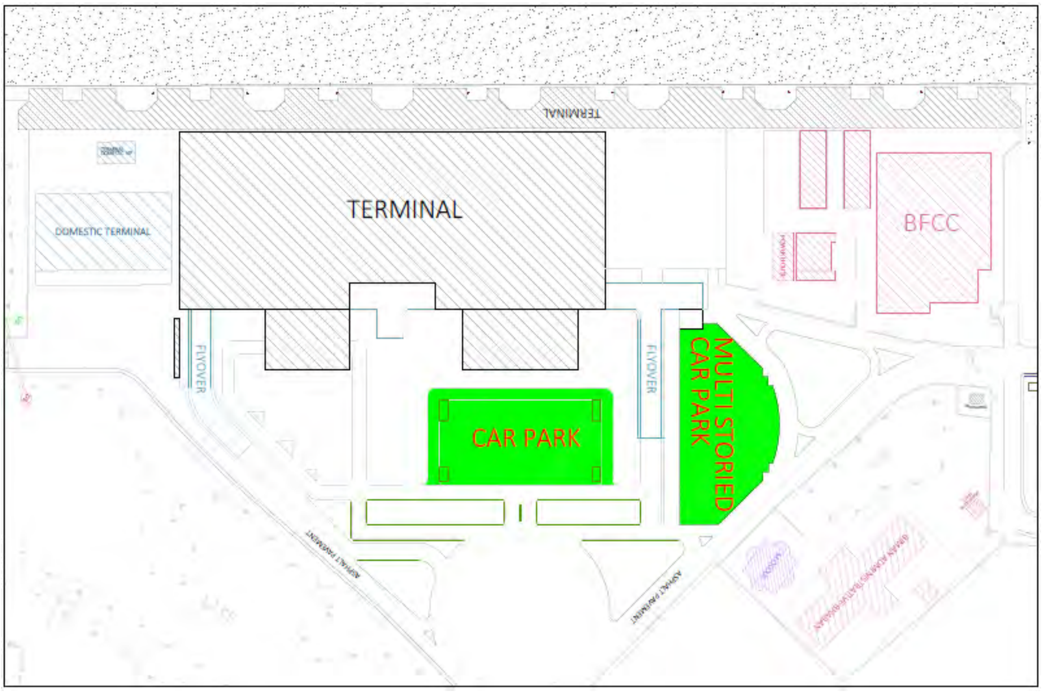
Source: JICA Study Team

The new T3 terminal at HSIA will be constructed 750 m south of the existing terminal. There are no railway stations nearby the new terminal location.

3.3.7 Car Parking

(1) Current Condition of Car Park

There is a car park in front of the passenger terminal, and a the multi-storied car park on the north side. The total number of parked cars is 1,000.



Source: JICA Study Team

Figure 3-33 Existing Car Park

(a) Car Park (b) Multi-storied Car Park

Source: JICA Study Team

Figure 3-34 Existing Car Park

(2) Issues of Car Park

The space for car parking and for staging of taxis will also be facing severe shortage in the near future due to the increase in passenger volumes that will entail a corresponding increase in the numbers of taxis or cars using the airport. Also, more airport employees will be commuting by car and requiring staff car parking areas.

3.4 Aeronautical Ground Lighting

Runways 14/32 at HSIA are operated in CAT-I (precision approach runway category I). Aeronautical ground lighting (AGL) system is located based on the International Civil Aviation Organization (ICAO) Annex14. The runway lights, approach lighting system (ALS), and an improved AGL system for taxiways are being implemented. The format of the ALS for Runway 14 is ‘distance coded centreline’ type. The ALS for Runway 14 from Station No. 11 to No. 30 has been installed outside the airport. The existing AGL system is shown in Table 3-8.

Table 3-8 Existing AGL System

DESCRIPTION	QUANTITY	
CAT-I Precision Approach Lighting System for 14R Approach	1 lot	30 m x 30 stations
Simple Approach Lighting System for 32L Approach	1 lot	30 m x 14 stations
Runway Threshold and End Lights for 32L-14R Runway	50	
Precision Approach Path Indicator for 32L-14R Runway	8 units	14L-32R
Runway Centerline Lights	116	15 m interval
Runway Touch Down Lights for 14L Approach	240	4 units x 60 barrete
Runway Edge Lights	106	
Taxiway Centerline Lights	1 lot	
Rapid Exit Taxiway Indicator Lights	1 lot	
Taxiway Edge Lights	1 lot	
Taxiway Guidance Signs	1 lot	
Intermediate Holding Position Lights	1 lot	
Illuminated Wind Direction Indicators	2	
Aerodrome Beacon	1	
Apron Floodlighting	1 lot	
Obstacle Lights	1 lot	

Source: JICA Study Team

The AGL cable used is 6.6 A, medium voltage, 6 mm^2 single core and direct buried cable. Its power source is supplied from the improved new cargo control room (CCR). The electric power for the inset type AGL in the pavement is supplied through the underground wire which is installed by 'saw cutting method'. Existing counterpoise wire for AGL system was installed on top of the AGL cable using a 16 mm^2 wire.

3.5 Utility Facilities

3.5.1 Power System

The power demand of HSIA is estimated at 8 MVA. It is supported by two intake power substations, called the CAAB DESCO Service Station in the north and ADA DESCO Service Station in the south.

From these DESCO service stations, CAAB's main power plant service substation in the north and Euro Tech Bangladesh (ETB) service substation in the south are connected by the 11-kV power cables. From CAAB's main power plant service substation and ETB service substation power supplied to other service substations via the 11-kV cable infrastructure.

The 11-kV cable is designed to connect emergency power generator of either CAAD DESCO Service Station or ADA DESCO Service Station. CAAB has placed a high priority on the reliability of their power infrastructure and has placed similar emphasis on the future power supply infrastructure (Figure 3.35).

Source: JICA Study Team

Figure 3-35 Inside of the Existing Power House

3.5.2 Water Supply

Water in HSIA is supplied from three filtration plants operated by the Dhaka Water Supply and Sewerage Authority (WASA). The filtration plants draw water from 240 to 300 A tube wells 70 to 100 meters deep, which are all used within the airport. The present condition of the water supply system is shown in Figure 3-36.

Source: JICA Study Team

Figure 3-36 Existing Water Supply

3.5.3 Wastewater Treatment

The wastewater treatment plant (WWTP) is located north of the airport. It uses traditional activated sludge process to treat wastewater, but the WWTP is not working at present. CAAB is planning to construct a new WWTP to cater to the future wastewater treatment demand under the HSIA development project**.** The technology for the new WWTP will be based on a patented non-decanter WF-SBR (Figure 3-37). WF-SBF is an improvement of the traditional sequencing batch reactor (SBR) method that increases the efficiency of the wastewater treatment process.

Source: JICA Study Team

Figure 3-37 Existing Wastewater Treatment

3.6 Support Facilities

3.6.1 Maintenance Hangar

The maintenance hanger at HSIA is located between the two cargo terminal buildings. Although this land is part of the airport area, the hanger is maintained and operated by Biman Bangladesh Airlines. The capabilities of Biman Bangladesh Airlines have not yet been confirmed and a detailed study will be carried in the future, if necessary.

The Biman Bangladesh Airline's maintenance hanger is shown in Figure 3-38Figure 3-38.

Source: JICA Study Team

Figure 3-38 Existing Biman Bangladesh Airline's Maintenance Hangar

3.6.2 General Aviation

The general aviation area is located in the southeastern corner of the airport and comprises some small hangars and aircraft parking. However, the area is within the new third passenger terminal site and should be considered for relocation (Figure 3-39).

Source: JICA Study Team

Figure 3-39 Existing General Aviation Hangar

3.6.3 Firefighting Facilities

The fire station is ideally located close to the centre of the runway with the shortest possible distance to both runway ends.

Table 3-9 and Figure 3-40 show the characteristics and conditions of the existing vehicles and equipment, respectively.

Table 3-9 Facilities in Existing Fire Station

Facility	Standard	Quantity	Remark
FFV	9,000 ℓ	1	Titan (USA)
FFV	11,200 ℓ	1	Titan (USA)
FFV	10,000 ℓ	1	Simon (UK)
FFV	10,000 ℓ	1	Simon (UK)
Ambulance		4	
Maintenance pit	Underground type	1	
Water hydrant		4	2 sets per point
Waiting room		1	
Control room		1	

Source: JICA Study Team

Fire Station (1)

Fire Station (2)

Water Hydrant

Control and Waiting Room

Source: JICA Study Team

Figure 3-40 Existing Fire Station

Two Japanese firefighting vehicles (FFVs) are to be introduced in February 2017 under the grant aid project initiated two years ago and will improve the ranking from the current category VII to IX. Some current vehicles are not operational, but the new vehicles combined with the present 4x4 vehicles will satisfy the required capacity at present. In the Aeronautical Information Publication (AIP), the fire and rescue service is categorized as CAT IX under the ICAO (Annex 14) classification for response and equipment in case of emergency situations, which satisfies the requirements for the Code E aircraft like the Boeing 747-400.

In future planning for relocation of the fire station, introducing new high-speed vehicles should be considered in order to shorten the arrival time from the current station location in central runway to the end of the runway. Also, in order to avoid temporary deterioration of firefighting capability due to vehicle maintenance and breakdown, it is necessary to add one more vehicle. It is also desirable to enhance the firefighting system to deal with emergency situations by introducing crushing cars and water supply cars.

3.6.4 Fuel Supply Facilities

The existing fuel supply facilities are located in the southeast of the airport; and operated by Padma Oil Co., Ltd. The Padma Oil Co., Ltd. is supplying fuel to existing passenger terminal by hydrant system.

Source：JICA Study Team

Figure 3-41 Current Exterior View of Fuel Depot

(1) Capacity and Current Issues of Existing Facilities

Outline of existing fuel supply facilities under operation is as follows;

- ✈ Owner : Bangladesh Petroleum Corporation（BPC）
- ✈ Facility Operator : Padma Oil Co., Ltd.
  Date of construction : Unknown (Since T1 was completed in 1980, the fuel supply facilities may have been constructed at the same time.)
- ✈ Annual fuel supply : 356,000 kl (Data for 2015 provided by Padma Oil Co., Ltd.)
- ✈ Daily average fuel supply : Approx. 1,000kl/day (Calculated from annual fuel supply)
- ✈ Transport to the airport depot : Fuel is transported by 9kl tank lorry
- ✈ Storage Tanks : 320kl/tank x 9 tanks (above ground) = Total 2,880 kl
- ✈ Capacity of hydrant pumps : Unknown
- ✈ Hydrant Pipelines : 14 inch. (Outer diameter 35cm) and 8 inch. (Outer diameter 20cm) 1 line each. The fuel supply capacity considering the pipelines (2 lines) diameter would be maximum 2,400 gpm (545kl/h).

1) Problems of the existing facilities

The facilities are antiquated and supply capacity is very small. The fuel supply for Terminal 1 and Terminal 2 appear to have already reached their maximum upper limit.

The total storage capacity is very small with only 2,880kl, equivalent to only a little over 2 days reserve, presenting issues with stable fuel supply. Presently, three storage tanks with 2,500kl capacity are under construction, which combined with present capacity would satisfy 7 days stock required by international standards for fuel supply for 2015 aircraft demand. However, this will still not be enough against storage capacity required for phase-1 volumes.

The hydrant pumps are also over-aged and delivery capacity is very limited. Even at present, current pumps seem insufficient to meet peak time demand.

Considering the above, additional tanks are required for fuel supply to the aircraft parked in T3 apron.

Existing Tank, Pump, and Filter Separator

Existing Tank Truck Receiving Facilities

14-inch and 8-inch Hydrant Pipes

Low Point Pit

Figure 3-42 Photos of Current Condition of Existing Facilities

3.6.5 Air Traffic Control Tower

The ATC tower satisfies its functional requirements at the present location. However, after the planned expansion and modification of the airport, some qualifications are anticipated for control operations, such as visibility of the south side of Terminal 3 will be obstructed. CAAB plans to construct a new ATC tower nearby Terminal 3 under the Bangladesh Air Traffic Management Upgrade Project (BATMUP), a public-private partnership (PPP) project. At present, the date for commencement of operation at the new ATC tower has not been clarified. However, the operation is expected to start before Terminal 3 opens. The current ATC Tower is shown in Figure 3-43

Source: JICA Study Team

Figure 3-43 Existing ATC Tower

3.6.6 Catering Facilities

The present Biman Bangladesh Airlines catering facility is located between the technical building and the import cargo area. The flight catering services are provided to Biman Bangladesh Airlines flights and some other airline companies. Existing catering facilities are shown in Figure 3-44.

Source: JICA Study Team

Figure 3-44 Existing Catering Facilities

3.7 CNS/ATM

Current location of communications, navigation, surveillance and air traffic management (CNS/ATM) systems is shown in Figure 3-45Figure 3-45.

Figure 3-45 Location of CNS/ATM Systems

3.7.1 Communication

The following very high frequency (VHF) radios were installed at the airport for aerodrome ATC services as shown in Table 3-10.

Table 3-10 ATS Communication Systems

Item	No.	Description	Specification
V/UHF Multi-transceiver	1	Equipment Type	Digital Multi-mode
	2	Frequency Range	117.975 – 137 MHz
	3	Output Power	TWR, SAR Mission Coordinator (SMC): 25 W APP, Ground: 50 W
	4	Channel Spacing	25 kHz
	5	Frequency Control	Synthesizer
	6	Manufacture	SELEX
	7	Install Year	2008
Voice Communication Control System (VCCS) and Emergency Voice Communication System (EVCS)	1	Controller Working Panel (CWP)	10 positions
	2	Analog Radio Interfaces	12
	3	Analog Telephone Interface	60 lines
	4	E1 Interface for Interconnection	1 lot
	5	QSIG (Q-Reference Point Signaling)	2 sets
	6	Digital Recording Outputs	E1 G. 703 (30 ch)
	7	Headsets, Handsets, Microphones	12 sets
	8	GPS Master Clock with Antenna	1 Set
Voice Recorder and Reproducer	1	Equipment Type	Digital Multi-mode
	2	Number of Channel	200 Ch (Dual)
	3	Equipment System	Dual Deck

Source: CAAB Master Plan

3.7.2 Navigation

(1) VOR/DME

The status of the VHF omnidirectional range (VOR)/ distance measuring equipment (DME) for instrument approach and departure in the HSIA terminal control area (TMA) is shown in Table 3-11.

Table 3-11 Status of VOR/DME

Item	No.	Description	Specification
VOR	1	Equipment Type	Doppler VOR
	2	Equipment System	Dual
	3	Frequency Range	108 to 118 MHz
	4	Output Power	100 w
	5	Antenna Type	-
	6	Manufacture	SELEX
	7	Install Year	2008
DME	1	Equipment System	Dual
	2	Frequency Range	960 to 1215 MHz
	3	Peak Power	1000 W
	4	Antenna Type	-
	5	Collocation	DVOR System
	6	Manufacture	SELEX Sistemi Integrati
	7	Install Year	2008

Source: JICA Study Team

(2) Instrument Landing System (ILS)

The status of the ILS for precision approach and departure to/from HSIA is shown in Table 3-12.

Table 3-12 Status of ILS

Item	No.	Description	Specification
Instrument landing system localizer (LLZ) (RWY 14)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	108 to 112 MHz
	4	Output Power	25 W
	5	Antenna Type	Capture effect method (M Type)
	6	Manufacture	THALES ATM
	7	Install Year	2012
Glide Path (GP) (RWY 14)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	328 to 336 MHz
	4	Output Power	5 W
	5	GP Angle	2 to 4 degrees
	6	Antenna Type	Two Frequency
	7	Manufacture	THALES ATM
	8	Install Year	2012
DME (RWY 14)	1	Equipment System	Dual
	2	Frequency Range	960 to 1215 MHz
	3	Peak Power	10 kW
	4	Antenna Type	FAN-88, directional antenna
	5	GP Angle	
	6	Manufacture	THALES ATM
	7	Install Year	2012
Middle Marker (MM) (RWY 14)	1	Peak Power	Replaced by L-DME
	2	Frequency Range	
	3	Antenna Type	
	4	Manufacture	
	5	Install Year	
Inner Marker (IM) (RWY 14)	1	Peak Power	Replaced by L-DME
	2	Frequency Range	
	3	Antenna Type	
	4	Manufacture	
	5	Install Year	
LLZ (RWY 32)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	108 to 112 MHz
	4	Output Power	25 W
	5	Antenna Type	Capture effect method (M Type)
	6	Manufacture	THALES ATM
	7	Install Year	2014
GP (RWY 32)	1	Equipment Type	Two Frequency
	2	Equipment System	Dual
	3	Frequency Range	328.6 to 335.4 MHz
	4	Output Power	5 W
	5	GP Angle	2 to 4 degrees
	6	Antenna Type	Capture effect method (M Type)
	7	Manufacture	THALES ATM
	8	Install Year	2014
DME (RWY 32)	1	Equipment System	Dual
	2	Frequency Range	960 to 1215 MHz
	3	Peak Power	100 W
	4	Antenna Type	FAN-88, directional antenna
	5	Collocation	With GP
	6	Manufacture	THALES ATM
	7	Install Year	2014

Source: JICA Study Team

3.7.3 Surveillance

The primary surveillance radar (PSR)/secondary surveillance radar (SSR) was installed at HSIA for radar surveillance for ATC services such as departure and approach control at the Dhaka Terminal Control area. The radar data are transmitted to the visual flight rules (VFR) room and instrumental flight rules (IFR) room in the control tower. The status of PSR/SSR is shown in Table 3-13.

Table 3-13 Status of PSR/SSR

Item	No.	Description	Specification
PSR	1	Coverage for Approach Control	60 NM
	2	Frequency	S-band, 2700 - 2900 MHz
	3	Accuracy	Azimuth 0.1 degree / Range 50 m
	4	Resolution	Azimuth 2 degrees / Range 225 m
	5	Antenna Gain	33 - 34 dB
	6	Azimuth Beam Width	1.3 degrees
	7	Elevation Beam Width	0.5 - 45 degree
	8	Polarization	Liner / Circular
	9	Transmitter	Solid-state
	10	Sub Clutter Visibility	> 45 dB
	11	Max. Tracks Number	1000
	12	Receiver Minimum Detectable Signal (MDS)	-108 dBm
	13	Receiver Digital Output	More than 14 bits
	14	Installation year	1984
SSR	1	Coverage	60 NM
	2	Frequency	TX 1030 MHz, RX 1090 MHz
	3	Accuracy	Azimuth 0.15 degree / Range 37 m Mode-S 0.068 degree/20 m
	4	Resolution	Azimuth 2.3 degrees / Range 230 m
	5	Antenna Gain	27 dB
	6	Azimuth Beam Width	2.3 degrees
	7	Elevation Beam Width	0.5 – 45 degrees
	8	Mode	Mode A, B, C, D, and S Level 2
	9	Transmitter	Solid-State
	10	Overlapping	Up to 4 SSR replies
	11	Max. Tracks Number	1000
	12	Receiver MDS	-87 dBm

Source: CAAB Master Plan

3.7.4 Meteorological Observation System

The following weather conditions are observed, recorded, and reported at the observation field:

- Wind speed and direction,
- Temperature,
- Dew point temperature,
- Humidity,
- Atmospheric pressure,
- Height of cloud, and
- Visibility.

The automatic weather observation system (AWOS) manufactured by VAISALA was installed in 2008. This system consists of weather data collecting equipment, runway field sensors such as wind speed and wind direction, temperature, pressure, runway visual range (RVR), ceilometer, and relevant indicators.

The status of the Meteorological Observation System is shown in Table 3-14.

Table 3-14 Status of Meteorological Observation System

Item	No.		Description	Specification
AWOS	1		Wind Vane	
		1	Range	0 to 75 m/s
		2	Distance Constant	2 m
		3	Threshold	0.1 m/s
		4	Resolution	.01 degree
		5	Time Averaging	Max. 3,600 s average
	2		Anemometer	
		1	Range	0 to 360 degrees
		2	Resolution	.01 degrees
		3	Time Averaging	
		4	Update	
	3		Ceilometer	
		1	Measurement Range	0 to 7.6 km
		2	Reporting Resolution	5 m/10 ft
		3	Reporting Cycle	programmable, 2...120 s
	4		Temperature	
		1	Display Range	
		2	Minimum Scale Space	
	5		Humidity	
		1	Recording Range	0 to 100%
		2	Minimum Scale Space	1%
	6		Pressure	
		1	Display Range	500-1100 hpa
		2	Recording Range	
		3	Minimum Scale Space	0.1 hpa
	7		Visibility Sensor	
		1	Measurement Range	5 ... 75 000 m with 1, 3, and 10-minute averaging +10% range 5 ... 10 000 m
		2	Accuracy	±20% range 10 000 ... 75 000 m
	8		Manufacture	VAISALA
	9		Installation Year	2008

Source: JICA Study Team

3.7.5 Airspace and Flight Route

(1) Airspace

Dhaka FIR is surrounded by Kolkata FIR, Gauhati FIR, and Yangon FIR. Air traffic service (ATS) for the southern part of Dhaka FIR from FL280 to FL460 has been delegated to Kolkata area control center (ACC)/flight information center (FIC).

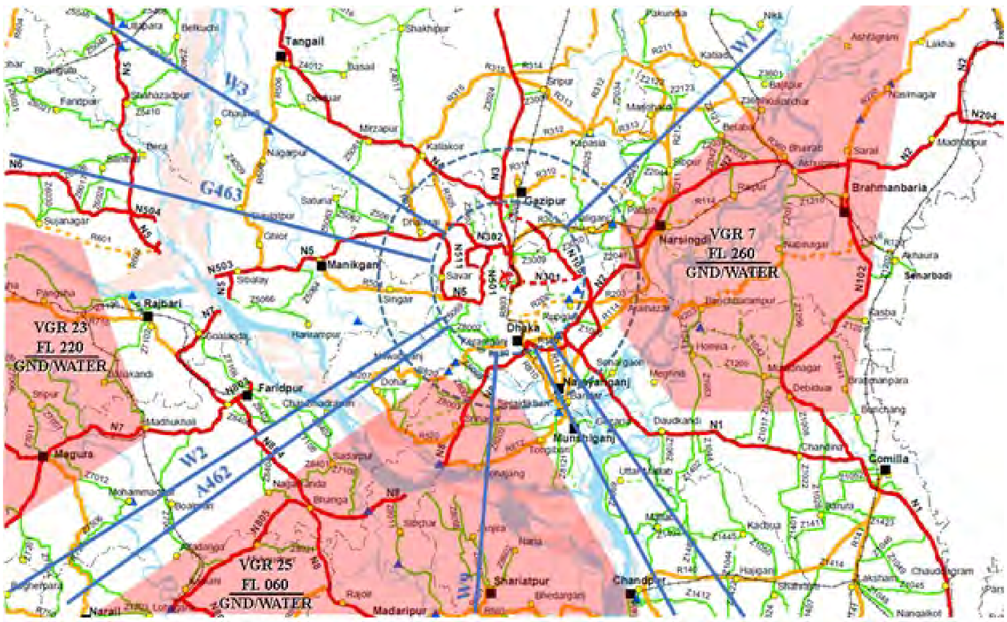
Other types of airspaces are shown in Table Table 3-15

Table 3-15 Characteristics of Airspace around HSIA

Type of Airspace	Description
Terminal Control Area (TMA)	Dhaka TMA is the airspace within the circle of 50 NM radius centered on Dhaka VOR excluding the area which falls within Indian territory and north of the straight line joining points 241145N 0910930E and 241145N 0893530E. The lower limit altitude is FL055 and the higher limit altitude is FL460.
Dhaka Approach Control Area (ACA)	To extend jurisdiction of approach control service within ACA has been established at and around HSIA. The area of lateral limits is same with Dhaka TMA. The lower limit is FL055 and the higher limit is FL155.
Aerodrome Traffic Zone (ATZ)	At HSIA, ATZ is established to handle the traffic in the vicinity of the airport. The lower limit of the airspace is ground, while the higher limit is FL040. The lateral limits are oval shaped area joining outer tangents of 5NM radius circles centered at the runway center and both ends of the runway.

Source: JICA Study Team

The HSIA is surrounded by five restricted areas and one prohibited area. Almost all international ATS routes are located in corridors that are formed by numerous large restricted areas as shown in Figure 3-46, while many domestic ATS routes move across the restricted areas. According to current AIP, civil aircraft can fly in restricted area located in TMA and controlled traffic region (CTR), if they have coordinated with the military.



Source: JICA Study Team

Figure 3-46 Prohibited and Restricted Areas Around HSIA

(2) Flight Route

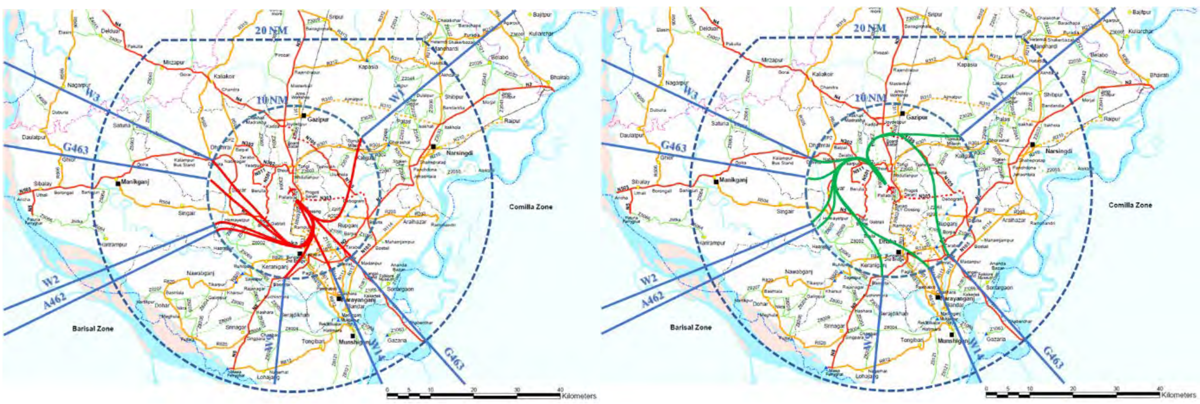
The currently established and published instrument approach procedures are listed in Table 3-16Table 3-16.

Table 3-16 Instrument Approach Procedures in HSIA

Runway	Navigational Aids	Procedure Name
14	NDB	NDB RWY 14
14	NDB/ILS	NDB/ILS RWY 14
14	VOR	VOR RWY 14
14	VOR/DME	VOR/DME RWY 14
14	VOR/DME, ILS	VOR DME ILS RWY 14
14	DA Locator	DA Locator RWY 14
14	DA/ILS	DA/ILS RWY 14
14	VOR/DME, ILS	VOR DME-ARC ILS RWY 14
14	-	RNAV (GNSS) RWY 14
32	VOR	VOR RWY 32
32	VOR/DME	VOR/DME RWY (1) 32
32	VOR/DME	VOR/DME RWY (2) 32
32	VOR/DME	VOR/DME-ARC RWY 32
32	VOR/DME, ILS	VOR/DME/ILS (1) RWY 32
32	VOR/DME, ILS	VOR/DME/ILS (2) RWY 32
32	VOR/DME, ILS	VOR/DME-ARC/ILS RWY 32

Source: JICA Study Team

There are 23 flight routes of the standard instrument departures (SIDs) which consist of 15 SIDs for RWY 14 and eight SIDs for RWY 32 in HSIA. All departure flights are directed by ATC to individual ATS routes according to submitted flight plan after passing 1,000 ft, 1,500 ft ,or 2,000ft as shown in Figure 3-47



Source: JICA Study Team

Figure 3-47 SIDs wPattern of RWY 14 and RWY 32

CHAPTER 4　STUDY OF NATURAL CONDITIONS

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Chapter 4 STUDY OF NATURAL CONDITIONS

4.1 Summary of Natural Conditions (Wind, Rainfall, and Temperature)

4.1.1 Geography

About 90% of Bangladesh lies on low flat alluvial plains reaching to the Bay of Bengal built up by silt from floods originating in the Himalayas. The area is a delta formed by the three great rivers of Ganges, Jamuna, and Mehguna. The delta is affected by recurring floods and approximately one-thirds of the country is flooded by over one meter of water during the rainy season.

4.2 Climate

Bangladesh belongs to the tropical monsoon climate zone. The seasons are divided into the minor rainy season from the end of March to May, the major rainy season from June to the beginning of October and the dry season from mid October to the end of March. Seventy percent of rain is concentrated in the rainy season. There is a large difference in rainfall between regions, with western areas receiving 1,500 mm per annum while South Chittagong and Sylhet to the southeast receive 3,000 mm. In general, rainfall increases when moving further east and closer to the Bay of Bengal. During the minor rainy season, strong north-westerly winds cause squalls accompanied by tornados and thunderstorms. At the change between the dry and rainy seasons in April-May and October-November, cyclones occur which assault the coastal regions once every two years on average causing heavy damage.

The average monthly high and low temperatures, rainfall and wind speed for the past five years in the Dhaka Region, where HSIA is located is shown in Table 4-1.

Table 4-1 Climate Data for Dhaka Region

Year	Average for the Years 2011-2015											
Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Highest Temperature (℃)	22.4	25.6	30.0	31.7	32.1	32.1	31.3	31.0	31.3	30.5	27.0	23.6
Lowest Temperature (℃)	13.1	18.3	23.2	24.0	25.0	26.3	26.5	26.6	26.6	24.6	21.5	14.7
Rainfall (mm)	3	8	19	134	216	306	344	338	186	76	14	2
Wind Speed (km/hr)	3.8	4.3	4.6	4.6	4.9	4.6	4.4	3.9	3.5	3.1	2.8	2.8

Source: JICA Study Team

4.3 Natural Condition Survey Conducted by CAAB

4.3.1 Review of Past Natural Condition Survey

The CAAB has already carried out much of the planning, study, and design regarding the HSIA expansion project, and the topographic survey for the airport site and the surrounding area were also performed under these works. The topographic survey was performed by the joint venture (JV) among Yooshin, CPG, and DDC, who were the consultants for CAAB for the past works on the HSIA expansion project. Especially, Yooshin was in-charge of the topographic survey among the JV members according to the information acquired by the JICA Study Team. The report of the topographic survey was submitted to CAAB in June 2015.

The outline of the topographic survey conducted by CAAB is shown in Table 4-2. The conditions of the benchmarks installed at the site are shown in Figure 4-1.

Table 4-2 Outline of the Past Topographic Survey (June 2015)

Survey	Quantity	Outline
Control Point Survey	40 points	✈ Establishment of temporary benchmark using reinforced concrete column (RCC) pillars at around 1 km interval. ✈ Coordinates were referred to four control points provided by the Survey of Bangladesh (SOB). ✈ Coordinates of temporary benchmarks were controlled by the global navigation satellite system (GNSS) static method and the differential leveling method.
Topographic Survey	Around 800 ha	✈ Coordinates measurement at 10 m grid. ✈ Cross sections were taken at 20 m interval, centered on the centerline of the proposed new runway. ✈ Existing physical features were shown in the topographic map based on the survey of existing facilities and structures

Source: JICA Study Team

Control Point administrated by SOB

Temporary Benchmark (Damaged)

Source: JICA Study Team

Figure 4-1 Condition of Benchmark at the Site

Based on the result of the confirmation of this CAAB's report, the topographic map shown in Figure 4.2 was prepared. The map is sufficient in providing the necessary data for the future works for the HSIA expansion project. However, the topographic data used the Universal Transverse Mercator

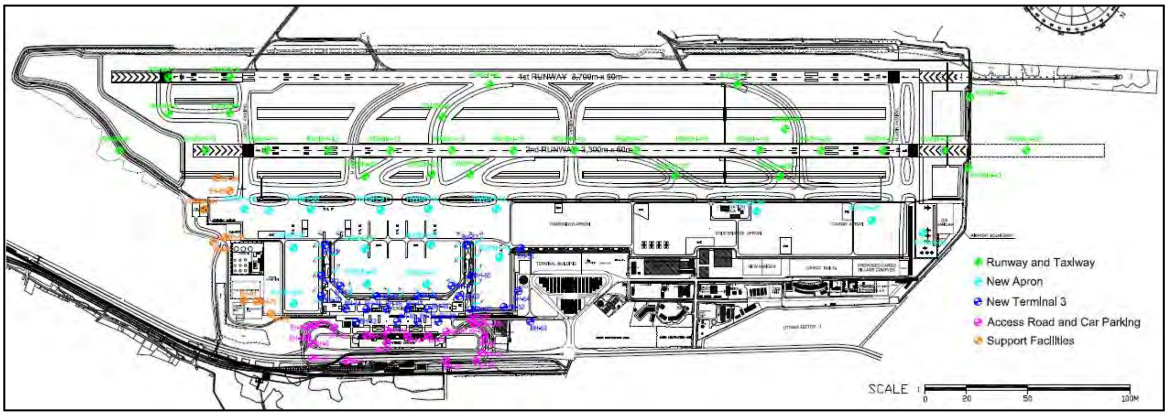
(UTM) coordinate system; The airport coordinate system, which is normally used for the development and management of airport facilities, has never been established for HSIA.

Source: CAAB

Figure 4-2 Topographic Map

4.3.2 Geotechnical Survey

Many geotechnical surveys, as shown in Table 4-3 and Figure 4-3, were carried out in the previous investigations for the existing runway, new runway, taxiway, new apron, multi-storied car park, and Terminal 3 areas.



Source: CAAB

Figure 4-3 Locations of the Past Geotechnical Survey

Table 4-3 Previous Geotechnical Investigations

		Existing, R/W, New R/W and T/W	New Apron	Multi-storied Car Park	New T-3
Borehole		30 Points	16 Points	20 Points	23 Points
Site Works	Boring	√	√	√	√
	Standard Penetration Test（SPT）	√	√	√	√
	Undisturbed Sampling	√	√	√	√
	Test Pit Sampling	√	√		
Laboratory Tests	Particle Size Analysis by Sieve and Hydrometer	√	√	√	
	Atterberg Limits	√	√	√	√
	Specific Gravity	√	√	√	√
	Natural Water Content	√	√	√	√
	Unit Weight Test	√	√	√	√
	Direct Shear Test	√	√	√	√
	Unconfined Compression Test	√	√	√	√
	Consolidation Test	√	√	√	√
	Compaction Test	√	√		
	Soaked CBR Test	√	√		

Source: JICA Study Team

However, the soil data analysis for the design has not been conducted satisfactorily so far. Many problems or insufficiencies were found in the previous geotechnical investigation reports.

In order to resolve the above insufficiencies and perform a more accurate design, the review of previous geotechnical investigation reports was conducted and additional geotechnical investigations were carried out during the Data Collection Survey of JICA in Phase-1 areas for Terminal 3, multi-storied car park, new apron, and connecting taxiway for Runway 14 threshold.

4.4 Implementation of Natural Condition Survey

4.4.1 Topographic Survey

(1) Control Survey

A control survey on four points was carried out in order to determine the conversion formula for the preparation of the airport coordinate system from the original coordinate data. Two points are on the runway centreline at each end of the runway, whose coordinates are shown in AIP Bangladesh. The other two points are set on a line parallel to the runway centreline on the parallel taxiway centreline. However, since the existing parallel taxiway is not exactly parallel with the runway, this line does not correspond exactly with the taxiway centreline. The locations of the points for the control survey are shown in Figure 4-4.

Source: Google Earth modified by the JICA Study Team

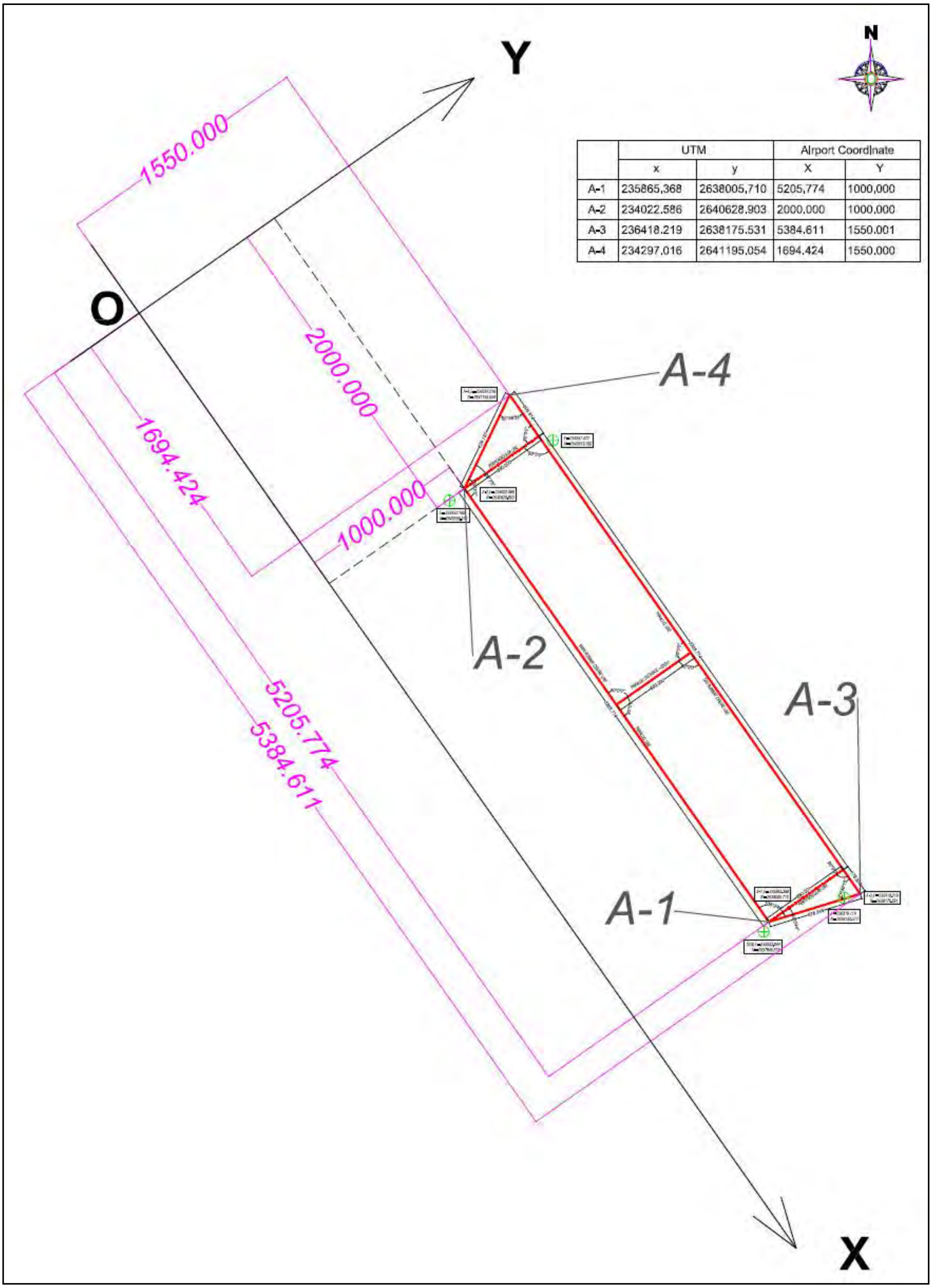
Figure 4-4 Location of Four Points for Control Survey

Based on the UTM coordinates acquired by the control survey, coordinates of each point are determined at the HSIA airport from geometrical relationship as shown in Table 4-4. The new coordinate system formulated from the results of the control survey is shown in Figure 4-5.

Table 4-4 Airport Coordinate of Control Survey Points

	UTM Coordinates		HSIA Airport Coordinates	
ID	**x**	**y**	**X**	**Y**
A-1	235865.368	2638005.710	5205.774	1000.000
A-2	234022.586	2640628.903	2000.000	1000.000
A-3	236418.219	2638175.531	5384.611	1550.001
A-4	234297.016	2641195.054	1694.424	1550.000

Source: JICA Study Team



	UTM		Airport Coordinate	
	x	y	X	Y
A-1	235865,368	2638005,710	5205,774	1000,000
A-2	234022,586	2640628,903	2000,000	1000,000
A-3	236418.219	2638175.531	5384.611	1550.001
A-4	234297,016	2641195,054	1694,424	1550,000

Source: JICA Study Team

Figure 4-5 New Airport Coordinate System Based on the Result of the Control Survey

(2) Conversion Formula

Based on the result of the control survey, the relationship between the UTM coordinates and the airport coordinates was clarified, and the conversion formula using Helmert Transformation was created. The general formula for Helmert Transformation is shown as:

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} a & b \\ -b & a \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} c \\ d \end{pmatrix} \quad \ldots (1)$$

In this formula, (X, Y) are the coordinates after transformation, (x, y) are the coordinates before transformation, and a, b, c, and d are transformation parameters. In this study (X, Y) are the HSIA airport coordinates, and (x, y) are the UTM coordinates.

The transformation parameters for the airport coordinates can be determined by the least squares method when more than three samples of the UTM coordinates are available. In this study, the transformation parameters are determined from the coordinates shown in Table 4-4.

$$\left.\begin{aligned} a &= 0.574836 \\ b &= 0.818280 \\ c &= 2028248.968 \\ d &= -1708425.771 \end{aligned}\right\} \ldots (2)$$

Therefore, the conversion formula from the UTM coordinates to the airport coordinates in this study is as follows:

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} 0.574836 & 0.818280 \\ -0.818280 & 0.574836 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} 2028248.968 \\ -1708425.771 \end{pmatrix} \quad \ldots (3)$$

Furthermore, the scale factor “s” and rotation degree “κ” in this study are shown as follows:

$$\left.\begin{aligned} s &= \sqrt{a^2 + b^2} = 1.000 \\ \kappa &= \tan^{-1}\frac{-b}{a} = 0.95840\ [rad] \\ &= 54.912\ [\mathrm{deg}] \end{aligned}\right\} \ldots (4)$$

(3) Topographic Map Based on Airport Coordinate System

Based on the conversion formula mentioned in the (2) above, the existing UTM coordinates of the topographic map were converted. The topographic map based on the new airport coordinate system is shown in Annex 1-1 and Annex 1-2.

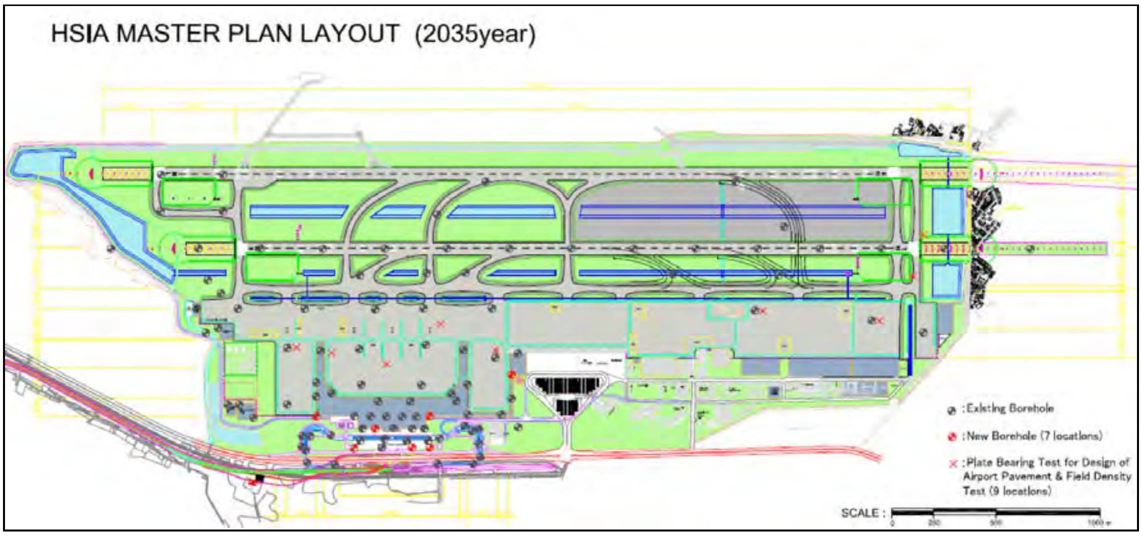
4.4.2 Geotechnical Investigation

(1) Outline of the Geotechnical Investigation

As mentioned in Section 4.2.2, the compilation and analysis of the past geotechnical investigation data were insufficient. Therefore, further data analysis was conducted in this study based on the classification of soil stratification. The data has been analysed for each location within the scope of phase-1 development, including the Terminal 3 area, the access road and car parking area, the new apron area, and the new taxiway area (the new southern rapid exit taxiway, the new northern rapid exit taxiway, and the new connection taxiway).

In addition, the results of the geotechnical investigation for points newly conducted in this study were also compiled in the same way.

The locations of the existing and new geotechnical surveys are shown in Figure 4-6.



Source: JICA Study Team

Figure 4-6 Location of Existing Survey and New Survey

(2) Soil Stratification

Soil stratification was reviewed and classified into eight layers, namely, clayey soil layer (C-1, C-2, C-3, and C-4) and sandy soil layer (S-1, S-2, S-3, and S-4), based on soil type and N-values as shown in Table 4-5.

Table 4-5 Soil Stratification

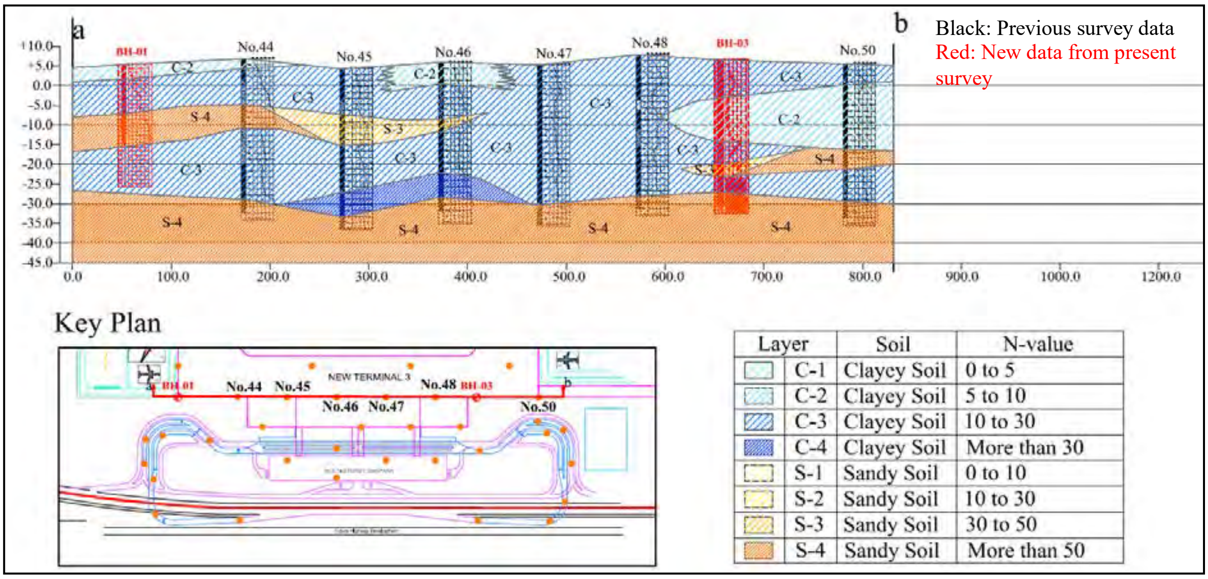
Layer	Soil	N-value	Relative Density or Consistency	Distribution
C-1	Clayey Soil	0～5	Very Soft to Soft	Very soft to soft clayey soil layer of the project area. C-1 layers are found in only a few locations in the project area. C-1 layer appears only near the ground surface level.
C-2		5～10	Medium Stiff	Medium stiff clayey soil layer distributed mainly at the shallow levels. C-2 layers are found mainly in airside boreholes rather than landside.
C-3		10～30	Stiff to Very Stiff	Stiff to very stiff clayey soil layer distributed widely from the surface to deeper levels. The soils in the present project area are mainly composed of C-3 layers.
C-4		Over 30	Hard	Hard clayey soil layer distributed mainly at deep levels around C-3 and S-4 layers.
S-1	Sandy Soil	0～10	Very Loose to Loose	Very loose to loose sandy soil layer. S-1 layers are found in only a few locations in the project area. S-1 layers appear only near the ground surface level.
S-2		10～30	Medium Dense	Medium dense sandy soil layer. S-2 layers are found in only a few locations in the project area. S-2 layer is not found at deeper levels.
S-3		30～50	Dense	Dense sandy soil layer distributed mainly at a depth of 0 ~ -30 m from the ground level.
S-4		Over 50	Very Dense	Very dense soil layer. S-4 is widely distributed at deeper levels with depth of around -30 m.

Source: JICA Study Team

(3) New Terminal 3

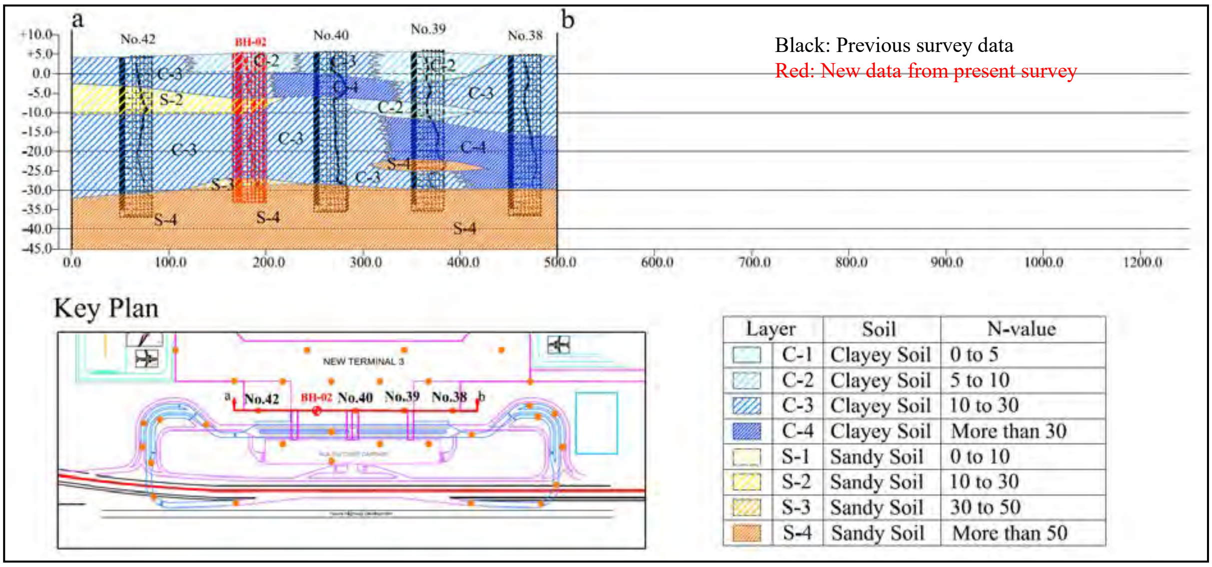
1) Soil Profile

The soil profile of Terminal 3 is shown in Figure 4-7 and Figure 4-8.



Source: JICA Study Team

Figure 4-7 Soil Profile (New Terminal 3) (1)



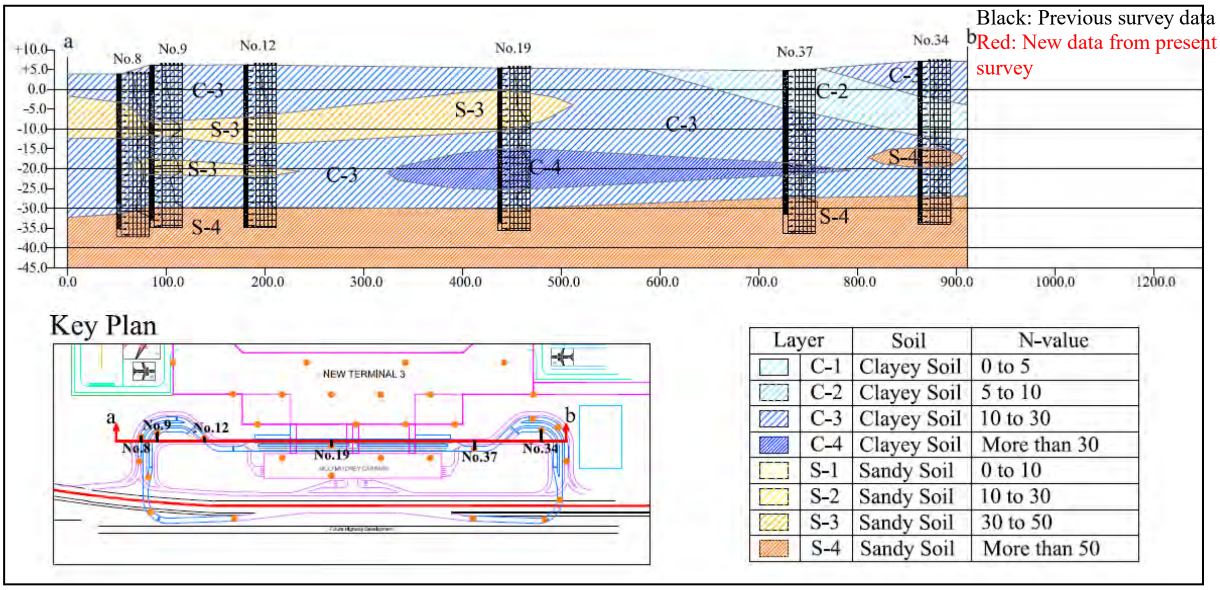
Source: JICA Study Team

Figure 4-8 Soil Profile (New Terminal 3) (2)

Terminal 3 is planned with pile foundations. In the pile foundations for this building, the support layer can be either the clayey soil layer with N-value over 30 or the sandy soil layer with N-value over 50. Therefore, either Layer C-4 or Layer S-4 is appropriate for the support layer. C-4 is intermittent under Terminal 3 while S-4 is uniformly distributed at a depth of approximately 30 m below ground level. In general, S-4 should be selected as the support layer for the pile foundations.

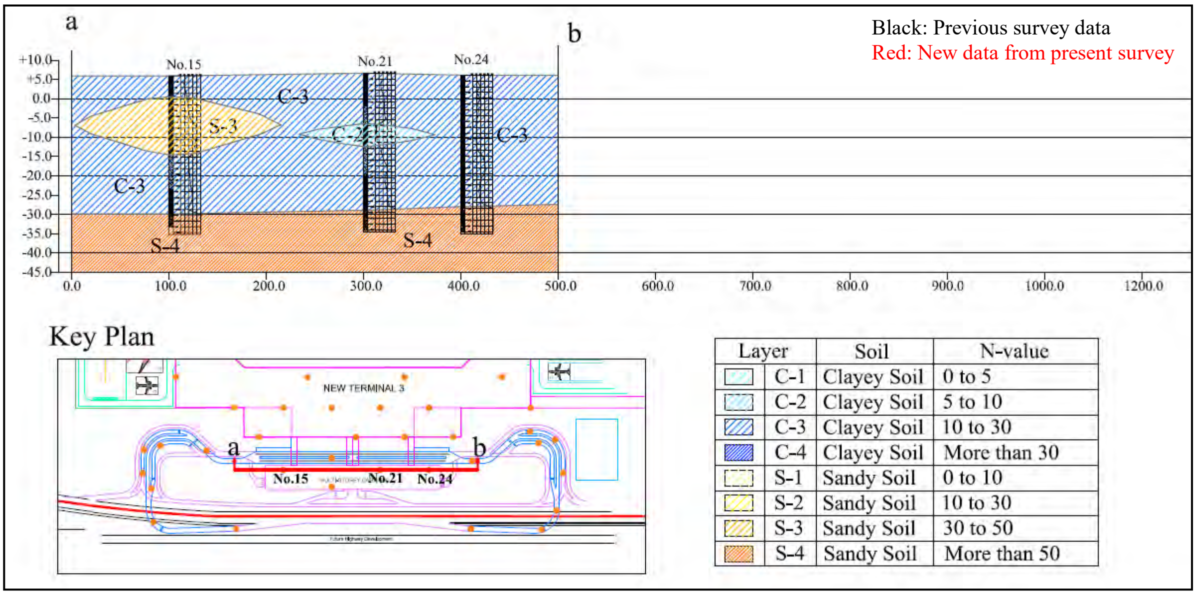
(4) Access Road and Car Parking Area

The soil profiles under the elevated access road and multi-storied car park are shown in Figure 4-9, Figure 4-10 and Figure 4-11, respectively.



Source: JICA Study Team

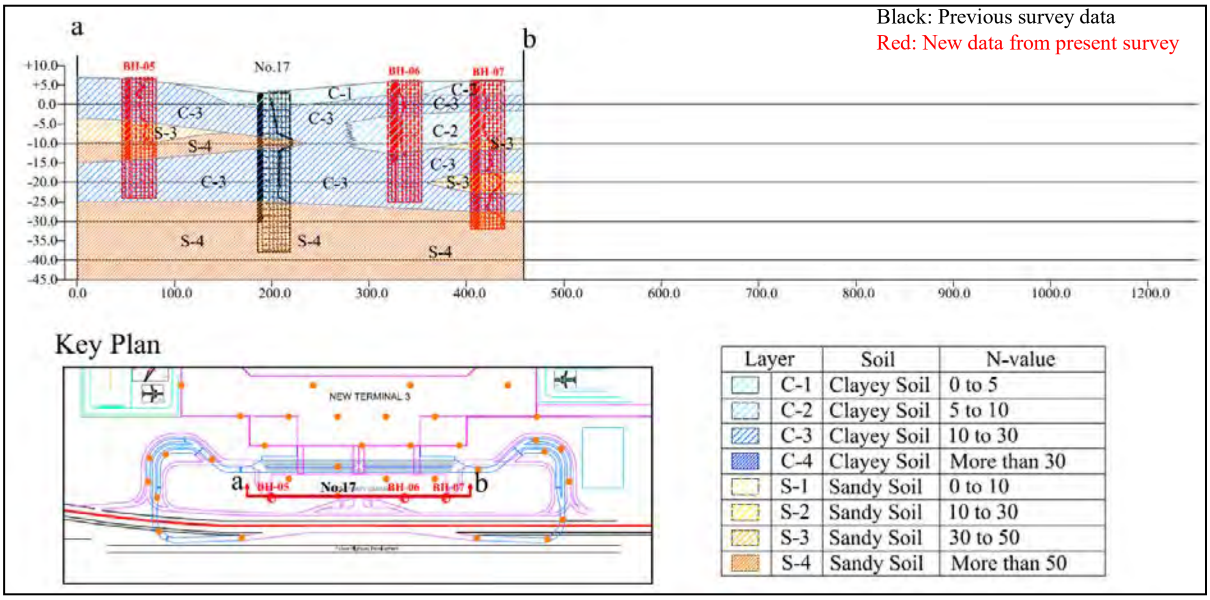
Figure 4-9 Soil Profile (Elevated Access Road)



Layer	Soil	N-value
C-1	Clayey Soil	0 to 5
C-2	Clayey Soil	5 to 10
C-3	Clayey Soil	10 to 30
C-4	Clayey Soil	More than 30
S-1	Sandy Soil	0 to 10
S-2	Sandy Soil	10 to 30
S-3	Sandy Soil	30 to 50
S-4	Sandy Soil	More than 50

Source: JICA Study Team

Figure 4-10 Soil Profile (Multi-storied Car Park) (1)



Layer	Soil	N-value
C-1	Clayey Soil	0 to 5
C-2	Clayey Soil	5 to 10
C-3	Clayey Soil	10 to 30
C-4	Clayey Soil	More than 30
S-1	Sandy Soil	0 to 10
S-2	Sandy Soil	10 to 30
S-3	Sandy Soil	30 to 50
S-4	Sandy Soil	More than 50

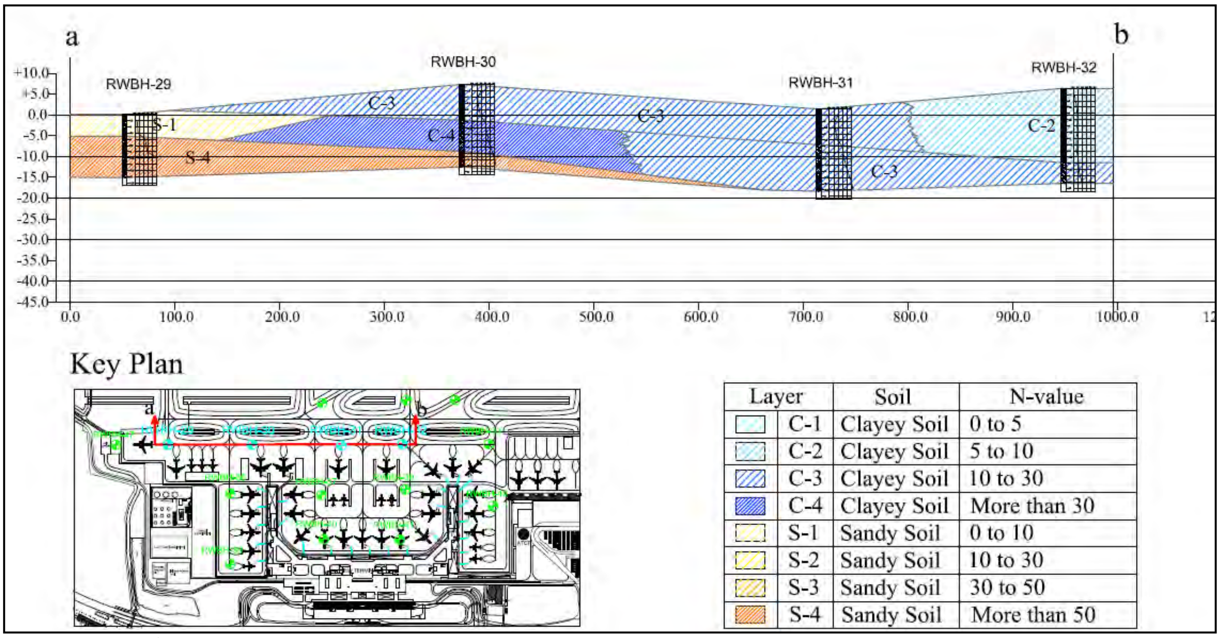
Source: JICA Study Team

Figure 4-11 Soil Profile (Multi-storied Car Park) (2)

Pile foundations are also planned for the elevated access road and multi-storied car park in this area. As with Terminal 3 area, C-4 and S-4 layers are appropriate as the support layer for the piles. Based on the distribution under each structure, S-4 layer should be selected as the support layer for the pile foundations.

(5) New Apron Area

The soil profile of the new apron is shown in Figure 4-12.



Layer	Soil	N-value
C-1	Clayey Soil	0 to 5
C-2	Clayey Soil	5 to 10
C-3	Clayey Soil	10 to 30
C-4	Clayey Soil	More than 30
S-1	Sandy Soil	0 to 10
S-2	Sandy Soil	10 to 30
S-3	Sandy Soil	30 to 50
S-4	Sandy Soil	More than 50

Source: JICA Study Team

Figure 4-12 Soil Profile (New Apron)

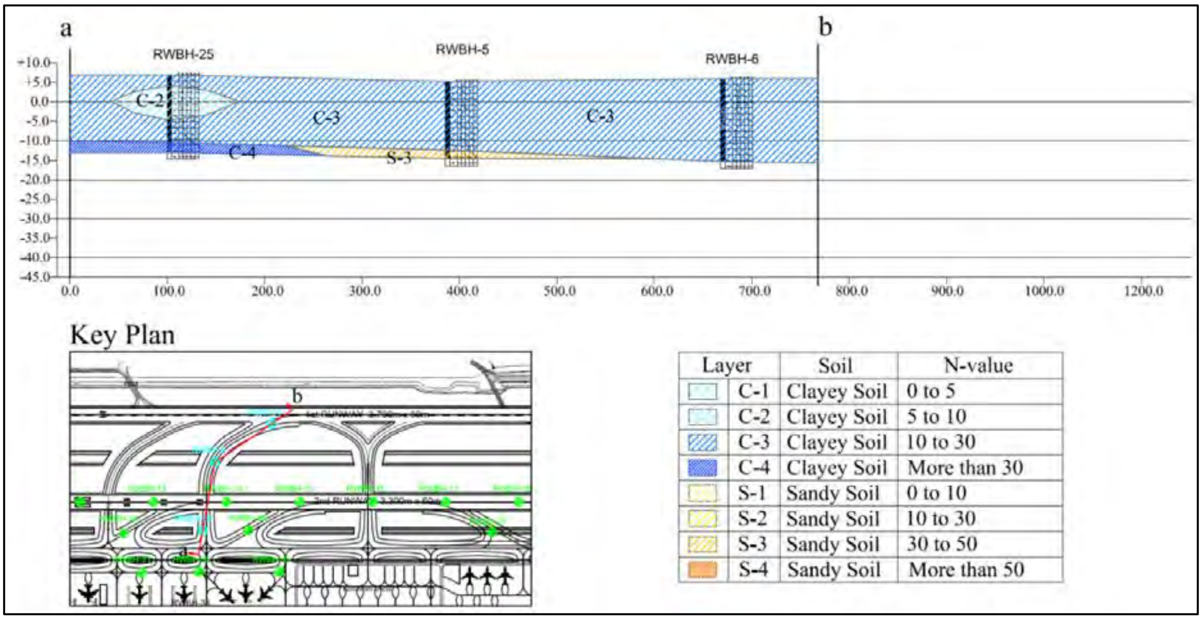
There are relatively large-scale C-2 layers at some locations of the new apron area. The analysis of settlement regarding the apron pavement structure is needed at these locations.

In the new apron area, S-1 layer is found (RWBH-29). Since loose sand layer may cause liquefaction during earthquakes, the analysis for liquefaction is needed at this area.

The results for K75 value in the plate bearing tests show large variations at each location. This is mainly caused by ground conditions such as current usage of land and construction methods in the past, which are different in each location because the tested locations have been used for some purpose for the current operation of the airport.

(6) New Southern Rapid Exit Taxiway

The soil profile for the new southern rapid exit taxiway is shown in Figure 4.13.



Source: JICA Study Team

Figure 4-13 Soil Profile (Southern New Rapid Exit Taxiway)

The C-2 layers are found at some locations of the taxiway area like the new apron area. The analysis for settlement regarding pavement structure is needed at these locations.

As for connection taxiway, the detailed data of the geotechnical investigation done by BUET should be acquired and utilized for the pavement design, considering how to utilize these data for the design.

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Chapter 5 Aviation Traffic Forecast

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Chapter 5 AVIATION TRAFFIC FORECAST

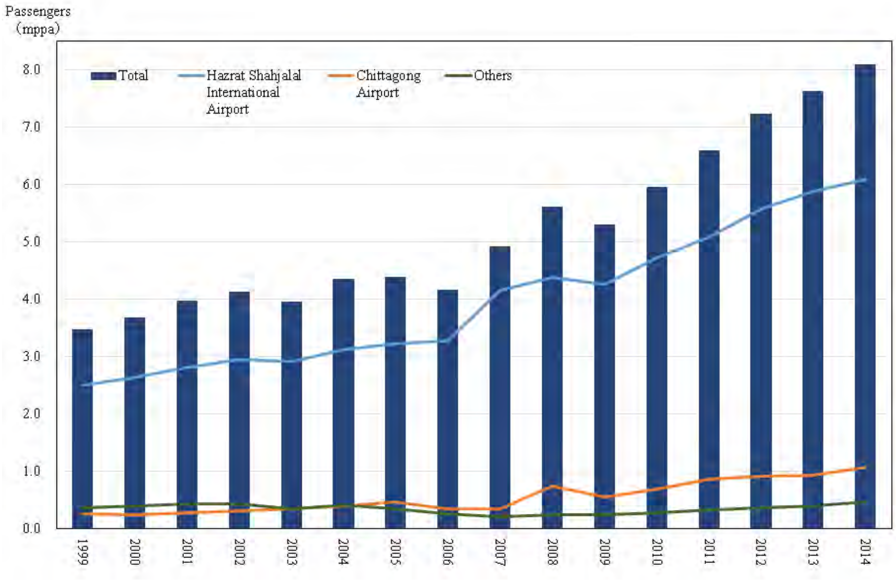
5.1 Aviation Demand in Bangladesh

HSIA handles approximately 75% of the total passenger demand and 90% of the total cargo demand in Bangladesh. Local airports such as Chittagong, Cox's Bazar, Jessore, and Sylhet handle the remaining demand. The passenger handling volume in 2014 at HSIA was approximately 6 million passengers per annum (mppa) and Chittagong Airport was second with approximately 1 mppa. The other airports handle much fewer passengers with annual passenger handling of less than 0.2 mppa each.

The annual average growth rate of the real GDP of Bangladesh has shown steady growth of 6% after 2004, achieving 6.85% in 2006. The rate in 2007-2008 decreased slightly and dropped to 5.3% in 2009 due to the financial crisis starting in September 2008. However, it recovered after 2010 and has maintained a growth rate of 6% or more.

The number of air passengers for Bangladesh as a whole and HSIA both increased in 2007 and 2008, but declined by approximately 300,000 passengers and 100,000 passengers, respectively, in 2009 due to the financial crisis. However, it has continued to grow by 6% after 2010 in step with economic growth.

Furthermore, although the annual average growth rate of passengers from 1999 to 2015 at HSIA was 6.17%, the growth rate after 2006 has increased to 7.88%, showing a prominent increase in demand in recent years.



Source: Statistical Year Book of Bangladesh 2014 and CAAB and JICA Study Team

Figure 5-1 Growth of Air Traffic Passenger Traffic in Bangladesh

In HSIA, the international passenger ratio was 77.2% in 1999, but the ratio has increased in recent years and international passenger has come to occupy approximately 90% of all passengers after 2011.

Domestic passenger numbers at HSIA have not seen major change from 1999 to 2009; while 0.7 mppa nationwide was recorded in 2007, it maintained approximately 0.6 mppa during this period, reducing to 0.52 mppa at its lowest in 2010. However, demand is now recovering after 2010 and the annual average growth rate from 2010 to 2015 was 5.84%.

5.2 Passenger Demand

The results of the passenger traffic forecast conducted by this study compared with the CAAB Master Plan forecast are shown in Table 5-1. The passenger numbers for high /low cases are derived by adjusting the GDP growth rate for base case by ±1.24% and forecasting the passenger demand numbers for each growth rate.

- The actual international passenger numbers for 2015 were approximately 5.6 mppa, but the CAAB Master Plan has assumed 6 million. Therefore, the CAAB forecast starts from a slightly inflated figure.
- The domestic passenger demand has previously trended from 10% to 15% of the international passengers, but the ratio has increased after 2010 and the domestic passenger numbers are expected to show further increase in the future. Based on the results of the forecast, the domestic passengers are expected to reach almost 5.2 mppa in 2035, approximately 20% of international passengers. This is a large revision of the CAAB Master Plan forecast.
- The combined demand for international and domestic passengers does show a large difference between the JICA Study Team and CAAB forecasts, but the differences can be explained by the following reasons:
- CAAB's forecast is based on aviation traffic demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- CAAB's forecast assumes GDP growth, which has a strong influence on aviation traffic demand, of 7% for 2015-2025, 6% for 2025-2030 and 5% for 2030-2035. In contrast, the JICA Study Team has assumed slightly lower GDP growth of 6.67% for 2013-2021, 6% for 2021-2025, 5.5% for 2025-2030, and 5% for 2030-2035, based on the latest data/forecast by IMF published in April 2016.

Table 5-1 Comparison of Passenger Demand Forecast (Million Passengers)

Category	Year	JICA Study Team			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Passenger	2015	5.569	5.569	5.569	6.120	5.997	5.875
	2020	9.252	8.669	8.112	9.312	8.671	8.069
	2025	13.662	12.042	10.583	14.206	12.564	11.100
	2030	19.366	16.082	13.295	20.623	17.313	14.513
	2035	26.611	20.835	16.214	28.451	22.659	18.012
	CAGR (2015-2035)		6.82%			6.87%	
Domestic Passenger	2015	0.913	0.913	0.913	0.691	0.685	0.679
	2020	1,493	1.379	1.270	0.820	0.796	0.773
	2025	2.410	2.086	1.793	0.974	0.926	0.881
	2030	3.632	2.959	2.388	1.134	1.056	0.983
	2035	5.226	4.017	3.050	1.294	1.179	1.073
	CAGR (2015-2035)		7.69%			2.75%	
Total	2015	6.482	6.482	6.482	6.811	6.682	6.554
	2020	10.745	10.047	9.382	10.132	9.467	8.842
	2025	16.072	14.127	12.376	15.180	13.490	11.981
	2030	22.997	19.041	15.683	21.746	23.838	19.085
	2035	31.837	24.852	19.264	29.746	23.838	19.085
	CAGR (2015-2035)		6.95%			6.57%	

Source: JICA Study Team

Note: CAGR: Compound Average Growth Rate; the mathematical average for the indicated period

5.3 Cargo Demand

Based on the actual numbers for international cargo, the cargo demand has shown a steady increase and a stable demand for cargo services can be assumed. However, the domestic cargo demand is very small and unstable compared with international cargo demand, having less than 1% of the volume and exhibiting violent fluctuations in demand. The combined cargo volume of international and domestic cargo for 2015 was approximately 260 thousand tons.

The following observations are made based on the comparison with the CAAB forecast:

- As shown in Table 5-2, the volumes for international cargo for 2015 in the JICA Study Team's and CAAB's forecasts are almost the same, but the growth rate afterwards is greater in the JICA Study Team forecast.
- The actual domestic cargo volume for 2015 is recorded at 1,900 tons, substantially larger than the 760 tons forecast by the CAAB Master Plan.
- The difference between the JICA Study Team and CAAB's forecasts for cargo volumes is due to the following reasons:
- The CAAB Master Plan is based on cargo demand data up to 2013, but the JICA Study Team was able to utilize data up to 2015.
- The growth in cargo volumes after 2010 is large and since the JICA Survey Team utilized the available data up to 2015 to build its forecasting model, the regression formula with the growth rate higher than that of CAAB model was derived.

Table 5-2 Comparison of Cargo Demand Forecast (tons)

Category	Year	JICA Study Team			CAAB Master Plan		
		High Case	Base Case	Low Case	High Case	Base Case	Low Case
International Cargo	2015	258,010	258,010	258,010	261,000	257,000	254,000
	2020	449,790	418,152	387,953	350,000	333,000	317,000
	2025	689,105	601,172	522,012	472,000	433,000	396,000
	2030	998,588	820,411	669,181	615.000	543,000	479,000
	2035	1,391,731	1,078,310	827,570	773,000	662,000	479,000
	CAGR (2015-2035)		7.41%			4.84%	
Domestic Cargo	2015	1,888	1,888	1,888	770	760	750
	2020	3,732	3,447	3,174	950	900	860
	2025	7,231	6,257	5,380	1,170	1,070	980
	2030	12,710	10,357	8,359	1,380	1,220	1,070
	2035	20,902	16,068	12,201	1,550	1,360	1,120
	CAGR (2015-2035)		11.3%			2.95%	
Total	2015	259,898	259,898	259,898	261,770	257,760	254,750
	2020	453,523	421,599	391,127	350,950	333,900	317,860
	2025	696,336	607,429	527,392	473,170	434,070	396,980
	2030	1,011,299	830,768	677,539	616,380	544,220	480,070
	2035	1,412,633	1,094,378	839,771	774,550	663,360	559,120
	CAGR (2015-2035)		7.45%			4.84%	

Source: JICA Study Team

5.4 Aircraft Movement

The number of aircraft movement between 2011 and 2015 showed a marked increase from 56,000 to 57,000 movements annually in 2010 and 2011 to 73,000 movements annually for 2015.

The general aviation (GA) (sightseeing flights and training flights, aircraft owned by private companies and individuals) and military aircraft accounted for 5,000 to 7,000 movements annually with little variation. The records separately obtained from ATC for 2015 showing monthly movements of aircraft by category showed that GA and military aircraft movements are stable at around 200 and 430 movements per month, respectively.

The forecast for aircraft movements is calculated based on the passenger numbers forecast by the JICA Study Team and formulating an aircraft mix and the average numbers of passengers on each craft (load factor).

Based on this analysis, when the aircraft movements are determined using the aircraft mix and passenger forecast, movements reached approximately 17.1 million in 2030. The JICA Study Team forecast exceeds the CAAB forecast by approximately 10%. This was caused by assuming a lower number of passengers on each flight due to the small upsizing of the aircraft compared with the CAAB Master Plan.

Table 5-3 Comparison of Aircraft Movement Forecast (Including GA and Military Craft)

Year	JICA Study Team			CAAB Master Plan		
	High	Base	Low	High	Base	Low
2015	73,235	73,235	73,235	70,400	69,400	68,500
2020	118,556	110,830	103,455	94,400	89,600	85,300
2025	165,430	145,460	127,483	129,100	117,700	101,400
2030	206,196	171,130	141,367	172,000	150,000	131,300
2035	264,178	206,900	161,077	222,100	185,000	154,900

Source: JICA Study Team

In addition, the JICA Study Team conducted a forecast for freighter aircraft movements. Freighter aircrafts are not used for domestic cargo in Bangladesh and are carried as belly cargo on passenger flights (permissible cargo on passenger flights). Domestic cargo volume will continue to be extremely low compared with international cargo even in 2035, accounting for only 1.5% of total volume. Since domestic cargo will continue to be carried as belly cargo in the future, the aircraft movement forecast for cargo was based on international cargo volume using freighter. The forecast for the base case is shown in Table 5-4.

Table 5-4 Freighter Aircraft Movement Forecast

	2015	2020	2025	2030	2035
Freighter	1,248	2,023	2,908	3,969	5,216

Source: JICA Study Team

5.5 Peak Hour Traffic

Based on the statistical data of HSIA, the numbers of passengers and aircraft movements during peak hour in the traffic demand base case were calculated. The aircraft movement numbers are exclusive of GA and military aircraft.

Table 5-5 Passengers and Aircraft Movements during Peak Hour and Peak Day (Base Case)

			2015		2020		2025		2030		2035	
			Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic
Passenger (mppa)		International/ Domestic	5.569	0.913	8.669	1.379	12.042	2.086	16.082	2.959	20.835	4.017
		Total	6.482		10.047		14.127		19.041		24.852	
A/C Movement		Internationa l/Domestic	37,192	32,212	56,289	47,540	75,260	63,200	96,880	67,250	121,133	78,767
		Total	69,404		103,830		138,460		164,130		199,900	
Average Daily Flight			102	89	155	131	207	174	266	185	332	216
Passengers	Peak Day Ratio (Terminal Building)		1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300
	PAX at Peak Day	International /Domestic	18,563	3,043	28,895	4,596	40,138	6,952	53,607	9,863	69,450	13,390
		Total	21,607		33,491		47,091		63,470		82,840	
	Peak Hour Ratio		0.1225	0.138	0.1196	0.1145	0.1182	0.102	0.1173	0.0997	0.1166	0.0946
	PAX at Peak Hour	International/ Domestic	2,273	402	3,456	526	4,744	709	6,285	984	8,098	1,267
		Total	2,694		3,982		5,453		7,269		9,365	
A/C Movement	Peak Day Ratio (Apron and Utilities)		1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330	1/330
	Peak Day Flight	International/ Domestic	113	98	171	144	228	192	294	204	367	239
		Total	210		315		420		497		606	
	Peak Hour Ratio		0.1233	0.1305	0.1202	0.1099	0.1186	0.0985	0.1176	0.0964	0.1169	0.0917
	Peak Hour Flight	International/ Domestic	14	13	21	16	28	19	35	20	43	22
		Total	27		37		47		55		65	
A/C Movement (Freighter)			1,248		2,023		2,908		3,969		5,216	
Peak Day Flight (Freighter)			4		6		9		12		16	

Source: JICA Study Team

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CHAPTER 6 REVIEW OF THE HSIA EXPANSION PROJECT IN CAAB MASTERPLAN

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Chapter 6 REVIEW OF THE HSIA EXPANSION PROJECT IN CAAB MASTERPLAN

6.1 General

In this chapter, information of the study, planning, and design works done by CAAB is organized. The results of the review of each item are described in Table 6-1.

Table 6-1 HSIA Expansion Project Made by CAAB

No	Title	Table of Contents	Date	Format	Remarks
1	MASTER PLAN AND FEASIBILITY STUDY	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Land Use Plan 6. Environmental Screening 7. Economic Analysis	February 2015	PPT	"5. Phased Development Plan" and "9. Financial Analysis" are not in this version.
2	MASTER PLAN REPORT	Executive Summary 1. Introduction 2. Overview of the Existing Airport 3. Aviation Demand Forecast 4. Conceptual Design 5. Phased Development Plan 6. Land Use Plan 7. Environmental Screening 8. Economic Analysis 9. Financial Analysis	June 2015	PPT	The latest version of the Master Plan Report
3	FEASIBILITY STUDY REPORT	1. Economic Analysis 2. Financial Analysis	June, 2015	PPT	Chapter 8 and 9 of No. 2
4	BASIC DESIGN REPORT (TERMINAL and LANDSIDE)	01 Project Background and Brief Description 02 Chapter: I Terminal Planning and Design 03 Chapter: II Structural: Terminal Buildings 04 Chapter: III Structural: Elevated Drive Way (EDW) 05 Chapter: IV Plumbing 06 Chapter: V Heating and Ventilation and Air Conditioning System	No information	PDF Report	The design report of Terminal 3, EDW, new VVIP, new domestic terminal and other infrastructures.
5	BASIC DESIGN REPORT VOL. 1 Airside	Chapter I. Introduction Chapter II. Executive Summary of Master Plan and Feasibility Study Chapter III. Design of Civil Works Chapter IV. Design of NavAids and AGL System	June 2015	PPT	The civil works, navigational aids, and AGL system
6	TENDER DOCUMENT	Section - 1 Instruction to Tenderers (ITT) Section - 2 Tender Data Sheet (TDS) Section - 3 General Condition of Contract (GCC) Section - 4 Particular Conditions of Contract (PCC) Section - 5 Tender and Contract Forms Section - 6 Bill of Quantities Section - 7 1 General Items 2 Preliminaries 3 Earth and Pavement Works 4 Concrete and Reinforcement 5 Sealing 6 Marking 7 Airfield Ground Lighting System and Navigation Aid 8 Drainage and Protective Works 9 Civil Works 10 Plumbing and Sanitary Works 11 Electrical Works 12 Substation Equipment 13 Diesel Generator 14 Installation of Passenger Lifts 15 Fire Protection Works. 16 Air Conditioning System 17 Installation of Deep Tube Well 18 Gas Connection System 19 Communication and CCTV 20 Steel Truss 21 Wastewater Treatment Plant 22 Siphonic Drainage System 23 Cargo Terminal 24 Intake Power Station 25 Pump House and Out Station 26 Landscaping / Particular 26 Specification / Drawings	June 2015	Word PDF CAD	

Source: JICA Study Team

6.2 Master Plan and Feasibility Study

The CAAB conducted the “Master Plan and Feasibility Study, Construction of Second Runway and Other Infrastructure Development Works at Hazrat Shahjalal International Airport” for the Dhaka International Airport Expansion Project in February 2015. Thereafter, the study was updated in June 2015. In the updated study report, the phased development plan has been proposed. According to the phased development plan, the second runway will not be constructed under the phase-1 development (completion in 2019), but will be constructed under the phase-2 development. The completion year of phase-2 is not mentioned in the report.

The consultant who executed this study was the JV of Yooshin (Korea), CPG (Singapore), and DDC (Bangladesh).

6.2.1 Summary of Master Plan and Feasibility Study

The indexes of the reports for the master plan and feasibility study (February 2015 version and June 2015 version) are shown in Table 6-2 and Table 6-3, respectively.

Table 6-2 Contents of the Report (February 2015 Version)

Chapter	Contents
Master Plan and Feasibility Study	
1.	Introduction
2.	Overview of the Existing Airport
3.	Aviation Demand Forecast
4.	Conceptual Design
5.	Land Use Plan
6.	Environmental Screening
7.	Economic Analysis
Feasibility Study (Separate Volume)	
1.	Economic Analysis
2.	Financial Analysis

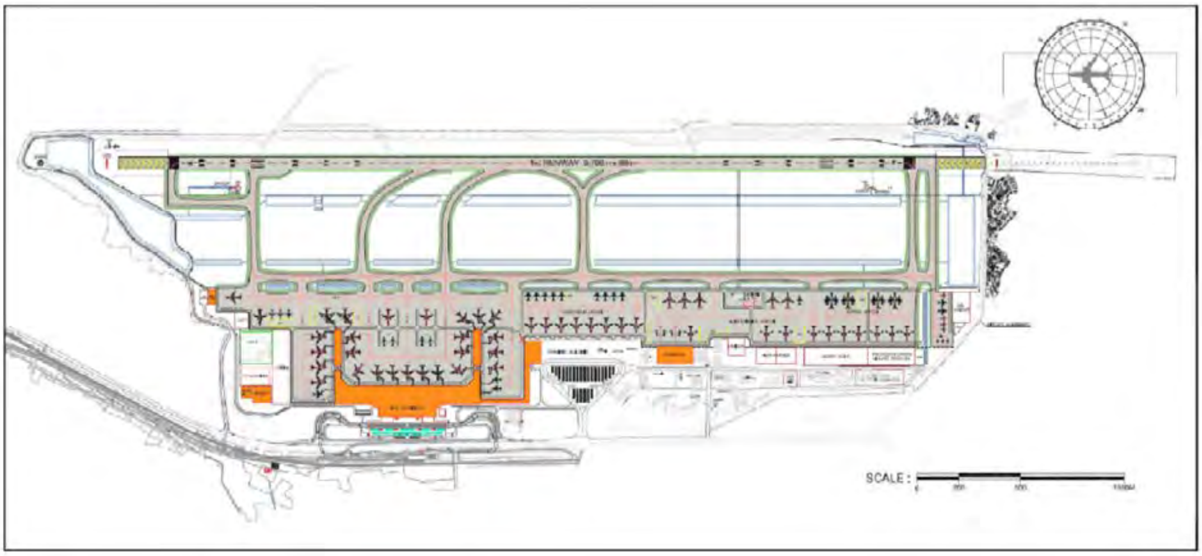
Source: CAAB

Table 6-3 Contents of the Report (June 2015 Version)

Chapter	Contents
1.	Introduction
2.	Overview of the Existing Airport
3.	Aviation Demand Forecast
4.	Conceptual Design
5.	Phased Development Plan
6.	Land Use Plan
7.	Environmental Screening
8.	Economic Analysis
9.	Financial Analysis

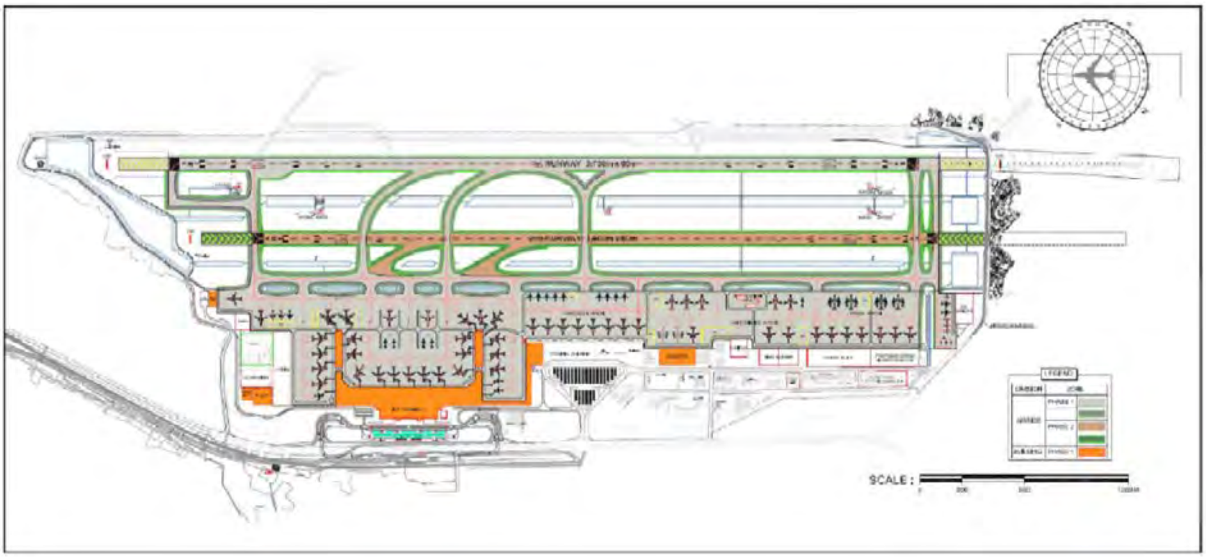
Source: CAAB

The scope of the expansion project based on the report (June 2015 version) is shown in Table 6-3, and the layout plans are shown in Figure 6-1 and Figure 6-2.



Source: CAAB

Figure 6-1 Master Plan Layout (Phase-1, Completion in 2019)



Source: CAAB

Figure 6-2 Master Plan Layout (Phase-2)

Table 6-4 Scope of the HSIA Expansion Project by CAAB

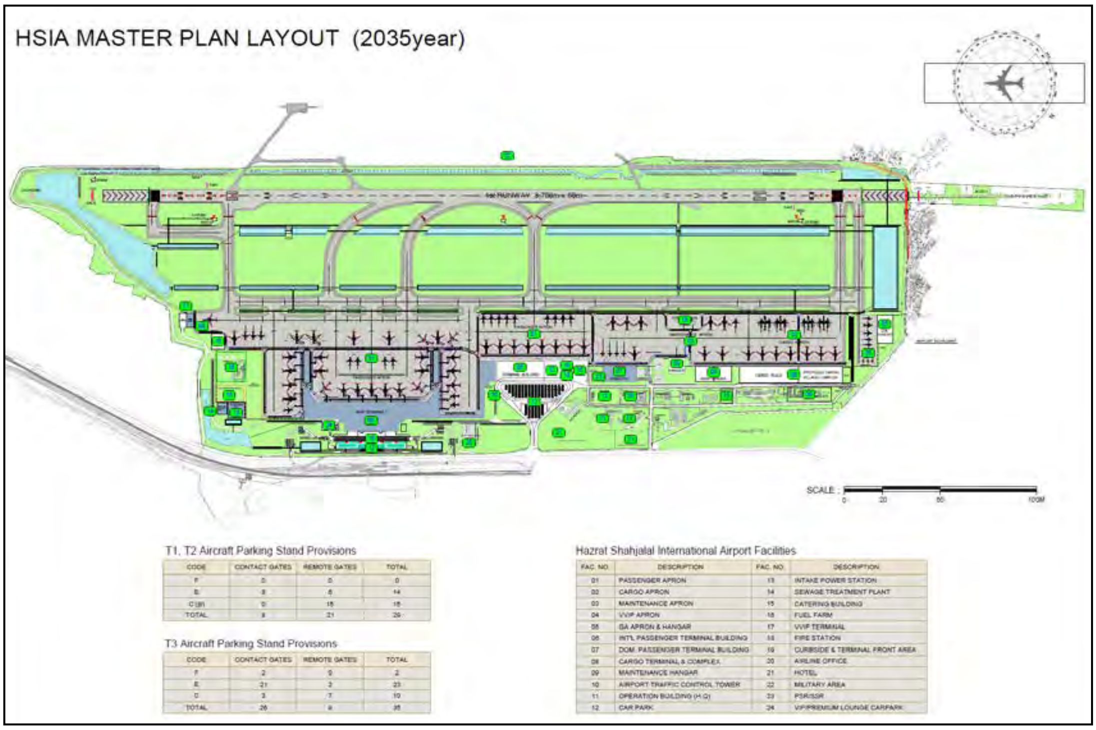
Facilities	Contents	Remarks
Existing Runway	Extension and Widening 3,200 x 46 m → 3,692 x 60 m	
New Runway	3,292 x 60 m	For dependent operation
New Taxiway	Rapid exit taxiways and other taxiways	
Access Road	New construction for new Terminal 3 Improvement for existing Terminal 1 and Terminal 2 and new domestic terminal	
Apron	Expansion and reconstruction area: around 1,000,000 m^2 Apron Spot: 29 → 64	
Terminal 3	Around 260,000 m^2	
New Domestic Terminal	Around 15,000 m^2	1.4 mppa
Existing Terminal 1 and Terminal 2	Following renovations: Check-in counter no.: 56 → 84 Gate no.: 15 → 20 Increase number of arrival immigration counter	
Navigation Aids	Upgrade of ILS from CAT-I to CAT-II New installation of AWOS Relocation of PSR/SSR	
Support Facilities	Relocation, expansion, and/or new construction of the following facilities: VVIP Complex, Rescue and firefighting services (RFFS), Sewage treatment plant, Intake power plant, PSR/SSR, ATC tower, Maintenance hangar, Catering building, Cargo complex, and GA apron and hangar	The locations of the support facilities are shown in Figure 6-3.

Source: CAAB

Source: CAAB

Figure 6-3 Support Facilities

While the second runway will be constructed by 2035 according to the report, the JICA Study Team has obtained the information from CAAB that the construction of the second runway was excluded entirely in this project. The JICA Study Team has received a separate master plan layout (Figure 6-4) concurring with this information, in which the second runway will not be constructed by 2035.



Source: CAAB

Figure 6-4 Future Master Plan Layout Without Construction of the Second Runway

6.2.2 Master Plan Report (June 2015 version)

(1) Introduction

The capital airport of HSIA is the air gateway to Bangladesh, but it is insufficient to handle the growing air traffic demand. In order to realize its role as the major international gateway airport, the development plan was formulated for the airport. This master plan describes the framework for the development of HSIA up to 2035. The master plan process commenced with a review of the existing facilities and the forecast of future traffic demand.

(2) Existing Facilities

The airport has a single runway (14/32), 46 m wide and 3,200 m long, with taxiways provided parallel to the runway and a number of runway exits. The length of the runway is insufficient for long-haul flights of large aircraft and the capacity of the single runway would be reached within the master plan framework period.

The existing passenger apron stands are 24 and there are aprons for VVIP, cargo, maintenance, and general aviation. During peak hour, congestion is observed in the contact gates for Code E aircrafts.

The HSIA was designed on a linear terminal configuration with frontal aircraft stands layout. The PTBs, consisting of two connected 2-level terminals, Terminal 1 and Terminal 2, for international operations and a smaller single-level domestic terminal, have a combined design capacity of around 7-8 mppa. The airport is currently handling passenger traffic of about 6.5 mppa with 85% being international passengers.

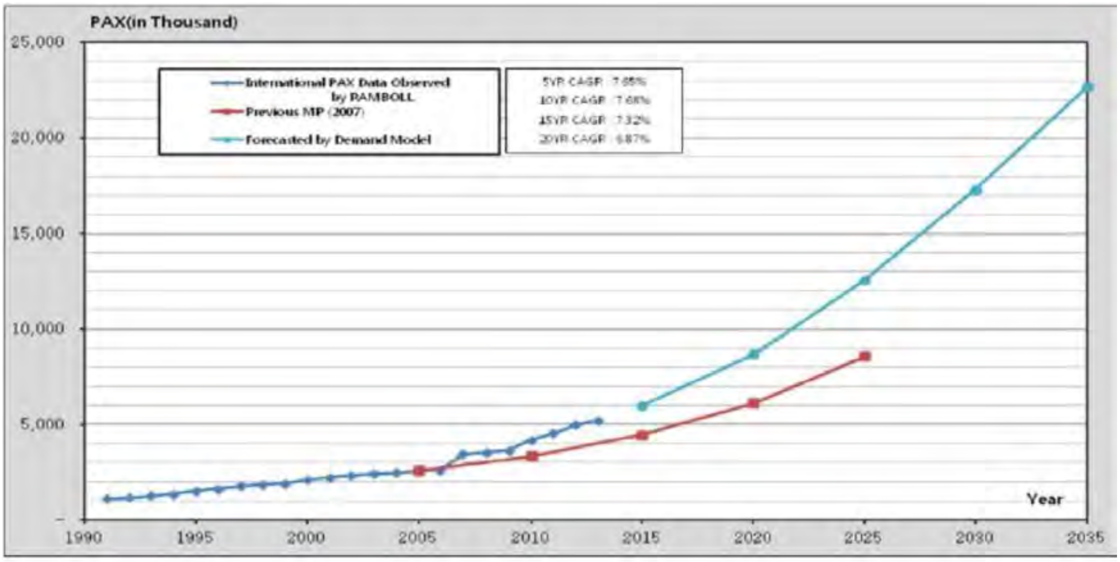
One acute problem is the congestion during the peak hours on the New Airport Road leading to the airport. Severe traffic jams are a daily occurrence especially at the roundabout access to the airport. Space for car parking will also be facing severe shortage in the near future due to the increase in passenger volumes.

For the navigational aids (NavAids) and AGL facilities at HSIA, precision approaches are available up to the end of Runway 14. The CAAB has recently taken up the initiative of upgrading the existing ILS to Category II.

Related facilities like utilities (water supply, sewage, and electricity) are provided for the existing facilities; however, the installation a new system for Terminal 3 will be required.

(3) Air Traffic Demand Forecast

Based on a review of economic drivers, the unconstrained forecast of demand is shown in Figure 6-5. The growth rate is expected to be 6.9% per annum, while the previous master plan expects a growth rate of 6.2% per annum.



Source: CAAB

Figure 6-5 Air Traffic Demand Forecast

Table 6-5 shows the passenger forecast (international and domestic) based on the model with GDP growth scenario for twenty years up to 2035.

Table 6-5 Passenger Forecast

(Unit: thousands)

	2015	2020	2025	2030	2035
International	5,997	8,671	12,564	17,313	22,659
Domestic	685	796	926	1,056	1,179
Total	6,682	9,467	13,490	18,369	23,838

Source: CAAB

The number of annual operations has been calculated by considering the annual demand, aircraft size, and load factor. Low, medium, and high growth assumptions were also taken into account. The total aircraft movement forecasts for HSIA are given in Table 6-6.

Table 6-6 Aircraft Movement Forecast

(Unit: Operations)

	2015	2020	2025	2030	2035
International	37,300	53,100	75,900	102,800	132,300
Domestic	21,100	24,000	27,400	30,700	33,700
Others	11,000	12,500	14,400	16,500	19,000
Total	69,400	89,600	117,700	150,000	185,000

Source: CAAB

Aviation demand is normally projected using GDP as an explanatory factor, but sufficient analysis was not done on the trends of departure and destination countries, the situation of import and export cargoes, and the impact of airline fare reduction due to low-cost carrier (LCC) service. Since these elements are not included as explanatory factors in the prediction model, it is necessary to analyze these factors separately, and develop a demand projection inclusive of the factors.

The air traffic demand forecast conducted in this preparatory survey is compared in Chapter 5.

(4) Master Plan Recommendations

The next step of the planning process is to identify a recommended development plan based on the projected needs. The layout process involves conducting an evaluation of the areas required to be procured for development and then developing the optimum layout designs and configurations.

The expansion plan was developed to accommodate the projected air traffic demand for 2035 of approximately 24 mppa.

Airfield Facilities

- ✈ Extension and widening of existing runway
- ✈ New second runway
- ✈ Additional taxiways
- ✈ New passenger apron to accommodate 35 aircraft parking stands
- ✈ New apron taxiway, taxi lanes, and ground service equipment (GSE) road
- ✈ Expansion of cargo and maintenance apron

Terminal 3 and Related Facilities

- ✈ New Terminal 3 with connection to the existing Terminal 1 and Terminal 2
- ✈ New landside roadways and car parks
- ✈ New multi-storied car park cum commercial building

- New domestic terminal with connection to the existing Terminal 1 and Terminal 2
- New VVIP complex
- New intake substation
- New sewage treatment plant

Navaids and AGL

- Upgrade existing ILS and AGL system to CAT-II
- New CAT-II ILS and AGL system for second runway
- Relocation of existing equipment

Support Facilities

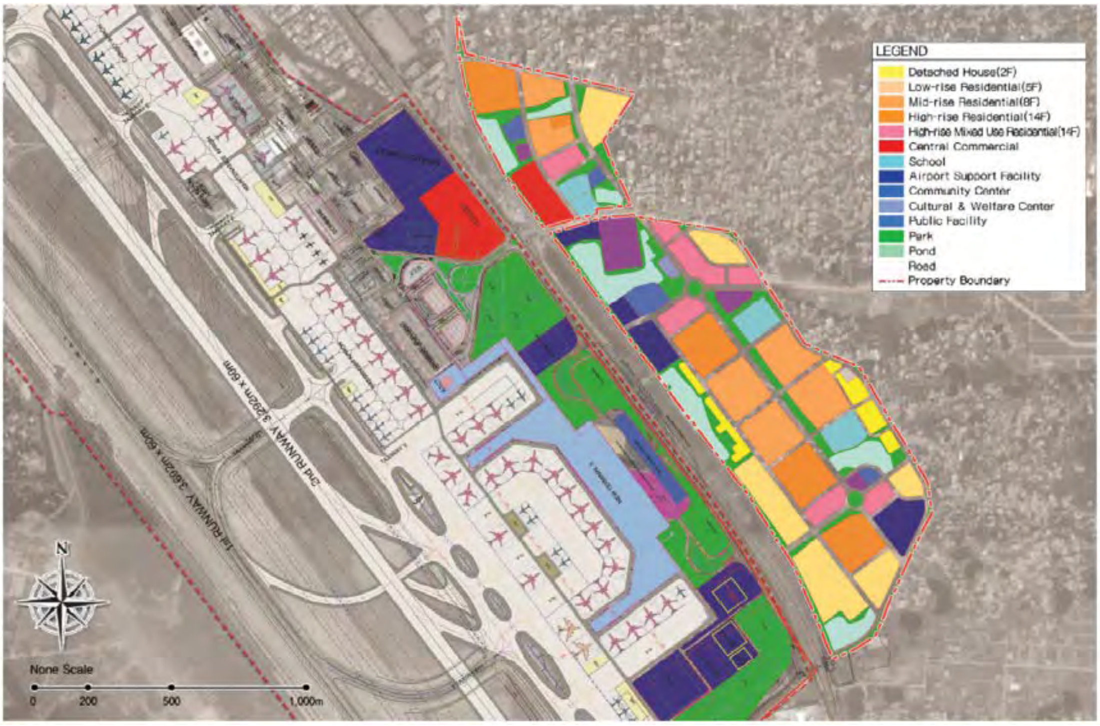
- New RFFS substation
- Relocation of general aviation facilities
- Relocation of ATC tower
- Relocation of catering facilities
- Expansion of cargo and maintenance facilities

(5) Phased Development Plan

All facilities excluding the second runway and the adjoining taxiways will be constructed in phase-1. Only the second runway and the adjoining taxiways will be constructed in phase-2.

(6) Land Use Plan

The CAAB has a land area of 941,597 m^2 on the east side of HSIA. The land, located around the east side of Terminal 3, is very close to the airport. It means that its place has very high potential for business and commerce. Therefore, there are many plans of development of business and commercial complexes.



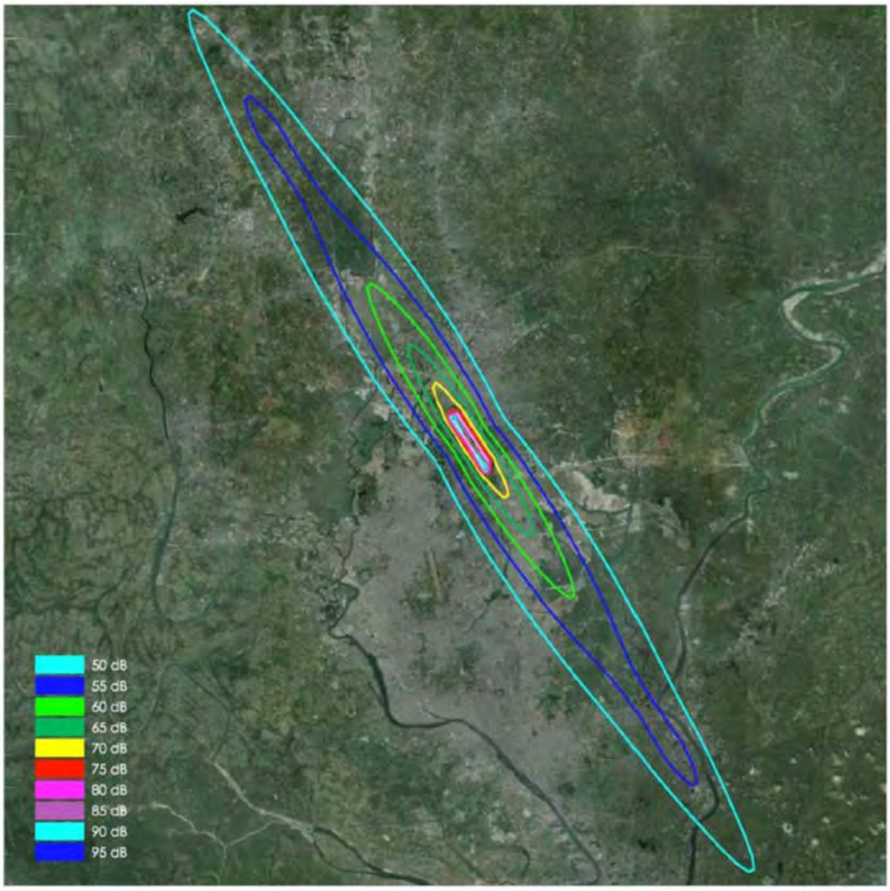
Source: CAAB

Figure 6-6 Land Use Plan at CAAB's Area

(7) Environmental Screening

This expansion project is included under the "Red Category in item 60" as per ECR 1997. Therefore, the location clearance certificate (LCC) and environmental clearance certificate (ECC) are required to obtained from the Department of Environment (DOE) to implement the project. For the application of LCC, initial environmental examination (IEE) along with environmental management plan (EMP) has to be prepared. For the application of ECC, environmental impact assessment (EIA) is needed.

Since aircraft movements at HSIA will be high, the noise impact analysis around HSIA in 2035 was conducted. The result of the noise impact analysis is shown in Figure 6-7.



Source: CAAB

Figure 6-7 Noise Contour of HSIA in 2035

(8) Economic Analysis

The basic premises of the economic analysis is that airport investments are viewed as public investments. It is desirable that the total sum of benefits to the traveling public exceeds, or is close to, the amount of investments. The measured benefits are converted into monetary terms. Because the benefits are measured in a time unit, the concept of value of time (VOT) and aircraft operating cost are required. The VOT employed Federal Aviation Administration (FAA) recommendation.

The result of the economic analysis for the expansion plan described in the report is summarized in Table 6-7.

Table 6-7 Economic Analysis

	NPV (USD in millions)	B/C	IRR (%)	Note
Baseline Scenario	974	1.6	8.2	VOT

Source: CAAB

Based on the underlying assumptions, the construction of the second runway and other infrastructure development works at HSIA are economically reasonable.

(9) Financial Analysis

Financial analysis was conducted viewing the project as an airport investment project by the private sector. Operating period is assumed to be 30 years after the completion of the expansion.

The result of the financial analysis based on the assumed capital expenditure, operating expenditure, operating aeronautical revenue, and operating non-aeronautical revenue is shown in Table 6-8.

Table 6-8 Result of Financial Analysis

	FNPV (M USD)	PI	FIRR (%)	Recovery Period (year)
Optimistic Scenario	956	1.3	11.5	14
Baseline Scenario	202	1.1	8.8	27
Pessimistic Scenario	-552	0.8	5.6	N/A

Source: CAAB

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CHAPTER 7 ANALYSIS OF AIRPORT CAPACITY AND VALIDITY OF THE PROJECT

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Chapter 7 ANALYSIS OF AIRPORT CAPACITY AND VALIDITY OF THE PROJECT

7.1 Analysis of Capacity of Current Airport Facilities

This chapter evaluates whether the current capacity of HSIA is sufficient to meet the projected demand for 2020, when the phase 1 facilities will be completed. The analysis will include the runway, taxiway, PTB, cargo terminal,car park and access road. The summary of the capacity analysis is shown in Table 7-1, and result of the capacity analysis is described in the following sections.

Table 7-1 Summary of Capacity Analysis of Each Facility of HSIA

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Runway	No.	Approximately 170,000 movements/year	103,830 movements/years	It is possible to meet the demand until 2020 with one runway by maximizing utilization of the operational capacity.
	Length	3,200 m	3,200 m	The longest flight in operation in 2015 is Dhaka-London by B777-300. Therefore, all flights can be operated, except for some long-haul flights using large aircraft which will require restriction on luggage,.
	Width	46 m	46 m	Width of 60 m is unnecessary, although desirable for operation of Code F aircrafts.
Rapid Exit Taxiways and Connection Taxiways	Peak hour aircraft movement	35movements/ hour	24 movements/hour	The peak hour aircraft movement in 2015 was 18, which will increase to 24 in 2020; therefore, existing facilities have no problem.
Taxiway	Width	23 m	23 m	Width of 25 m is unnecessary, although it is desirable for operation of Code F aircrafts.
Apron	No. of Spots	29	32	Although the demand will exceed the current capacity in a few years later, the aprons in front of cargo terminal and maintenance area could be used during peak hour.
International Passenger Terminal Building	Check-in Check-out Counters	56	60	The capacity of the existing international terminal building (T1/T2) is 8 mppa. According to the aviation traffic demand forecast in this study, the demand of international passenger in 2020 will reach 8.7 mppa. Therefore, low service level will be found temporarily during peak hour, However, emigration counters, baggage retrieval conveyors and security checkpoints
	Security Checkpoints	19	19	
	Emigration Counters	38	21	
	Immigration Counters	22	25	
	Baggage Claim Counters	8	8	
Domestic Passenger Terminal Building	Check-in Counters	12	11	The capacity of the existing domestic terminal building is 640,000. Domestic passengers have already reached beyond 910,000. Therefore, chronic congestion will be found in 2020.
	Security Checkpoints	3	4	
	Baggage Claim Counters	1	4	

Items		Current Condition/ Capacity	Requirement in 2020	Evaluation
Cargo Terminal Building	Area	27,800 m^2 Export: 12,800 m^2 Import: 15,000 m^2	42,000 m^2 Export: 14,000 m^2 Import: 28,000 m^2	According to future demand requirement, the capacity of cargo terminal is expected to fall short in 2020.
Car Parking	No. of Cars	1,000 cars	1,008 cars	Although excess demand over capacity at peak hour is a concern, it will not considerably affect airport operations.
Utility	Power Supply	8 MVA	TBD	Temporary capacity overload of each facility are concerns since the capacity of T1/T2 will be exceeded in 2020. However, it will not considerably affect the operation of the airport.
	Water Supply	Tube well	TBD	
	Waste Water Treatment	TBD	TBD	
	Fuel	TBD	TBD	
Navaids	Communication	V/UHF	V/UHF	Since the age of most facilities will still be less than 15 years at 2020, there is no problem with service life..
	PSR/SSR	PSR/SSR	PSR/SSR	
	DVOR/DME ILS (CAT-I)	DVOR/DME ILS (CAT-I)	DVOR/DME ILS (CAT-II)	

Source: JICA Study Team

7.1.1 Capacity of Runway

In the CAAB Master Plan, the current runway capacity is approximately 170,000 movements per year.

In 2015, the aircraft movement, including GA and military, in HSIA was 73,235. Even if the separation between civil and military aircraft or between arrival and departure is considered, the current runway capacity is sufficient up to 2030.

7.1.2 Taxiway

There are four taxiways, which consist of south taxiway, north taxiway, central taxiway, and high speed exit taxiway. The south and north taxiways connect to both runway ends; the central taxiway is used for arrival aircraft from both runway directions and the high speed exit taxiway is used for arrival aircraft from Runway 14.

At present, approximately 90% of operations are for the south wind and the large jet ratio is about 45%, with the remainder small aircraft or turboprop aircraft. Therefore, there are no issues with the current number and location of taxiways if the current aircraft movements and equipment configuration are maintained.

On the other hand, when the airport operates in the opposite wind direction, the high speed exit taxiway cannot be used. However, the current runway capacity still has enough margin and there is no severe impact on airport operations caused by increased runway occupancy time during north wind operation resulting in delay of arrival and departure aircraft.

According to the demand forecast in this study, the aircraft movement will increase by approximately

2.9 times in 2035. Also, the study shows that turbo prop aircraft will be replaced by small jet and large aircraft will increase. Therefore, the installation of new high-speed exit taxiway should be considered for decreasing runway occupancy time and increasing runway capacity.

7.1.3 Apron

The current apron situation is described in Chapter 3 and the existing apron stands are shown in Figure 3.10 and Table 3.4. The current specification of operational aircraft for domestic and international flights is that almost all domestic flights are operated by turbo prop or small regional jet types and international flights are operated by B777 and B737 class aircrafts. As mentioned above, spots with boarding bridge are used for international flights and domestic flights use open spots.

In addition, according to Table 5.5, there will be 21 international flights and 16 domestic flights during peak hour in 2020. Although the future required number of apron stands in 2020 will exceed the existing number, some aircraft may park in the maintenance area and cargo terminal area during peak hours.

7.2 Passenger Terminal Building

7.2.1 Existing Terminal (Terminal 1 and Terminal 2) Capacity

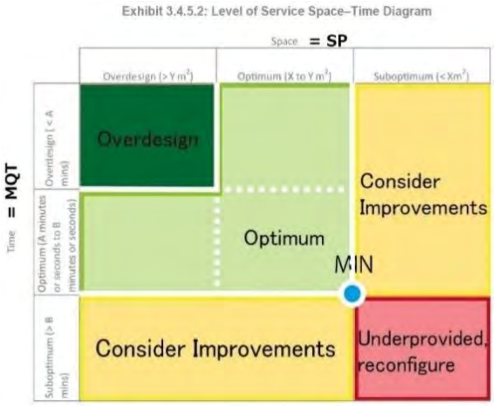
The JICA Study Team confirms that the capacity of existing international Terminal 1 and Terminal 2 (8 mppa in CAAB Master Plan), is able to satisfy the passenger demand until Terminal 3 opens.

(1) The number of check-in counters and other facilities

The JICAStudy Team calculated the required number of check-in counters and other facilities based on future passenger demand forecast. The required number is compared with the existing facilities.

The following items are the premises used to calculate the required facilities:

- ✈ Calculation formula is based on the International Air Transport Association's (IATA) Airport Development Reference Manual (ADRM) 10th edition.
- ✈ The level of service (LOS) is assumed at the low level in optimum range.



Source: IATA

Figure 7-1 IATA ADRM 10th LOS Table

- For the demand forecast for peak hour passenger, the direction factor is 65%, based on the data in CAAB Master Plan.
- Processing time is also based on CAAB Master Plan data.
- Because there is no condition given in the CAAB Master Plan, the gate security check time duration is set at 120 seconds, based on the data collected directly by the JICA Study Team on site.
- Baggage claim calculation during peak hour is one conveyor per flight, the operation standard used in the present international terminal (T1/T2).
- The forecast calculation formula is based on the conditions shown in Table 7.2.

Table 7-2 Condition for Calculation of Required Number

	Facility	Process Time (sec/pax.)	Max Waiting Time in Optimum Low in LOS (min)	Comment
Departure	Check-in Counter	180	20	
	Emigration	20	10	
	Security	20	10	Gate Security
Arrival	Immigration	50	10	
	Baggage Claim	-	-	Based on peak flight nos.

Source: JICA Study Team

The required numbers in 2020 and current number of facilities calculated based on Table 7.2 is shown in Table 7-3. Security check point, emigration counter, and baggage claim will be enough to satisfy the demand forecast in 2020. On the other hand, check-in counters and arrival immigration counters will not be enough to satisfy the demand forecast. Long lines in immigration procedure will make it difficult to guarantee the proper service level. However it is possible to maintain the same service level and improve the queuing condition by taking space from the waiting room next to the immigration area to expand the immigration area.

The time duration for arrival immigration processing time in CAAB Master Plan is 50 seconds, which was also used for the JICA Study Team, but it should be possible to shorten the processing time by improvements in operation.

As mentioned above, the existing terminal will satisfy the demand forecast by improvement of operations and partial renovation.

Table 7-3 Comparison of Capacity Between Existing and Required Facilities in Terminal 1/2

		Existing Terminal	Required Number (2020)
	Million Passenger Per Annum (mppa)	8.0	8.7
Departure	Check-in Counter	56	60
	Security Check Point	19	19
	Emigration	38	21
Arrival	Immigration	22	25
	Baggage Claim	8	8

Source: JICA Study Team

(2) Gate Lounge Capacity

The security check process in the current terminal for departure passengers is a gate security type with security checks immediately before entry to the boarding lounges. There is one VIP lane (first and business class passengers) and one lane for economy class. Security check takes longer than usual (more than 60 seconds) since shoes as well as hand baggage are checked.

Since there are no concessions or toilets inside the current gate lounges, most departure passengers spend their time waiting in the departure concourse lobby and approach the gates immediately prior to boarding.

Table 7.4 shows the basic unit of gate lounge capacity.

Table 7-4 Gate Lounge Capacity Basic Unit

Facility	Basic Unit
Seat Ratio (%)	80
Space per Seated Person (m^2/person)	1.5
Space per Standing Person (m^2/person)	1.2

Source: JICA Study Team

Based on Table 7-4, the processing time for different aircraft size is computed as shown in Table 7-5.

Table 7-5 Processing Time for Different Aircraft Size

		ICAO A/C CODE		
		CODE E (B777-300)	CODE D (B767)	CODE C (A320)
Conditions	Number of Seats	350	250	180
	Load Factor (%)	75		
	Pax (Pax/Flight)	262	188	135
Requirement	Gate Lounge Area (m^2)	377	300	194
Existing Area	Gate Lounge Area (m^2)	386		
	Evaluation	Almost Comfortable	Comfortable	Comfortable

Source: JICA Study Team

The gate lounge capacity will satisfy the LOS requirements for aircraft types during phase-1 timeframe.

(3) Evaluation of Existing Domestic Terminal Capacity

The JICA Study Team evaluated the the capacity of existing domestic terminal (0.64 mppa in CAAB Master Plan) to meet the projected passenger demand in 2020.

The required number of facilities in domestic terminal in 2020 is calculated by the conditions of Table 7-6.

Table 7-6 Required Number of Check-in Counters and Other Facilities in Domestic Terminal

Items		Existing Terminal	Required Facility (2020)
Condition	Passenger (mppa)	0.64	1.38
Check-in Counters		12	11
Security Check Points		3	4
Baggage Claim		1	4

Source: JICA Study Team

According to Table 7-6, the number of security check points and baggage claims in the existing domestic terminal will not satisfy the future demand. Therefore, severe congestion and decrease in service level will be expected.

7.2.2 Cargo Terminal

Approximately 80% of export cargo in HSIA is cloth and/or textile. Therefore, it is assumed that the operational capacity per square meter is much more than the base unit of operational capacity in cargo terminal at IATA ADRM 10th edition.

On the other hand, import cargo terminal is expected to handle some products which would normally be transported by maritime or land transportation, due to the geographical characteristics and insufficient infrastructure in Dhaka. Furthermore, the JICA Study Team will adopt the low automated category base unit in IATA ADRM 10th, for import cargo terminal due to the conditions and operations in the existing facilities.

The selected base unit for export and import cargo terminal is shown in Table 7-7.

Table 7-7 Existing Cargo Terminal Base Unit

Facilities	Unit (t/m^2)
Export Cargo Terminal	20
Import Cargo Terminal	5

Source: JICA Study Team

The expected export and import cargo volume is shown in Table 7-8 and the resulting required cargo terminal area is shown in Table 7-9.

Table 7-8 Demand Forecast and Current Volume in International Air Cargo

Category	Ratio	2015	2020
Export	67 %	172,007 t	278,768 t
Import	33 %	86,003 t	139,384 t
Total	100 %	258,010 t	418,152 t

Source: JICA Study Team

Table 7-9 Required Cargo Terminal Area

Planned Year / Facility	Existing Facility	Required Current Cargo Terminal Area (2015)	Required Cargo Terminal Area (2020)
Export Cargo Terminal	12,800 m^2	9,000 m^2	14,000 m^2
Import Cargo Terminal	15,000 m^2	17,000 m^2	28,000 m^2
Total	27,800 m^2	26,000 m^2	42,000 m^2

Source: JICA Study Team

Table 7-9 shows that the existing cargo terminal will not satisfy the cargo demand forecast in 2020. Therefore, the shortage of cargo terminal area has to be improved by introducing efficient operation as well as deploying automated racking system.

7.2.3 Car Parking

The condition of current car park is shown in Table 7-10. The future parking demand forecast for 2020 is 1008 spots. Lack of capacity will be a concern during peak hours, since present capacity is less than demand. However, this will not cause severe issue, because both numbers are very close.

Table 7-10 Situation of Car Parking in HSIA

	Existing Car Park		Future Demand Forecast (2020)
	Parking Lots	Area (m^2)	
Existing (International Terminal)	800	24,500	806
Existing (Domestic Terminal)	200	2,000	202
Total	1,000	26,500	1008

Source: CAAB

7.2.4 Utilities

(1) Power Supply

The power demand of the existing HSIA is estimated to be 8 MVA, supported by two intake power substations. The power for HSIA is maintained by two power supply lines and backup generator; therefore, 24/7 operation stability is ensured.

The total amount of power demand is normally calculated by estimated power usage per unit area in each facility. There is no plan of expanding the existing facilities for future demand increase until 2020; therefore, it is assumed that power demand in 2020 is almost the same as current demand.

As mentioned above, the current power supply system will be enough for future power demand in 2020.

(2) Water Supply

The existing water demand at HSIA is sustained by three tube-wells. The JICA Study Team could not confirm precise data of amount of water supply per day in each tube well and capacity of water reserve per day in each water supply; however, the JICA Study Team did not find any issue concerning water supply volumes in this study.

The demand for water depends mainly on the number of passengers in the airport. The shortfall of water supply during peak hour in 2020 is a concern because the international passengers demand forecast in 2020 (8.6 mppa) will be slightly beyond the capacity of Terminal 1 and Terminal 2 (8 mppa). However, since CAAB is planning to develop three new tube wells for Terminal 3 and the new VVIP, the capacity of the existing system is sufficient to meet the demand for Terminal 1/Terminal 2 in 2020.

As seen above, the existing water supply system will sufficiently meet the future demand in 2020.

(3) Wastewater Treatment

Wastewater of HSIA is treated by sewage system located in the northern corner of the airport. At present, the existing sewage treatment facility is not in operation because of problems. The JICA Study Team could not obtain clear data on the capability of the existing sewage system; however, no reports of issues with the sewage system have been confirmed.

The amount of wastewater, similarly to water supply, depends on the number of passengers in the airport. Therefore, the lack of capacity of the sewage system in 2020 is a concern, because the projected passenger demand in 2020 is slightly beyond the existing facility's capacity. Although current issues and improvement plan have not been clarified, CAAB urgently needs to improve the existing facility. The plan should include adding efficient treatment method or functionality, which could allow some excess capacity over demand for wastewater treatment. Furthermore, the passenger demand forecast is very close to the capacity of the existing terminal. As a result, the amount of wastewater in 2020 is within the range of error of the capacity limit of the existing sewage system. As mentioned above, the existing sewage system will be able to treat wastewater demand in 2020.

7.2.5 Navigation Aids

The situation of the existing NAVAIDs is described in Sections 4.8.1 - 4.8.4.

At present, all NAVAIDs are maintained by CAAB. According to the interview with the NAVAIDs maintenance section, the whole system works appropriately. On the other hand, some deteriorated systems will need to be renewed and upgraded in turn.

7.3 Confirmation of the Necessity and Validity of the Expansion Project

Based on the capacity analysis of the existing HISA and the CAAB Master Plan, the necessity and validity of the project planned by the Bangladesh government are shown in this section. The summary of the evaluation of the necessity and validity of the project are shown in Table 7-11.

Table 7-11 Summary of the Project Scope and Evaluation

Facility	CAAB Master Plan (Target Year: 2035)	Phase-1 Plan (Target Year: 2025)	Evaluation
Existing Runway	Extension and widening From “3,200 x 46 m” to “3,692 x 60 m”	None	Importance and priority are low; although, extension and widening are desirable for Code F aircraft operation in the future.
New Runway	3,292 x 60 m	None	Importance and priority are not high for 2025, although it will be necessary for long-term plan in view of future demand.
New Taxiways	Rapid exit taxiways and other taxiways	Rapid Exit Taxiway: 2 Attached Taxiway (RWY 14): 1 Attached Taxiway (Parallel Taxiway): 9	It is reasonable for maximizing the capacity of one runway.
Landside Service Road	Landside service road for the new Terminal 3	Landside service road for the new Terminal 3	It is necessary for operation of the new Terminal 3.
Apron	Area of expansion and reconstruction: approximately 1,000,000 m^2 Apron Spot No: from 29 to 64	Apron expansion: Approx. 520,000 m^2 Apron Spot No: 42	Since apron expansion and number of apron spots were set based on future demand the planned figures are deemed appropriate for phase-1. The improvement of current apron is under CAAB funding and not included in scope for phase-1.
New Terminal 3	Approximately 260,000 m^2 3 Stories Passenger Capacity: 16.2 mppa	Approximately 220,000 m^2 3 Stories Passenger Capacity: 12 mppa	Based on future demand, the expansion of 220,000 m^2 set for phase-1 is deemed appropriate. Phase-2, will need to expand to 260,000 m^2.
Existing International Terminal T1/T2	Following renovation works: - No. of check-in counters: from 56 to 84 - Addition of immigration and emigration counters Passenger Capacity: 8 mppa	None	There is no urgency for expansion up to 2020. Renovations are required to meet additional demand after 2025.
New Domestic Terminal	Approximately 15,000 m^2	None	Based on priority of facilities, a new domestic terminal will be needed in phase-2. In phase-1, the existing domestic terminal will continued to be used and parts of T1/T2 will be used temporarily as necessary.

Facility	CAAB Master Plan (Target Year: 2035)	Phase-1 Plan (Target Year: 2025)	Evaluation
Cargo Terminal	40,000 m^2 (Existing export cargo terminal: 12,800 m^2, Import cargo terminal: 27,200 m^2)	47,000 m^2 (Export cargo terminal: 27,000 m^2, Import cargo terminal: 20,000 m^2)	The development of cargo terminal is necessary for increasing cargo capacity and operational improvement. Necessary facility capacity requires further study.
VVIP Terminal	Approximately 5,000 m^2	Approximately 5,000 m^2	Relocation is needed due to the construction of new Terminal 3.
Car Park	1,948 lots (T1/T2: 800, Terminal 3: 1,148)	Terminal 3: 1,148 lots	In phase-1, the capacity of new car park for Terminal 3 is sufficient for the demand of all passengers accessing the airport by car.
NAVAIDs	- Upgrading of ILS from CAT-I to CAT-II - Installation of AWOS - Relocation of Control Tower	- Upgrading of ILS from CAT-I to CAT-II - Installation of AWOS	ILS upgrade is appropriate to improve flight safety and efficiency. The relocation and upgrade of the control tower is progressing under CAAB. New AWOS near center of the runway is required due to ILS upgrade.
Supply Facility	- RFFS	RFFS	New construction is reasonable considering the response time.
	- Wastewater treatment plant	Wastewater treatment plant	Expansion of facilities is needed according to the expansion of the airport.
	- Intake power plant with distribution system	Intake power plant with distribution system	
	- Maintenance hangar	Maintenance hangar	The upgrade and improvement of these facilities are planned under CAAB funding.
	- Catering facility	Catering facility	
	- GA apron and hangar	GA apron and hangar	

Source: JICA Study Team

7.3.1 Analysis of Phased Expansion based on Demand Forecast

As mentioned above, the necessity and validity is high for the scope of the expansion project in the CAAB Master Plan and the planned expansion or new construction of each facility. However, the target year in the CAAB Master Plan is 2035 and there is concern that the design of the CAAB Master Plan may significantly exceed the capacity demand forecast in 2020. The capacity demand forecast is affected by various factors influenced by economic activity in Bangladesh and abroad; therefore, phased development based on demand forecast is appropriate for airport expansion projects.

The phase-1 project in the current CAAB Master Plan will be completed in 2020. Therefore, it is desirable to construct the HSIA expansion project in two phases wherein phase-1 will target 2025 or five years from completion of project facilities and phase-2 will target the additional demand projected for the subsequent five years up to 2030.

Following the phased development plan will allow review of the demand forecast with a five-year interval and to flexibly adjust project scope to match changes in demand forecast or needs of airlines and passengers. This will also allow investment to be set at appropriate and reasonable values for projected demand.

The validity of phased development, based on current demand forecast is shown in Table 7-12.

Table 7-12 Change of Demand Forecast in Each Target Year of Phased Development

Phase	Target Year	Completion Year	Passenger Demand Forecast (mppa)		
			International	Domestic	Total
Operation Start Terminal 3	2020		8.7	1.4	10.1
Phase-1	2025	2020	12.0	2.1	14.1
Phase-2	2030	2025	16.1	3.0	19.1

Source: JICA Study Team

7.3.2 Runway and Taxiway

(1) Runway Length and Width

At present, the Dhaka-London flight, operated by B777-300ER, has the longest flight distance in operation at HSIA. There is no plan to open a new route with a longer flight distance than the London flight. Therefore, the runway length is sufficient for operations in the near future.

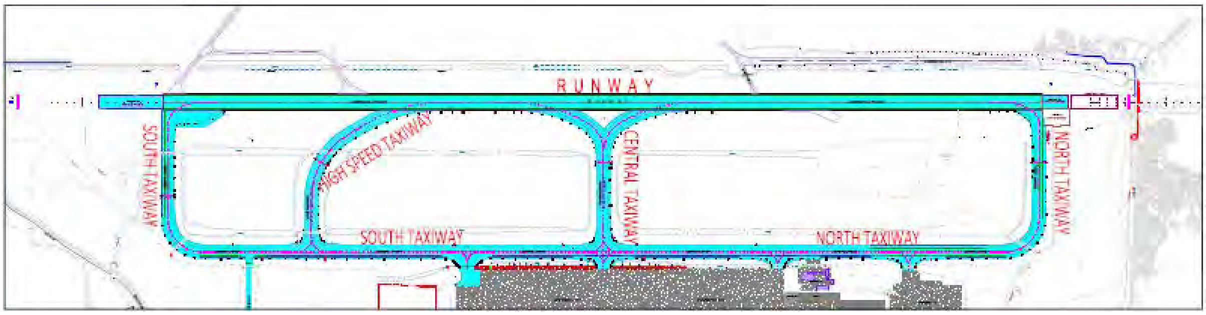
On the other hand, the operation of Code F aircrafts requires a runway width of 60 m in ICAO Annex 14. However, FAA and the European Aviation Safety Agency (EASA) have approved A380 operations under Code 4E, which requirements are satisfied by a 45 m runway width and 7.5 m runway shoulder. There are many airports with A380 flights in operation under the Code 4E requirement for runway width,.

Therefore, the expansion of runway width is not essential.

(2) Taxiway

There are one parallel taxiway, two attached taxiways, central taxiway, and one high-speed exit taxiway in HSIA. The taxiway width and runway width satisfy the operational requirement for A380.

However, there is only one high-speed exit taxiway located 2,350 m from the northern runway end.



Source: JICA Study Team

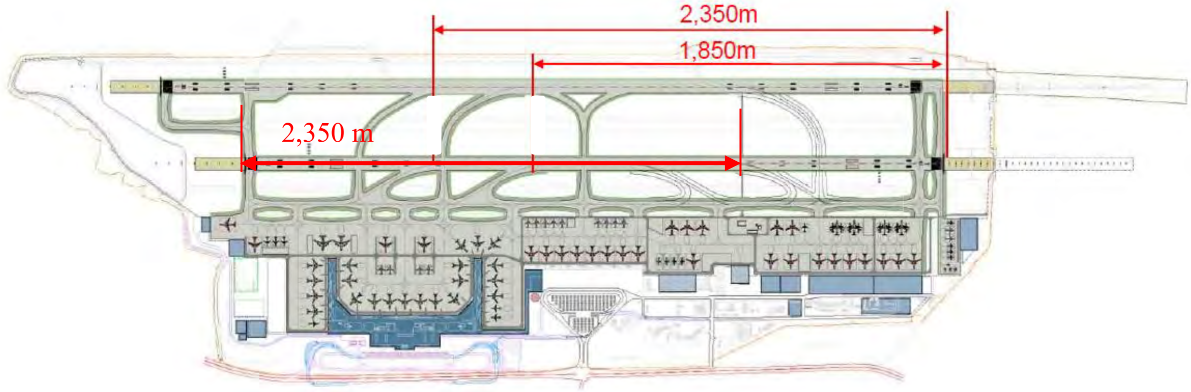
Figure 7-2 Location Map of Runway and Taxiway in HSIA

At present, small jets are already in operation for domestic and international flights.and domestic flights currently operating turboprop aircraft are expected to change to small jets in the future. Therefore, the JICA Study Team evaluated the adequacy of the existing high speed exit taxiway by calculating the minimum landing runway length for B737-800, which will be the major aircraft for domestic and international flights.

According to the aircraft characteristics of B737 provided by Boeing, the minimum landing runway length is 1,750 m at the maximum landing weight. The B737 is operated for short haul international flights and some domestic flights at HISA, but in reality flights landing at maximum landing weight are extremely rare. Therefore, there is concern that the current runway occupancy time is slightly longer than necessary because the distance from the runway edge to the high speed exit taxiway is longer than the minimum landing runway length for B737.

The need for a new high speed exit taxiway is not an urgent issue because there is enough runway capacity and almost all aircrafts for domestic flights are using turbo prop. However, reducing runway occupancy time and increasing runway capacity will be required due to the growth of flight demand and shift of aircraft mix to small jet. As mentioned above, the JICA Study Team considers that the establishment of high speed exit taxiway for small jet in Runway 14 is appropriate.

Furthermore, high speed exit taxiway could not be used for north wind operation, even if it is only about 10% of annual operation. The rapid decrease of runway capacity during that operation is a concern. Therefore, the establishment of high speed exit taxiway in Runway 32 will efficiently minimize the delay due to holding caused by the decreasing runway capacity when HSIA has runway direction change under the increase of air traffic demand in the future.



Source: JICA Study Team

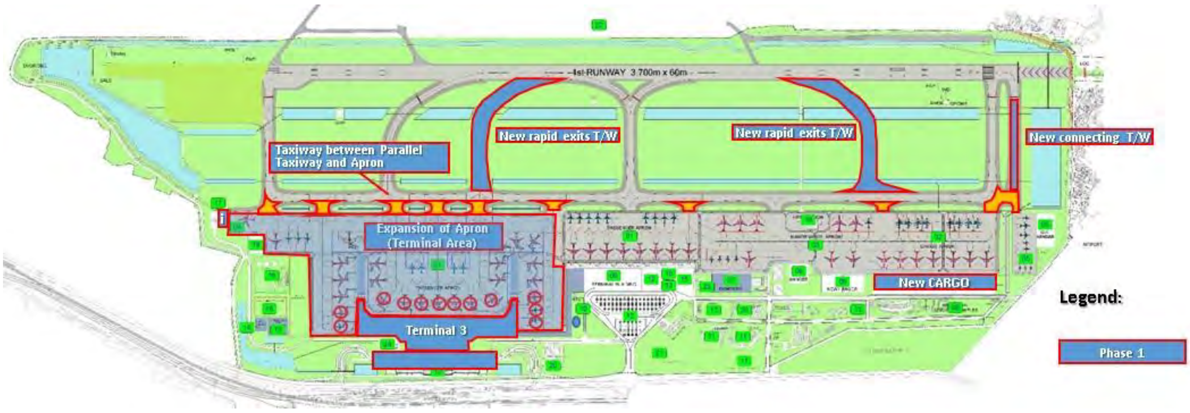
Figure 7-3 Location Map of New High Speed Exit Taxiway

At airports where air traffic demand is high, several rapid exit taxiways are laid out at runway ends. This allows for departure aircraft to utilize several different taxiways and increase the number of aircraft waiting for takeoff. This contribute towards increasing the runway capacity by maximizing the efficiency of departure aircraft operations such as reversing the departure order in consideration of wake turbulence in some instances. In addition, when departure aircraft encounter trouble, they are able to execute ground turns (turning back without taking off) without occupying the runway. Therefore, it is reasonable to provide a number of rapid exit taxiways at both runway ends for this project in order to maintain smooth operations at HSIA.

The width of the high speed taxiway and attached taxiway is 23 m, and the width of both shoulders is

7.5 m.

The location of attached taxiway which connects between the parallel taxiway and apron is shown in Figure 7-4



Source: JICA Study Team

Figure 7-4 Location Map of New High Speed Exit Taxiway

The necessary and appropriate project scope for each phase is shown in Table 7-13.

Table 7-13 Project Scope in Each Phase (Runway and Taxiway)

	Runway		Taxiway
	Length	Width	
Phase-1 (Target Year: 2025)	—	—	High Speed Exit Taxiway x 2 (for RWY 14 and 32) Attached Taxiway x 9 (for Parallel Taxiway) Attached Taxiway x 1 (for RWY 14 Edge)
Phase-2 (Target Year: 2030)	Extension from 3,200 m to 3,692 m	Expansion from 45 m to 60 m	Attached Taxiway x 1 (for RWY 32 Edge)

Source: JICA Study Team

7.3.3 Apron

The required number of spots is calculated by the following steps. In this calculation, the JICA Study Team used aircraft mix and the number of flights during peak hour, which are described in Sections 6.6.1 and 6.7.4.

- Peak Hour Landing for Each Aircraft Type
- Number of Planned Spot for Each Aircraft Type
- Number of Required Spot

(1) Peak Hour Landing for Each Aircraft Type

In this survey, based on the interview with several airlines, it is assumed that the aircraft mix will change as shown in Table 7-14.

Table 7-14 Aircraft Mix for Domestic and International Flights

	Reference Code	2015	2020	2025	2030	2035
Domestic	Code B	80%	75%	60%	50%	40%
	Code C (Turbo Prop)	20%	20%	20%	20%	20%
	Code C (Jet)	0%	5%	20%	30%	40%
	Total	100%	100%	100%	100%	100%
International	Code B	2%	0%	0%	0%	0%
	Code C (Turbo Prop)	25%	22%	15%	9%	1%
	Code C (Jet)	25%	30%	35%	40%	45%
	Code D	2%	2%	2%	2%	2%
	Code E	45%	45%	47%	48%	51%
	Code F	1%	1%	1%	1%	1%
	Total	100%	100%	100%	100%	100%

Source: JICA Study Team

Also, the aircraft movements for domestic and international flights during peak hour are shown in Table 7-15.

Table 7-15 Aircraft Movements during Peak Hour

2015		2020		2025		2030		2035	
International	Domestic	International	Domestic	International	Domestic	International	Domestic	International	Domestic
14	13	21	16	28	19	35	20	43	22

Source: JICA Study Team

As mentioned above, the peak hour landing for each aircraft type (PAi) is calculated by the following formula:

PAi = Peak Hour Landing * Aircraft Mix * 0.5 … (1) (i: Aircraft Type)

The peak hour landing for each aircraft type calculated from formula (1) is shown in Table 7-16.

Table 7-16 Peak Hour Landing for Each Aircraft Type

	2015		2020		2025		2030		2035	
	International	Domestic	International	Domestic	International	Domestic	International	Domestic	International	Domestic
Code B	0.14	5.2	0	4.8	0	5.7	0	5	0	4.4
Code C (Turbo Prop)	1.75	1.3	2.31	1.6	2.1	1.9	1.58	2	0.22	2.2
Code C (Jet)	1.75	0	3.15	1.6	4.9	1.9	7	3	9.68	4.4
Code D	0.14	0	0.21	0	0.28	0	0.35	0	0.43	0
Code E	3.15	0	4.73	0	6.58	0	8.4	0	10.97	0
Code F	0/07	0	0.11	0	0.14	0	0.18	0	0.22	0

Source: JICA Study Team

(2) Number of Planned Spots for Each Aircraft Type

The number of planned spots for each aircraft type is calculated by the following formula:

PSi = PAi * Spot Occupancy Time * Surplus Ratio … (2)

The spot occupancy time is assumed as shown in Table 7-17 because the spot occupancy time for each aircraft type is different between domestic and international flights.

Table 7-17 Spot Occupancy Time (min)

Reference Code	International	Domestic
Code B	80	60
Code C (Turbo Prop)	80	60
Code C (Jet)	80	60
Code D	120	—
Code E	120	—
Code F	120	—

Source: JICA Study Team

The spot occupancy time is set with surplus ratio to allow for delays. The JICA Study Team set the surplus ratio based on the result of the investigation of the delay ratio over one week.

Table 7-18 Delay Ratio

Date	Departure		Arrival		Delay Ratio (%)
	Delay	Total	Delay	Total	
April 27	6	104	6	88	6.25
April 28	14	102	11	102	12.26
April 29	17	99	10	98	13.71
April 30	17	95	15	98	16.58
May 1	18	102	17	101	17.24
May 2	19	99	9	99	14.14
May 3	16	103	5	94	10.66
Total	107	704	73	680	13.01

Source: JICA Study Team

Based on the result of actual flights from April 27 to May 3, 2016, the delay ratio for one week was 13%. According to this result, the surplus ratio is set as 1.2, which includes a safety factor. The number of planned spots for each aircraft type is calculated by formula (2) and shown in Table 7-19.

Table 7-19

Table 7-19 Number of Planned Spots for Each Aircraft Type

	2015		2020		2025		2030		2035	
	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter-national	Domestic	Inter national	Domestic
Code B	1	5	0	4	0	5	0	4	0	4
Code C	6	2	10	4	12	4	15	5	17	6
Code D	1	0	1	0	1	0	1	0	2	0
Code E	8	0	12	0	16	0	21	0	27	0
Code F	1	0	1	0	1	0	1	0	1	0
Total	24		32		39		47		57	

Source: JICA Study Team

(3) Number of Required Spots

The number of required spots (AS) is calculated by the following formula:

AS = $\sum PSi$ + Spare Spot + Night Stay Spot … (3)

The spare spot is used for considering long time parking due to mechanical trouble and short-time parking by charter flight or diverted flight. In this study, one spare spot for each ten planned spots was set.

On the other hand, this study did not consider night stay spots because the spots are sufficient for night stay of domestic aircrafts. International flights could use normal spots as night stay spots if required, since HSIA operates 24 hours a day and Biman Bangladesh Airlines is the only company based in HSIA operating international flights.

From the above, the number of required spots in each phase is shown in Table 7-20.

Table 7-20 Number of Required Spots

	Phase-1			Phase-2			CAAB Master Plan		
	International	Domestic	Total	International	Domestic	Total	Terminal3	T1/T2*	Total
Code B/C	13	9	22	16	10	26	10	9	19
Code E	18	0	18	23	0	23	23	14	37
Code F	2	0	2	2	0	2	2	0	2
Total	33	9	42	41	10	51	35	23	58

* The number of spots in T1/T2 is considered about reduction by construction Terminal 3.
Source: JICA Study Team

Phase-1 project will be completed around 2021 and Terminal 3 will start to operate at the same time. The number of required spots in 2020 is 32 as shown in Table 7-19. The lack of spots is expected during peak hour, because the current number of spots is 29. However, if the maintenance area apron and export cargo apron are utilized, the current spot number and arrangement will be sufficient until the completion of expansion project.

The number of required spots in the CAAB Master Plan is very similar to the result of the study based on the demand forecast. Therefore, the proposed number of required spots and composition of spots in the CAAB Master Plan are appropriate. In addition, the CAAB Master Plan shows that the number of spots around Terminal 3 corresponds with the required number of spots for international flights in phase-1. Therefore, it is valid to develop the spots around Terminal 3 according to the CAAB Master Plan. On the other hand, deficiency of spot numbers located around Terminal 3 for international flight will occur in phase-2. If part of the spots in Terminal 1/Terminal 2 are released for international flights, the available number of spots will match future demand of spots for international flights.

(4) Number of Cargo Spots

First, the JICA Study Team calculated the number of cargo flights during the peak hour based on the number of cargo flights during the peak day in Section 6.7.4. Second, the number of required spots for cargo is calculated as well as the passenger flights spot. The necessary conditions for calculation are as follows:

- The number of cargo flights during peak hour is calculated by the formula for international flight during peak hour, which is described in Section 6.7.3.

Number of Flight during Peak Hour = 1.05 / Aircraft Movement per Day + 0.114

- Current aircraft mix for cargo flight is Code C: 8% and Code E: 92%. Basically, large jets are used for freighter. Therefore, the JICA Study Team assumed that this composition of aircraft type will not change.
- The spot occupancy time is 180 min.
- The surplus rate is 1.2 for cargo as well as for passenger aircraft.

Based on the above conditions, the peak hour landing for each aircraft is calculated as shown in Table 7-21.

Table 7-21 Peak Hour Landing for Each Cargo Aircraft Type

Code	2015	2020	2025	2030	2035
Code C	0.06	0.07	0.08	0.10	0.11
Code E	0.69	0.80	0.95	1.11	1.32

Source: JICA Study Team

Based on the above results, the numbers of planned spots for each cargo aircraft type and required spots are calculated as shown in Table 7-22 and Table 7-23, respectively. Also, the number of spare spot is set as one.

Table 7-22 Number of Planned Spots for Each Cargo Aircraft Type

	2015	2020	2025	2030	2035
Code C	1	1	1	1	1
Code E	3	3	4	5	5
Total	4	4	5	6	6

Source: JICA Study Team

Table 7-23 Number of Required Spots for Cargo in Each Phase

	Phase-1	Phase-2	CAAB Master Plan
Code C	1	1	7
Code E	5	6	7
Total	6	7	14

Source: JICA Study Team

The number of required spots based on cargo demand forecast in this survey and the number of spots in CAAB Master Plan for Code E is almost the same. Therefore, the number of spots for cargo aircrafts, type Code E, is valid. On the other hand, there is over capacity in the planned number of spots for Code C, because the cargo demand forecast in the CAAB Master Plan is lower than that of JICA study. In addition, the current trend where domestic cargo, which is assumed to mainly use Code C aircraft, is significantly lower than international cargo is expected to continue in the future.

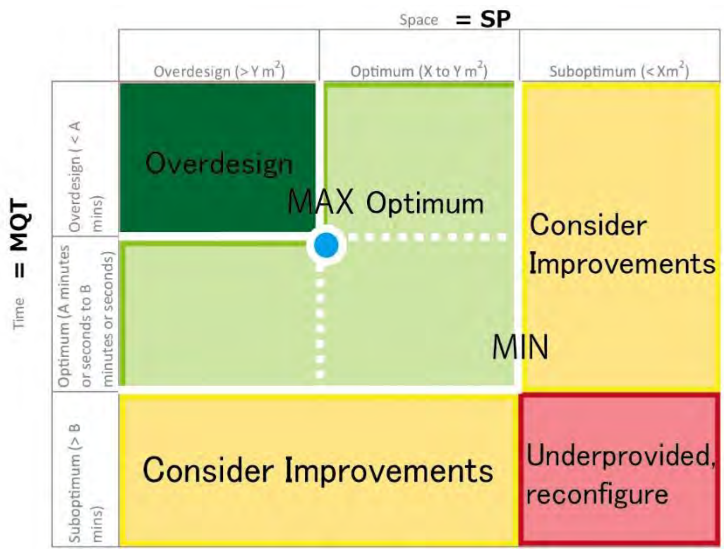
7.3.4 Passenger Terminal Building

The calculation of the processing capacity for the new Terminal 3 is based on the CAAB Master Plan and the assumptions of the JICA Study Team. The objective is to calculate the capacity of the facilities for the peak hour passenger (PHP) demand forecasts in 2025 and 2030.

(1) Pre-conditions

The pre-conditions for the calculation formula are as follows:

- The LOS is set at the high point level in optimum based on IATA ADRM standard.
- The calculation method is based on IATA ADRM book 10th edition.
- Processing time is referred to the conditions of the CAAB Master Plan.
- Since the new Terminal 3 security check facilities will be required to meet international airport standards, it should be possible to set processigng times equivalent to Japanese domestic airports. Since there is no condition given by CAAB Master Plan for security check process, the calculation will assume 20 seconds from the actual process time at Japanese domestic airports.
- Baggage claim will be based on the current T1/T2 operations of one conveyor per flight during peak hour condition.



Source: IATA

Figure 7-5 IATA ADRM 10th LOS Table

Standard conditions for the calculation are shown in Table 7-24. Security check in the existing international terminal (Terminal 1 and Terminal 2) employs the gate security system. The security check process time at the new Terminal 3 will be different from the existing terminals since it has a designated security check area.

Table 7-24 Processing Time Parameter for Departure and Arrival Passengers

	Facility	Process Time (sec/pax)	Max Waiting Time in Optimum Low in LoS (min)	Comment
Departure	Check-in Counter	150	10	
	Emigration	20	5	
	Security	20	5	
Arrival	Immigration	50	5	
	Baggage Claim	-	-	Number of Flight Base

Source: JICA Study Team

(2) Calculation Result and Validation

Table 7-25 shows the calculation result of the current design capacity by the JICA Study Team.

In phase-1, reduction of Terminal 3 area is appropriate because the planned Terminal 3 area on the CAAB Master Plan exceeds the demand in phase-1 timeframe. If Terminal 3 piers are delayed until phase-2, the terminal development plan will become appropriately matched with future demand for the target years of both phase-1 and 2. The total floor area of Terminal 3, excluding the piers, is approximately 220,000 m^2. The floor area per passenger during peak hour in 2025 will be 46 m^2, which is appropriate. Therefore, Terminal 3 capacity in phase-1 is appropriate.

In phase-2, the required facilities for departures and arrivals will exceed the planned facilities in the CAAB Master Plan. Even after the piers are extended in phase-2, the capacity of Terminal 3 will not be able to match future demand. Therefore, it is necessary to renovate and reuse Terminal 1/Terminal 2 to accept part of the future demand in phase-2. At that time, the airside corridor, which connects between Terminal 3 and Terminal 1/Terminal 2, will be necessary.

Table 7-25 Required Number of Check-in Counter and Other Facilities in Terminal 3

		2025 (Phase-1) Required Number	2030 (Phase-2) Required Number	CAAB Master Plan Planned Number
Condition	Passenger (mppa)	12.0	16.1	14.8
Departure	Check-in Counters	114	130	120
	Security	33	45	46
	Emigration	33	45	24
Arrival	Immigration	44	53	46
	Baggage Claim	9	12	13

Source: JICA Study Team

(3) Confirmation of Existing Domestic Terminal Facilities Availability and Processing Capacity

The capacity of the existing domestic terminal is lower than the current demand. Considering the situation, CAAB agreed that the new import cargo terminal will be constructed in phase-1 (2025) and the new domestic terminal will be developed in phase-2 (2030) after removing the existing import cargo terminal.

The existing domestic terminal will be continuously used during phase-1 and a part of Terminal 1/Terminal 2 will be used for domestic terminal, if necessary.

The required capacity of the new domestic terminal in phase-2 will be 15,000 m^2, when calculated from the number of passengers during peak hour and the required area of each passenger during peak hour, which is 15 m^2. The planned capacity of the new domestic terminal in the CAAB Master Plan corresponds with the JICA Study Team's result; therefore, the required capacity is appropriate.

7.3.5 Cargo Terminal

(1) Dimensions of the Cargo Terminal

While import cargo at HSIA shows an average increase of 9% between 2011 and 2015, exports show a dramatic increase of 14% annually for the same period. The export and import volumes for 2015 are 200,560 tons and 84,379 tons, respectively.

The size of the existing cargo terminal is shown in Table 7-26.

Table 7-26 Dimensions of the Existing Cargo Terminals

Facility	Existing Floor Area
Export Cargo Terminal	12,800 m^2
Import Cargo Terminal	15,000 m^2
Total	27,800 m^2

Source: JICA Study Team

Based on the site investigations on the existing operations carried out on 21 December 2016, the following are confirmed:

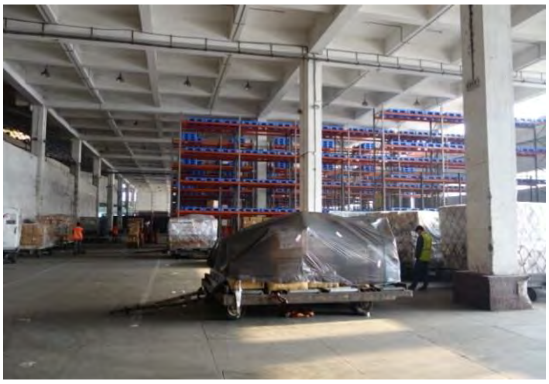
1) Export Cargo Terminal Building

The export cargo terminal building is operated without exhibiting much crowding inside, but the truck yard is heavily congested. It was confirmed that there were issues with the capacity for scanning cargo when transported into the building.

Furthermore, cargo are scanned as individual items resulting in a large number of scanning operations compared with the volume service.

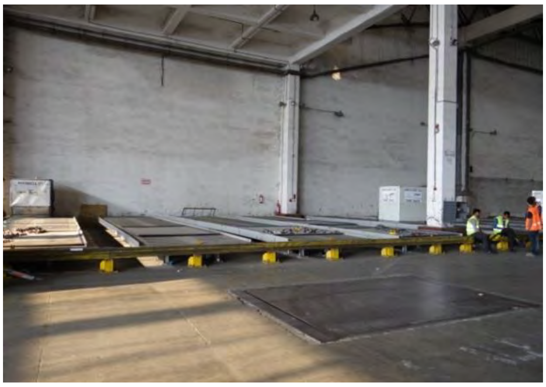
Since the existing facility is servicing over 200,000 tons of cargo in the 12,800 m^2 floor area with adequate interior space, which converts to 15.6 tons/ m^2 unit added capacity from the commencement of operation of the rack system already in place, the base unit for service capacity is expected to be 17~ 20 tons/m^2.

Present Export Cargo Operations



Large Scanning Equipment and Small Parcels

Under-utilized Facilities in Export Cargo Terminal (1)



Under-utilized Facilities in Export Cargo Terminal (2)

Source: JICA Study Team

Figure 7-6 Export Cargo Terminal Building

2) Import Cargo Terminal

The import cargo terminal was extremely crowded at the time the study was conducted and cargos were observed to be overwhelming the facility.

The lack of space was especially acute in the breakdown area for arriving cargo; and at present, breakdown is being carried out on the apron in the open.

The area used for breakdown on the apron is approximately 40 m by 230 m (11,500 m^2) and the existing terminal floor area is 15,000 m^2 for a combined area of approximately 26,500 m^2 in actual operational use.

The reported import volume for 2015 was 85,000 tons handled, resulting in a base handling unit of 3.4 tons/m^2.

However, the present handling operations were confirmed to have the following issues:

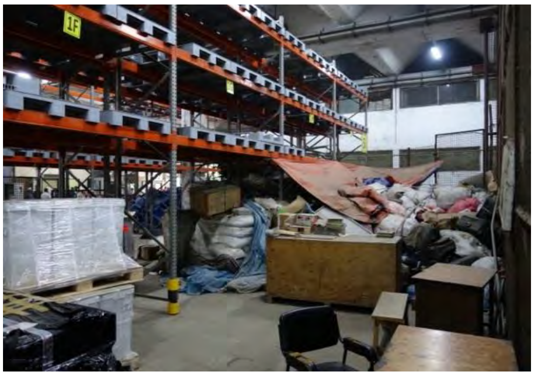
- Cargo arrives on a 24-hour basis, but customs and quarantine services are only available between 9:00 a.m. to 5:00 p.m. This causes the need for excessive space for breakdown, but under-utilized space was sporadically observed in the interior of the building, resulting in a very low base handling unit value.
- Single parcels are extracted in the breakdown area, causing uneven handling of cargo and exacerbating the lack of space with unneeded breakdowns.

- ✈ The need of claimers and cargo discharge is not synchronized, since the operation of large trucks is limited to night time, resulting in unclaimed cargo unnecessarily taking up the limited space.

Due to these situations, the base unit for import handling diminished to a very low value. It is assumed that the base unit can be doubled to about 7 tons/m^2 by improving the import facilities, including the refurbishment of the under-utilized equipment in the existing facility to allow multi-level storage of cargo during the time the customs services are shut down.

Open air breakdown

Broken down cargo waiting to be carried in



Under-utilized racks

Cargo storage situation

Source: JICA Study Team

Figure 7-7 Import Cargo Terminal Building

Based on the above analysis, the following base units are set out:

Table 7-27 Base Unit for Future Cargo Facilities

Facility	Handling Unit (t/m^2)
Export Cargo Terminal	20
Import Cargo Terminal	7

Source: JICA Study Team

Table 7-28 Floor Space for International Cargo Terminal Building

Category	Distribution	Phase-1 (2025) Cargo Volume	Phase-1 (2025) Required Floor Space (m^2)
Export	67%	400,781 t	20,040
Import	33%	200,391 t	28,630
Total	100%	601,172 t	48,670

Source: JICA Study Team

7.3.6 Car Parking

The number of parking lot and area in the existing car park and planned car park for Terminal 3 is shown in Table 7-29.

Table 7-29 Details of Car Park in Expanded HSIA

Items	Parking Lot	Area (m^2)
Existing (International Terminal)	800	24,500
Existing (Domestic Terminal)	200	2,000
Expansion (Terminal 3)	1,148	50,000
Total	2,148	76,500

Source: CAAB

In addition, the details of car park for Terminal 3 are shown in Table 7-30.

Table 7-30 Details of Car Park for Terminal 3

	Usage	Parking Lot
Ground Floor Level	General	402
	VIP	58
Ground Floor Mezzanine Level	General	402
First Floor Level	General	286
Total	－	1,148

Source: CAAB

The required capacity of car park based on the traffic volume for each access mode in HSIA, which is described in the following sections, is assumed as shown in Table 7-31.

Table 7-31 Required Capacity of Car Park

Target Year / Facility	Existing Facility	Phase-1 (2025) Required Capacity	Phase-2 (2030) Required Capacity	CAAB Master Plan Planned Capacity
Car Park for International Terminal	800 lots	1,280 lots	1,700 lots	1,948 (T1/T2: 800 lots) (Terminal 3: 1,148 lots)

Source: JICA Study Team

The required capacity of car park in phase-1 is 1,280 and the planned capacity in the CAAB Master Plan is 1,148 for Terminal 3. Therefore, the demand of car access to HSIA will satisfy the new Terminal 3 car park in phase-1 timeframe. On the other hand, the required capacity of car park in phase-2 is expected to reach about 1,700. In phase-2, it is planned that the existing Terminal 1/Terminal 2 will be renovated and used for international terminal. Therefore, considering the use of its car park is a rational idea. In that case, the total capacity of car park will reach about 2,000. As a result, the current car park capacity plan and phased development plan are appropriate.

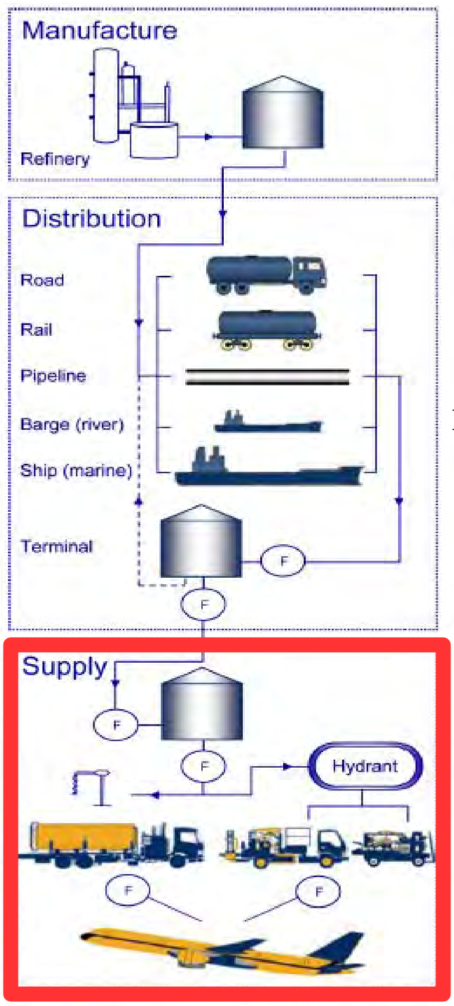
7.3.7 Fuel Supply Facility

The fuel supply facility is not indicated in the CAAB Master Plan. However, according to the development of new terminal 3 (T3), the hydrant facility for new parking spots at T3 is required.

Fuel supply system consists of following facilities;

- Jet Fuel Refinery
- Distribution System of Jet Fuel
- Fuel Depot (Storage Tanks, Hydrant Pumps, etc.,)
- Hydrant Facilities (Apron)

Schematic diagram of fuel supply system is shown in Figure 7-8. The project scope is indicated in the red square box.



Manufacture (Refinery)

Distribution System

(Project Scope)
Airport fuel depot & Fuel Hydrant facility

Source: EI1550 (Reference of ICAO Doc9977)

Figure 7-8 Schematic Diagram of Fuel Supply System

(1) Treatment of existing facility and T3 facility

The treatment of the existing facilities and T3 facility are defined as follows;

- The fuel depot and hydrant facility are a single fuel supply system and cannot be segregated individually. Therefore, the implementation of fuel supply system (Fuel depot and hydrant facility) for T3 must also be implemented as an integrated system.
- However, the construction time for the existing fuel supply facility and new fuel supply facility will differ and the facility design codes/standards, equipment specifications and equipment capacity/pressure are all different between fuel supply facility for T3 and existing facilities. Therefore, the fuel supply facilities for T3 and existing facilities must be developed and installed individually.
- Accordingly, the existing fuel supply facility will continue to supply jet fuel to T1, T2 and cargo area, etc., while a land fuel depot and hydrant system to supply fuel to T3 will be separately required.

- The existing storage tanks currently have 2,880kl capacity and the three additional storage tanks under construction each have a capacity of 2,500kl for a total storage capacity of 7,500kl. The combined capacity is not sufficient to meet requirements (17,000kl) after the completion of T3, and a dedicated storage facility is required separately for T3.
- The three 2,500kl storage tanks under construction by Padma Oil Co., Ltd., shall be considered solely for the supply to T1 and T2 at Phase 2 stage. Therefore, these tanks are not considered for the development of fuel supply facility at Phase 1 stage.
- According to the meeting between CAAB and Padama Oil Co., Ltd. held on 24th October 2016, the relocation of existing pipeline under T3 terminal building and installation of new hydrant pipeline to GA apron at the north area will be developed by Padama Oil Co., Ltd. was confirmed, butt the hydrant facility for T3 was not discussed. The hydrant facility for T3 is under coverage of Japan Yen Loan Package and further discussion with Padama Oil Co., Ltd. concerning its plans for the fuel supply system to T3 and detailed demarcation of work.

(2) Planning of Supply Volume

1) Current fuelling capacity at HSIA

The current fuel supply capacity is shown in Table 7-32.

Table 7-32 Current Fuel Supply Capacity at HSIA

Item	current(2015)	Basis
Annual passenger demand	12.42mppa	JICA Study Team data
Annual fuel supply	356,000kl./year	Data from Padma Oil
Average daily fuel supply	1,000 kl/day	Annual fuel supply/365

Source: JICA Study Team

2) Projected fuelling capacity at HSIA

The projected fuel supply capacity is shown in Table 7-33.

Table 7-33 Projected Fuel Supply Capacity at HSIA

Item	Phase 1(2025)	Phase 2 (2030)	Basis
Annual passenger demand	14.127mppa	19.041mppa	JICA Study Team data
Annual fuel supply	776,000kl./year	1,046,000kl./year	Data from Padma Oil
Average daily fuel supply	2,126 kl/day	2,866 kl/day	Annual fuel supply/365

Source: JICA Study Team

3) Projected fuelling capacity at T3

The fuel supply to Terminal 3 is set out for passenger capacity of 12 mppa. The required fuel reserve capacity will be seven days to manitain stable suupply of fuel at the airport.

The estimated fuel capacity and required reserve capcity are shown in Table 7-34.

Table 7-34 Estimate of Fuel Supply Volume and Required Reserve Capacity

Item	Phase 1(2025)	Phase 2 (2030)	basis
Planned T3 passenger capacity	12.42mppa	16.082mppa	JICA Study Team data
Estimated annual Fuel supply for T3	661,000kl./year	883,000kl./year	Based on increased passenger numbers
Average daily fuel supply of T3 facilities	1.811 kl/day	2,419 kl/day	Annual fuel supply/365
Required reserve capacity	12,667 kl	16.993 kl	Daily fuel supply x 7

Source: JICA Study Team

4) Planning of Reserve Tank Capacity based on required Reserve Capacity

The new reserve tank facilities for T3 are shown in Table 7-35. 3 tanks of 4,500kl capacity will be required in phase-1 and 4 tanks in phase 2.

Table 7-35 Planned Reserve Tank Facilities

Item	Phase 1(2025)	Phase 2 (2030)
Required reserve capacity (7 days)	12,677 kl	16,933 kl
Capacity of one tank	4,500kl	4,500kl
No of tanks	3	1
Total tank capacity	13,500 kl	18,000 kl
Reserve days	7.5 days	7.4 days

Source: JICA Study Team

The following considerations were made in the planning

- ✈ The unit cost for tank become lower as tanks are made bigger. Small tanks are not planned and the largest possible sizes are selected.
- ✈ The additional units are made the same size to simply operations.
- ✈ Tank operations operated with three tanks as a system with one receiving tank, one stilling tank and one discharge tank in order to maintain quality and therefore require three tanks as a minimum. Therefore, each unit is planned as one thirds the required

reserve capacity for phase 1 with three units in total for efficiency. As a result the additional tank planned for phase 2 can be used as the reserve unit.

(3) Fuel Hydrant Capacity Planning for Terminal 3

Fuel hydrant facilities with the capacity to meet the peak hour departures at terminal3 will be required. The flow rate for hydrant facility at Terminal3 is shown in Table 7-36.

Table 7-36 Hydrant Flow Rate

Items	Phase-12025)	Phase-2(2030)	Basis
Aircraft movement at peak hour	28 times/hour	35 times/hour	JICA Study Team reports
Simultaneous fueling	6 aircrafts	10 aircrafts	
Phase-1 Hydrant flow rate	817 kL/h (3,600 gpm)	817 kL/h (3,600 gpm)	Hydrant servicer @600 us-gpm
Phase-2 Hydrant flow rate	-	545 kL/h (2,400 gpm)	
Phase-1,Phase-2 Total	817 kL/h (3,600 gpm)	1,362 kL/h (6,000 gpm)	

Source: JICA Study Team

The refuelling service shall be done by fueller (lorry with fuel tank) at the new cargo terminal because the fuelling volume is small.

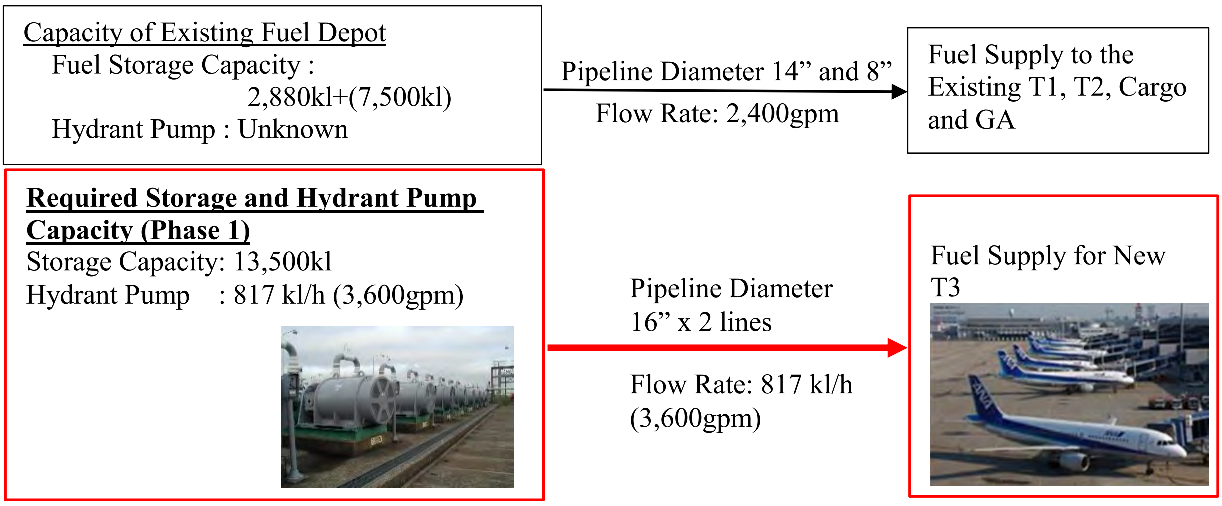
1) Planning and Realization of Facility Capacity

The planned dimensions for the fuel supply system are shown in Table 7-37 and Figure 7-9.

Table 7-37 Summary of Current Capacity of Fuel Supply Facility

Item		Phase-1 (2025)	Phase-2 (2030)	Total
Fuel Tanks	Phase 1	4,500kl x 3 units	-	4,500kl x 3 units
	Phase 2	-	4.500kl x 1 units	4,500kl x 1 units
	Total	4,500kl x 3 units	4,500kl x 1 units	4,500kl x 4 units
Hydrant flow rate	Phase-1	817 kL/h	-	817 kL/h
	Phase-2	-	545 kL/h	681 kL/h
	Total	817 kL/h	545 kL/h	1,362 kL/h

Source: JICA Study Team



Note: 1,000gpm = 227kl/h

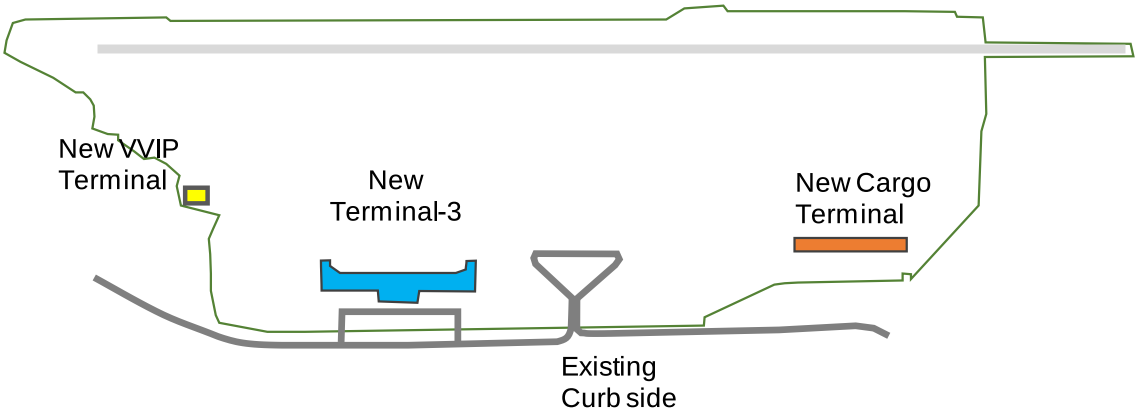
Source: JICA Study Team

Figure 7-9 Summary of Fuel Supply Facility Plan

7.4 Proposal of Phased Development Based on Priority of Each Facility

7.4.1 HSIA Phased Development

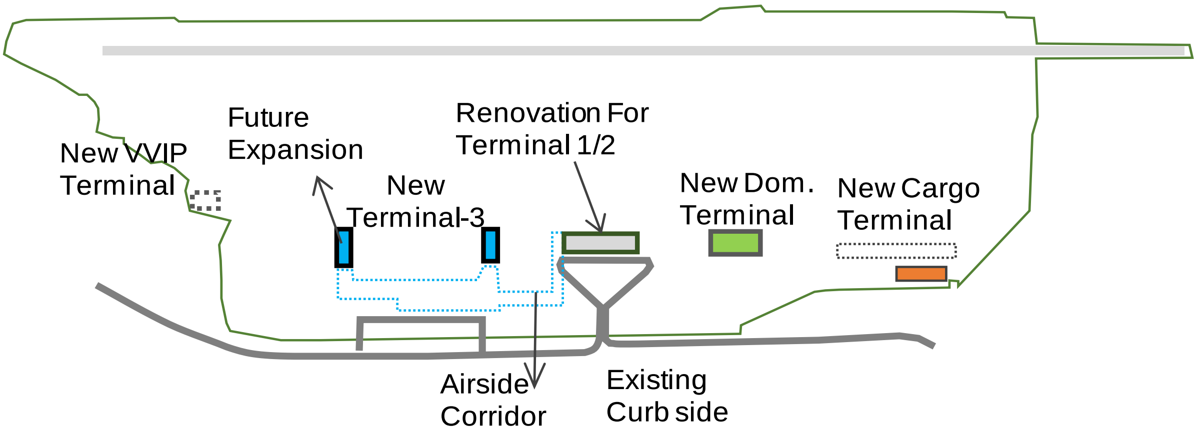
After the discussions with CAAB, it was confirmed that the future development of the HSIA airport facilities would be divided into two phases. During phase-1 (2020) development, the new Terminal 3 will be built without the piers on both left and right sides. In the next step, the pier extension will be planned based on future demand.



Source: JICA Study Team

Figure 7-10 Phase-1 of HSIA Development

During phase-2 development as shown in Figure 7-9, the piers for international flights will be extended at T3. It is projected that the current domestic terminal will not have enough capacity to satisfy future demand. Part of current terminal (T1/T2) can be renovated and used as the domestic terminal or a new domestic terminal constructed on its northwest side. After moving the domestic terminal into new location, the existing terminal (T1/T2) will be renovated and connected to the new Terminal 3, and operated as an international passenger terminal to increase the operation capacity of international passengers. In this case, to ensure that all the functions of the original terminal can be performed normally, the connection with the new Terminal 3 shall be taken by airside corridor.



Source: JICA Study Team

Figure 7-11 Phase-2 of HSIA Development

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CHAPTER 8 AIRPORT IMPROVEMENT PLAN

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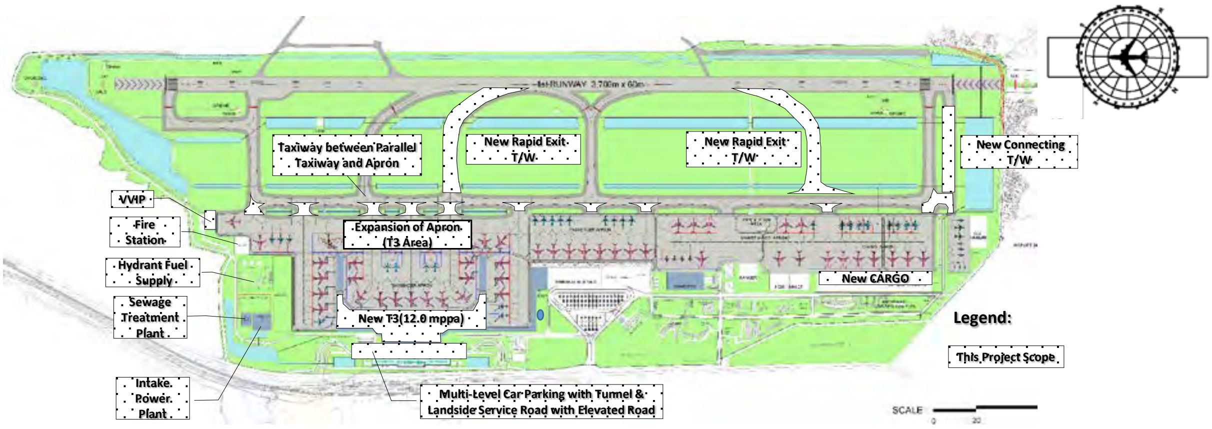
Chapter 8 AIRPORT IMPROVEMENT PLAN

The scope of the the Airport Improvement Plan is examined based on the present condition and required size of the facilities as shown in Table 8-1 and Figure 8-1. The target of the plan is 12 mppa in 2025, five years after the commencement of services at the new international terminal (Terminal 3). The Airport Improvement Plan follows the capacity of necessary facilities calculated in the data collection survey.

Table 8-1 Details of Scope of Works (Phase - 1)

Works	Division	Facilities
Building	New Passenger Terminal Building (Terminal 3)	Three-story building with area of approximately 220,000 m^2 including supply of related equipment with capacity of 12.0 mppa
	Multi-Level Car Parking with Tunnel	Area of approximately 62,000 m^2
	New Cargo Complex	Area of approximately 42,200 m^2
	VVIP Complex	Area of approximately 5,000 m^2
	Rescue and Fire Fighting Facilities	
Civil	Parking Apron (Terminal 3 Area)	Approximately 520,000 m^2
	Taxiways	9 connecting taxiways connecting to the Terminal 3 apron: approximately 35,000 m^2
	Landside Service Road with Elevated Road	
	Taxiways (two rapid exit and one connecting taxiway for the runway 14 threshold)	Approximately 60,000 m^2
	Improvement of Drainage System	
Utility	Water Supply System	
	Sewage Treatment Plant	Area of approximately 3,000 m^2
	Intake Power Plant with Distribution System	Area of approximately 7,000 m^2
	Hydrant Fuel Supply System	
	Communication System	
	Security and Terminal Equipment	

Source: JICA Study Team



Source: JICA Study Team

Figure 8-1 Layout of Scope of Works

8.1 Passenger Terminal Building

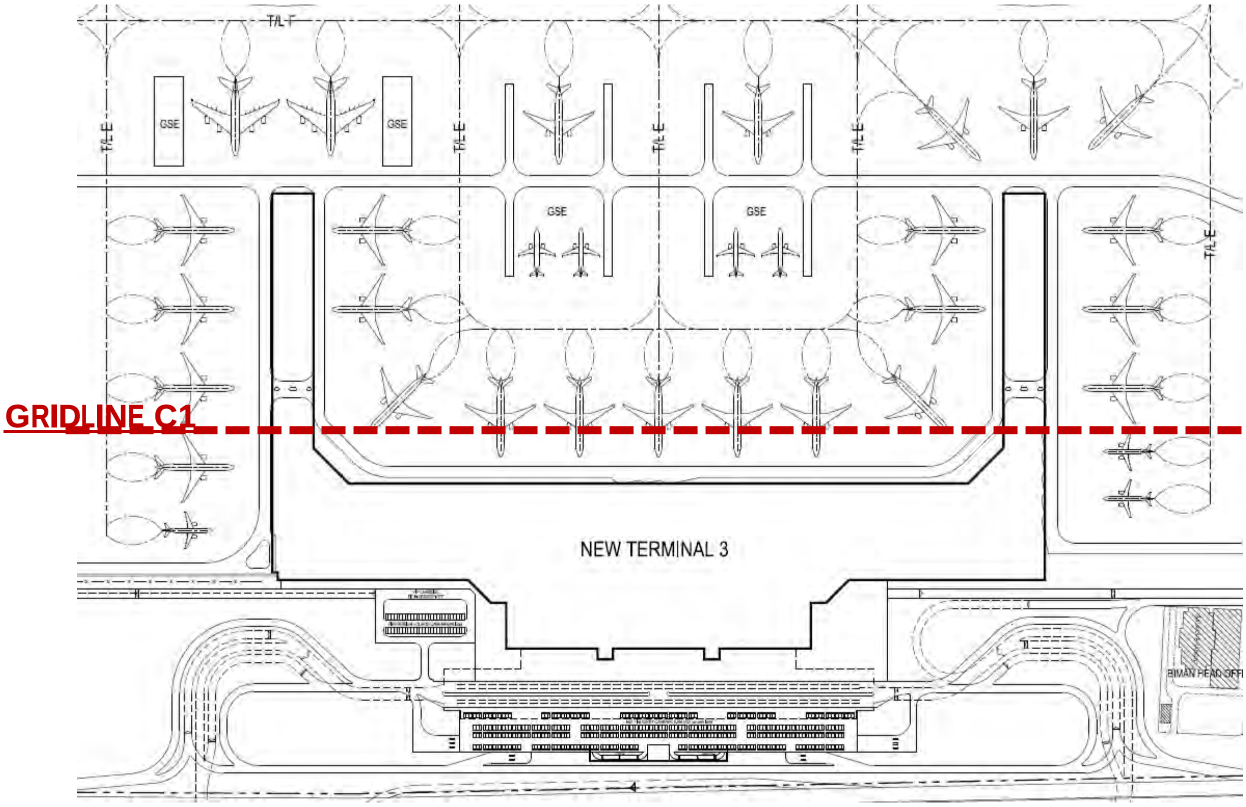
8.1.1 Area and Location Plan

In the improvement plan for Terminal 3, the contact stand will secure 12 spots in accordance with the improvement plan area (about 220,000 m^2) corresponding to the target planning year (2025) of Terminal 3. The case that C1 line in Figure 8-2 is set as the boundary line of Phase-1 was confirmed in a meeting with CAAB. The result of confirmation with CAAB is shown in Figure 8-2 to Figure 8-5.

In case the scale of Phase-1 is up to the C1 line, the area is minimal, and passenger flow is not to be troublesome. However, it is necessary to consider the adjustment of the gate lounge area on the first floor and the concession area since the gate lounge area on the first floor is not large enough in this case. For this adjustment, a meeting with CAAB is necessary. Also, in the next stage, the detailed design based on the Phase-1 function is necessary.

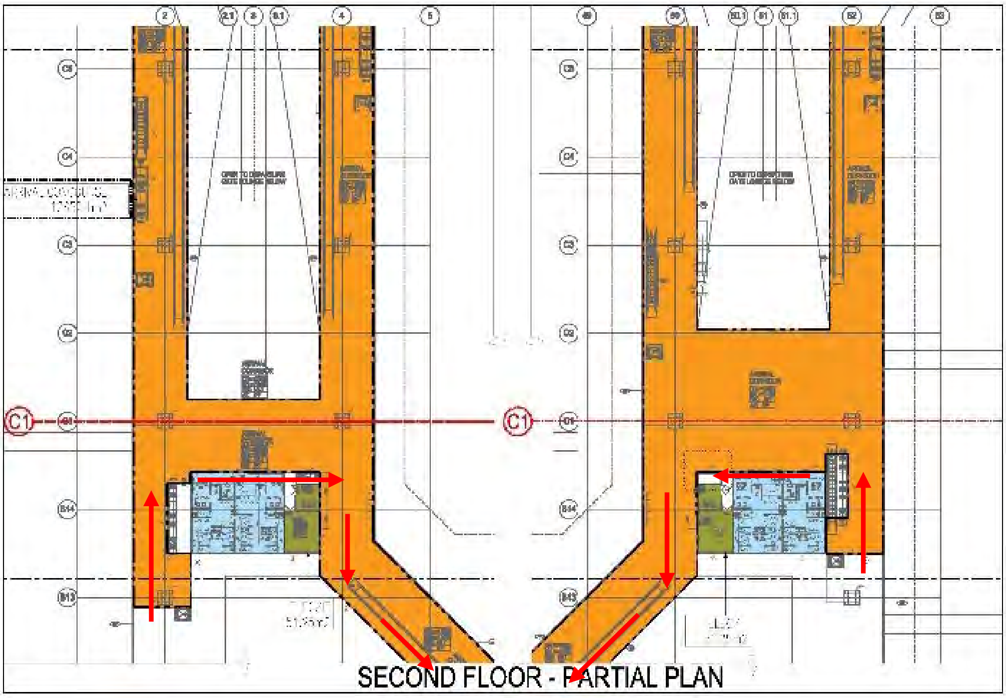
In the 2nd meeting with CAAB held on 6th Feb 2017, the above scope of Phase-1 facilities was reconfirmed. The necessity for rearrangement of layout to satisfiy functional requirements of a 12 mppa terminal, especially the detailed design of M&E, TE, Security and Police Rooms required in the next stage was also comfirmed.

8.1.2 Phased Improvement Plan and Construction Term



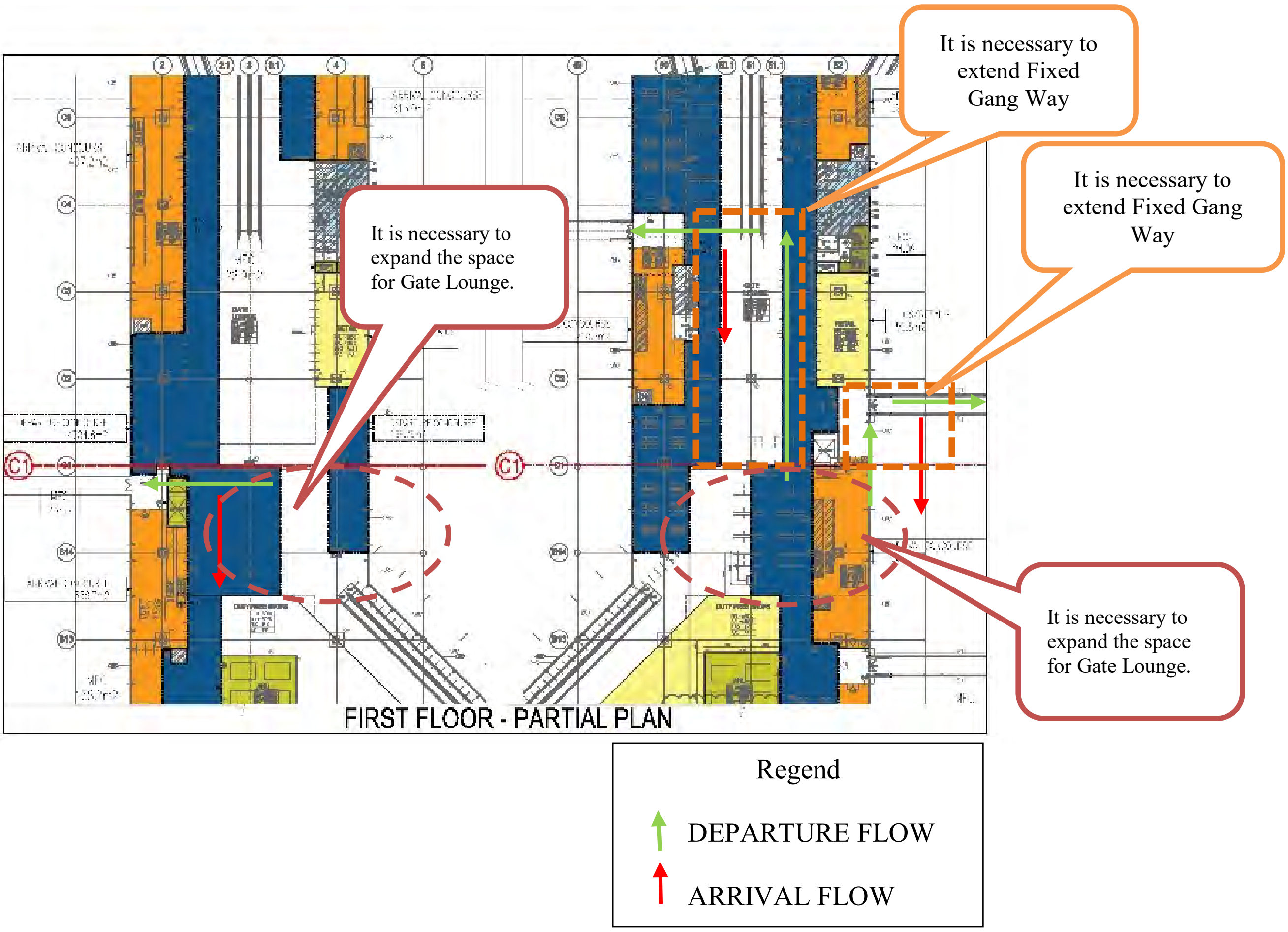
Source: JICA Study Team

Figure 8-2 Improvement Area of Phase-1（Up to GRID LINE C1）



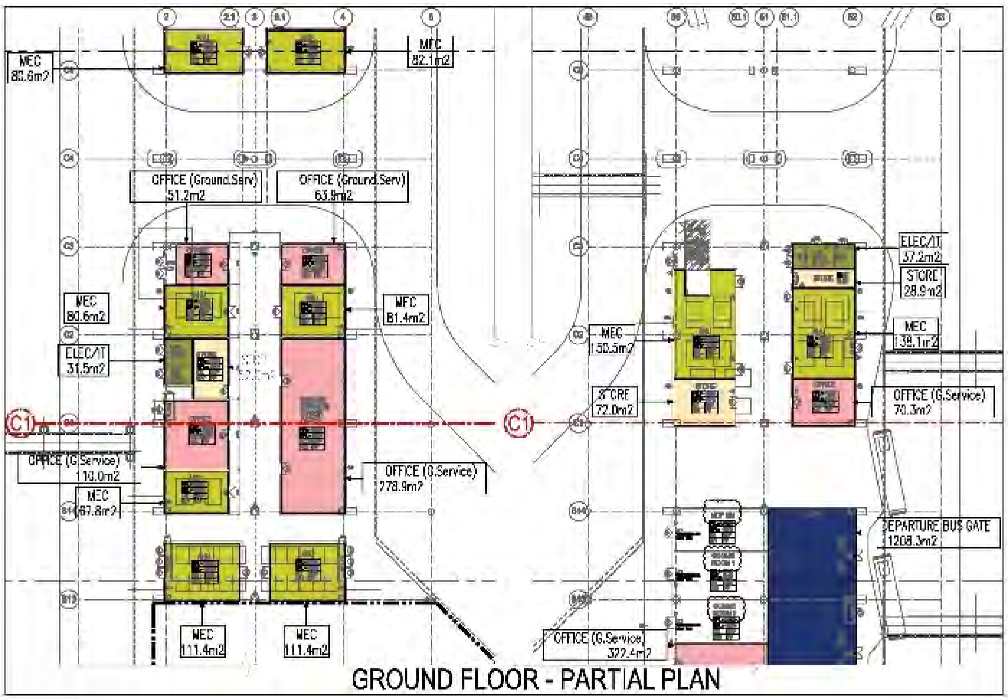
Source: JICA Study Team

Figure 8-3 Second Floor Plan



Source: JICA Study Team

Figure 8-4 First Floor Plan



Source: JICA Study Team

Figure 8-5 Ground Floor Plan

8.2 Cargo Terminal

8.2.1 Layout Plan, Schedule and StagedConstruction Plan and Process

More than a decade has passed since the construction of the current export cargo terminal, based on the explanation of CAAB and a structural evaluation is necessary regarding the soundness of the building.

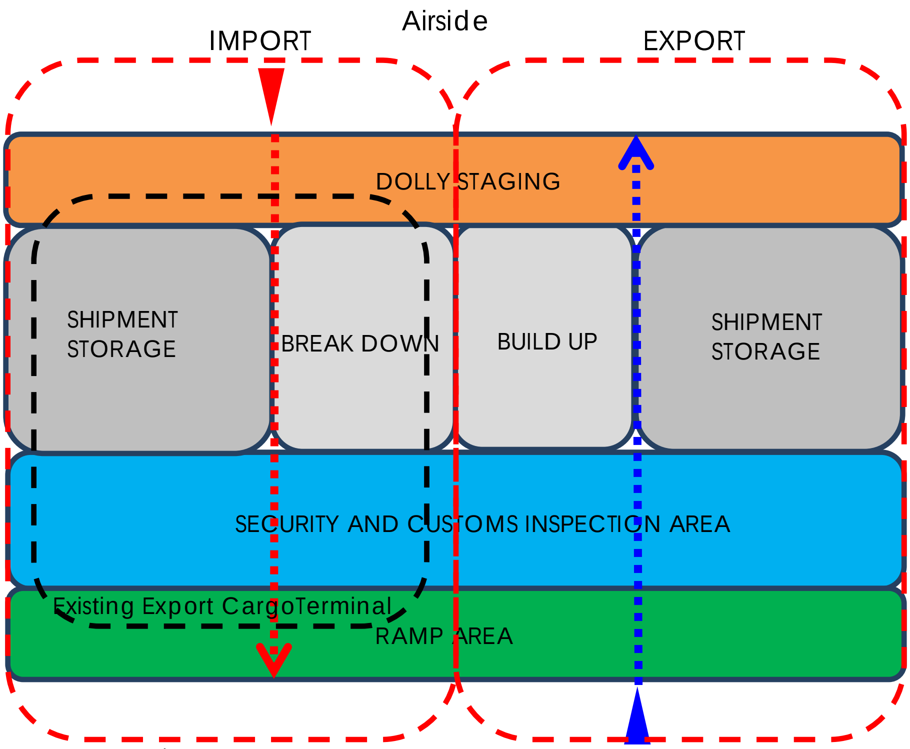
In addition, unused equipment is left abandoned inside the building and layout of some equipment is not appropriate for operations.

In addition, part of the existing export cargo terminal building is included in the scope of the apron construction plan, and partial removal is necessary at the time of apron constraction.

Even if the existing building is kept available for the export cargo terminal, a drastic change of the layout, removal of some equipment, and installation of new equipment are considered necessary.

On the other hand, it is not permitted to close an existing export terminal during operation. Therefore, the new export cargo terminal will be built on the right side (northwest side) of the existing export cargo terminal. After moving export cargo operations to the new facility, the new import cargo terminal will be constructed on the left side (southeastern side).

At present export and import cargo terminal are operated separately. On site inspections revealed serious issues with the space for breakdown and build-up operations. Rebuilding the import and export cargo terminals as a single integrated structure is essential for the improvement of basic handling unit.



Source: JICA Study Team

Figure 8-6 Cargo Terminal Layout

8.3 VVIP Buiding

The policy of the improvement plan for the VVIP building is as follows:

- The functions of the new VVIP building will follow that of the existing VVIP building.
- It was confirmed with CAAB that only general drawings (plan view, elevation view, sectional view) exist for the new VVIP building, and since there are no further drawings, detailed designs including recommended improvements are required.

8.4 Fire Fighting Facility

Based on the rescue manual of ICAO, a Class 9 fire fighting facility with water tank capacity of more than 36,400 liters is necessary. A new Class 9 fire station shall be built.

The Preparatory Study Report for National Aviation Security Facilities Improvement Plan (April 2014) in Bangladesh states that "two of the four main fire fighting vehicles are out-dated and have difficulty in securing the supply of spare parts. They are end-of-life and should be renewed". Subsequently, a fire fighting vehicle of 9,000 liters has already been ordered. Combined with the two operational fire engines, the total water tank capacity will be 38,200 liters and satisfy the ICAO category requirements.

In addition, on-site inspections could not confirm any crash tender or a command car, but these will be necessary in the future since large aircraft are in operation.

Furthermore, it is expected that a water tank lorry is necessary in the future because a fire fighting water tank is not maintained in landing strip unlike airports in Japan.

Based on the above, the following Table 8-1 lists the scope of the fire fighting station to be built.

Table 8-1 Planning Scale of Fire Fighting Facility

Item	Standard	Qty	Remark
FFV	9,000 L	1	
FFV	11,200 L	1	
FFV	9,000 L	2	To be delivered in Feb 2017
Ambulance		4	
Command car		1	
Water tank lorry		1	
Crash tender		1	
Maintenance pit	Underground type	1	
Water hydrant		5	
Waiting room		1	
Control room		1	

Source: JICA Study Team

8.5 Apron

8.5.1 Design Aircraft and Design Load

Based on aircraft movement forecast in this survey, the aircraft traffic volume for apron pavement design is shown in Table 8-2. The design period for apron pavement is 20 years, from 2016 to 2035.

Table 8-2 AircraftTraffic Volume for Apron Pavement Design

ICAO Aerodrome Reference Code (Aircraft Type)	Total Departure and Arrival (from 2016 to 2035)			Total Departure	Average Annual Departure for 20 years (number per year)	Input
	Domestic (20 years)	International (20 years)	Total (20 years)			Design Traffic Volume (number per year)
B (Small Propeller)	676,723	0	676,723	338,362	16,918	16,918
C (Turboprop)	250,587	147,124	397,711	198,855	9,943	9,943
C (Small Jet)	325,625	608,047	933,672	466,836	23,342	23,342
D (Medium Jet)	0	31,064	31,064	15,532	777	777
E (Large Jet)	0	751,448	751,448	375,724	18,786	18,786
F (A380)	0	15,532	15,532	7,766	388	388
Total	1,252,936	1,553,215	2,806,151	1,403,075	70,154	70,154

Source：JICA Study Team

8.6 Taxiway

8.6.1 Design Aircraft and Design Load

Since only 10% of aircraft land in runway 32 direction, the design traffic volume for the north rapid exit taxiway of the taxiway constructed in Phase-1 is 10% of total arrival aircrafts. Based on the aircraft movement forecast in this survey, the aircraft traffic volume for the north rapid exit taxiway pavement design is shown in Table 8-3. The design period for the rapid exit taxiway is 20 years, from 2016 to 2035.

Table 8-3 Aircraft Traffic Volume for the North Rapid Exit Taxiway Pavement Design

ICAO Aerodrome Reference Code (Aircraft Type)	Total Departure and Arrival (from 2016 to 2035)			Total Departure	Average Annual Departure for 20 years (number per year)	Input
	Domestic (20years)	International (20years)	Total (20years)			Domestic (20years)
B (Small Propeller)	676,723	0	676,723	338,362	16,918	1,692
C (Turboprop)	250,587	147,124	397,711	198,855	9,943	994
C (Small Jet)	325,625	608,047	933,672	466,836	23,342	2,334
D (Medium Jet)	0	31,064	31,064	15,532	777	78
E (Large Jet)	0	751,448	751,448	375,724	18,786	1,879
F (A380)	0	15,532	15,532	7,766	388	39
Total	1,252,936	1,553,215	2,806,151	1,403,075	70,154	7,015

Source: JICA Study Team

The aircraft traffic volume used for the design of pavement for the rapid exit taxiways, excluding the north rapid exit taxiway, is the same as that for apron pavement design. The design period for rapid exit taxiway pavement is 20 years, from 2016 to 2035.

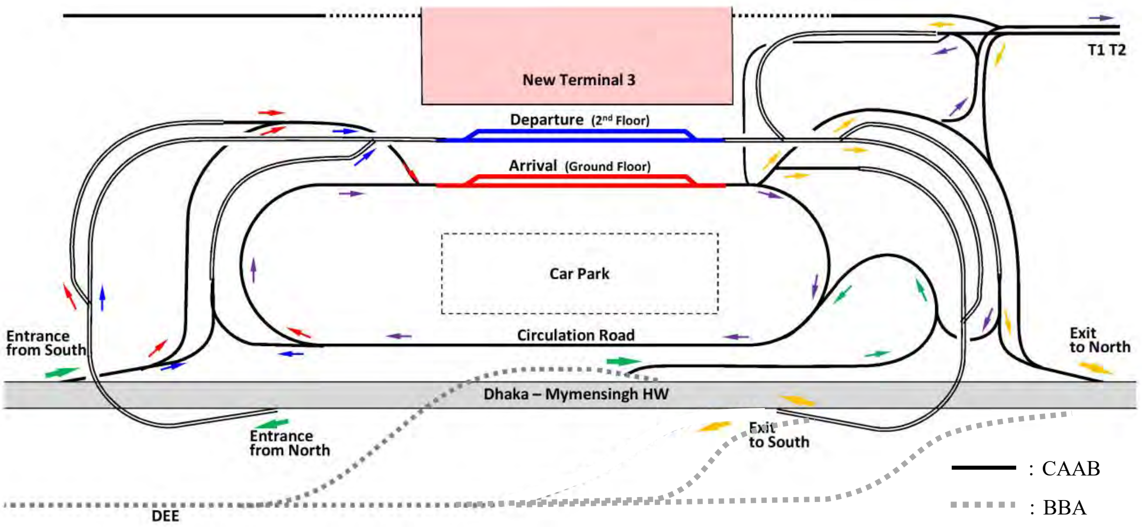
8.7 Internal Road

8.7.1 Road

(1) Basic Policy

The basic policy for planning the internal road is shown below.

- The road layout will follow the past conceptual design.
- The crossing of a major road should adopt elevated crossovers for smooth traffic.
- The circulation road should be provided for functional access in internal area.
- Highest possible service level should be provided in the limited landside space.
- The roads and bridges should be designed for easy recognition of directions.



Source: JICA Study Team

Figure 8-7 Traffic Line of Access / Approach Road

(2) Road Classification

1) Design Standard

Landside road is based on the design standards of Bangladesh and will also refer to the standards of Asian Highway, Japanese road, and IATA manual.

- Geometric Design Standards / Oct 2000 / Roads and Highways Department
- Road Design Standards / May 2004 / Planning Commission

2) Road Classification

The road classification of internal road is equivalent to Type-4 of the Roads and Highways Department (RHD), and the target design speed is 40 km/h. In unavoidable cases, a reduced value will be adopted due to the limited landside spaces. However, a higher service level should be provided whenever possible.

Table 8-4 R oad Classification

Parameter	Bangladesh			Asian Highway		Japan		Proposed
Road Classification	Type3	Type4	Type5	Class2	Class3	3-2	Ramp-B	
Design Speed km/h	50-80	40-65	30-50	40-80	30-60	40-60	30-60	40 (20-30) *1

*1: The reduced value of 20-30 km/h is adopted in a part of curves and curbsides.
Source: JICA Study Team

3) Lane Number

The required number of lanes is analyzed based on the traffic demand forecast in the airport in 2035. In the main internal road, more than two lanes should be provided in consideration of manintaining service levels and the mixture of low speed vehicles such as buses.

Table 8-5 Analysis of Lane Number

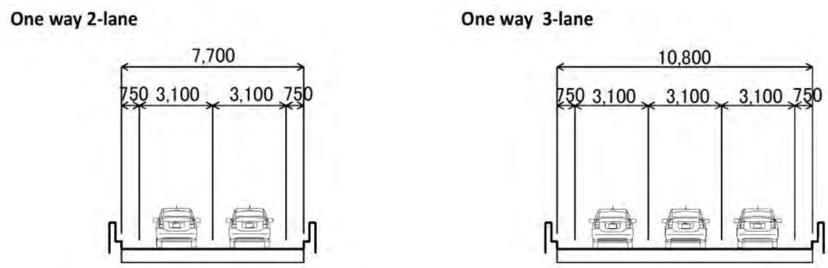
Traffic Capacity

	Basic Capacity Value (pcu/h)	Correction Factor				Service Level	Traffic Capacity (veh/h)
		Lane Width	Lateral Clearance	Roadside Condition	Large Vehicle		
Multi Lane	2,200	0.94	0.95	0.75	0.86	0.90	1,140

Required Number of Lane (2035)

Road		Total Traffic Volume (veh/h)	Distribution (%)	Traffic Volume (veh/h)	Traffic (veh/h)	Required Number of Lane	
						Calculated Value	Recommend
Entrance	N3 South	4,300	30%	1,290	1,140	1.14	2
	N3 North		30%	1,290	1,140	1.14	2
	DEE		40%	1,720	1,140	1.51	2
Exit	N3 South & DEE		70%	3,010	1,140	2.65	3
	N3 North		30%	1,290	1,140	1.14	2

Source: JICA Study Team

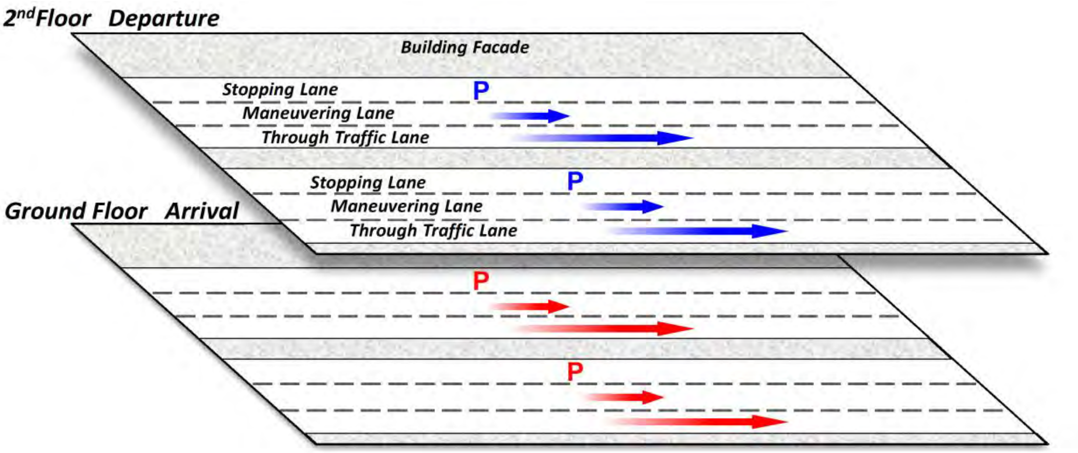


Source: JICA Study Team

Table 8-6 Cross Section of Access / Approach Road

4) Kerbside

The departure and arrival floors are each provided with two kerbsides for smooth traffic at peak hour, al of which will be composed of three lanes for stopping, through traffic, and maneuvering.



Source: JICA Study Team

Figure 8-8 Layout of Kerbside

CHAPTER 9 STUDY OF MULTIMODAL HUB FUNCTION

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Chapter 9 STUDY OF MULTIMODAL HUB FUNCTION

9.1 Current Condition

The daily trip number at HSIA was surveyed in the project for the Revision and Updating of the Strategic Transport Plan for Dhaka (RSTP) by the Japan International Cooperation Agency (JICA) in 2015.

- The daily trip number of airline passengers and well wisher/greeters is estimated at about 60,000 persons, of which about 56,000 persons (93%) visited the international terminal and 4,000 persons (7%) visited the domestic terminal. Only 11,000 persons (18%) out of the 60,000 are airline passengers and the other 49,000 persons (82%) are well-wisher/greeters of the airline passengers.
- The survey results show that almost all visitors used road transportation for access such as CNG (12%), car/taxi (17%), bus (44%), and microbus (26%). The Study found that no passenger use of the railway Airport Railway Station to access the airport.
- The Airport Railway Station of Bangladesh Railways (BR) is heavily used with an estimated daily access by 43,355 railway passengers and well wisher/greeters. Almost all railway access is by bus. Station access survey by RSTP shows the modal share for the Airport Railway Station to be: bus (65.8%), car/taxi (2.7%), and CNG (14.5%).

The Airport Railway Station actually functions as the northern railway hub for long-distance trips to all parts of Bangladesh, and also as the commuter hub from northern Dhaka to the Kamalapur Railway Station hub in central/southern Dhaka.

Although the Airport Railway Station is located only 600 m from the entrance to the exisiting terminal building at HSIA, there are no pedestrian facilities connecting the Airport Railway Station and the Airport Terminal Building and access is very difficult at present.

In the general vicinity of the Airport Railway Station, a five-star hotel and shopping mall are under construction on the opposite side of the Airport Road. However, pedestrian accessibility between the Airport Railway Station and these commercial facilities is not yet available, although a new pedestrian bridge crossing over the Airport Road is now under construction.

9.2 Urban Transportation Network Development Plan Connecting with HSIA

The RSTP proposed a mass transit network for Dhaka City by 2035, which consists of five mass rapid transit (MRT) and two bus rapid transit (BRT) lines. The existing BR lines are also a significant part of the public transportation network of Dhaka City. However, it is doubtful that high density train operation on the BR lines between the Airport Railway Station and Kamalapur Railway Station is feasible considering that the existing double track railway is at-grade and various level crossings exist, which would seriously disrupt the traffic flow in the city. Based on the future railway network in Dhaka, the JICA Study Team assessed the possibility of twin hubs development with multimodal transport functions. One is the northern hub at the Dhaka International Airport and the other is the southern hub at the Kamalapur Railway Station. The northern hub, i.e., HSIA, will have access through MRT Line-1, BRT Line-3, and double-double track of BR. In addition, the Dhaka Elevated Expressway (DEE) will be connected with HSIA.

9.3 Traffic Demand Forecast for HSIA

9.3.1 Assumption of Traffic Volume at HSIA

Daily passengers were calculated from total domestic and international passengers numbers for 2015 obtained from CAAB. Total number of well-wishers is estimated from the ratio of passengers and well-wishers according to the RSTP Study.

Modal share is applied based on the above reports to allocate domestic and international terminal visitors into passengers and well-wishers for each transport mode.

Table 9-1 Daily Total Passengers and Staffs for Each Transport Mode in 2015

	Domestic		International		Staffs	Total
	Passengers	Well-wishers	Passengers	Well-wishers		
CNG	368	1,047	1,992	10,274	23	13,704
Car	416	1,184	12,825	29,476	371	44,272
Microbus	813	2,315	3,378	15,412	179	22,097
Bus	1,412	4,019	291	29,055	1,202	35,979
Total	3,009	8,565	18,486	84,216	1,776	116,053

trip / day
Source: JICA Study Team

In order to calculate the traffic volume at HSIA, the daily total passengers, well-wishers, and staffs for each transport mode are divided by the average occupancy rate. Average occupancy rate is given by the RSTP screen line survey. This survey was conducted within the Dhaka central area. It is considered that much more passengers are riding together in the airport access car and microbus compared with those in the Dhaka central area because the majority of well-wishers are family members. Two additional fellow passengers are estimated for private cars and microbuses as summarized in Table 9-2.

Table 9-2 Average Occupancy Rate

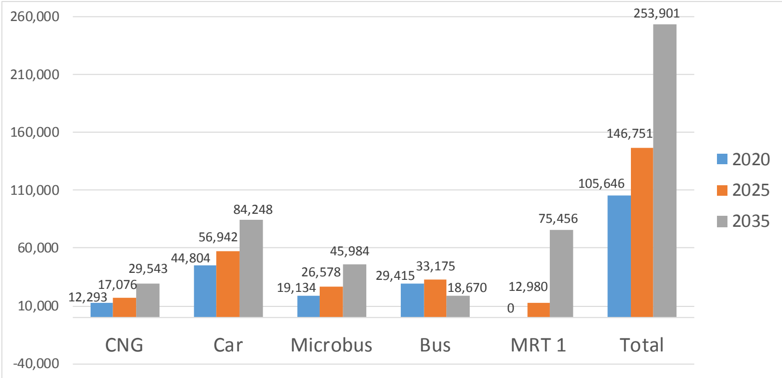
Vehicle Type	Obtained from RSTP	Modified by the JICA Study Team
CNG	2.3	2.3
Car	2.4	4.4
Microbus	3.8	5.8
Bus	42.3	42.3

Source: RSTP and JICA Study Team

9.3.2 Preliminary Future Airport Access Traffic Demand Forecast

(1) Future Person Trip Demand at HSIA

Applying the above future demand and modal share, the future traffic demand is assumed as summarized in Figure 9-1.

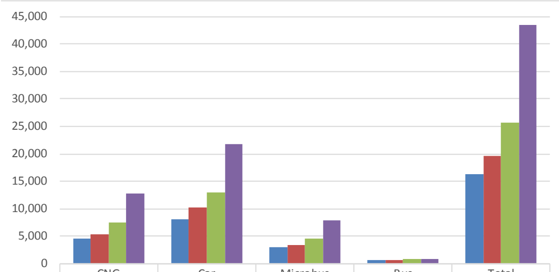


Source: JICA Study Team

Figure 9-1 Future Person Trip Volume

(2) Future Traffic Demand at HSIA

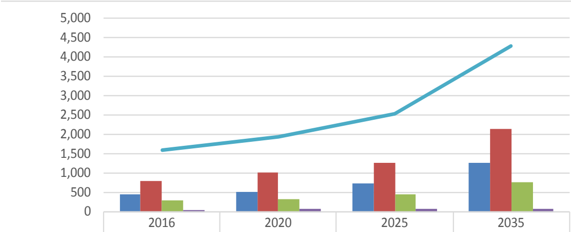
Total assumed traffic volume is shown in Figure 9-2, and total assumed hourly peak hour traffic volume is shown in Figure 9-3.



	CNG	Car	Microbus	Bus	Total
2016	4,549	8,153	2,908	622	16,232
2020	5,345	10,183	3,299	696	19,523
2025	7,425	12,942	4,583	785	25,735
2035	12,845	21,743	7,929	894	43,411

Source: JICA Study Team

Figure 9-2 Total Assumed Traffic Volume



	2016	2020	2025	2035
CNG	450	529	735	1,271
Car	807	1,008	1,280	2,151
Microbus	288	326	453	784
Bus	62	69	78	88
Total	1,606	1,932	2,546	4,295

Source: JICA Study Team

Figure 9-3 Total Assumed Hourly Peak Hour Traffic Volume

9.4 Current Development Plan for Multimodal Hub Facilities

9.4.1 Overview of the Development Plan Proposed by Bangladesh Railway

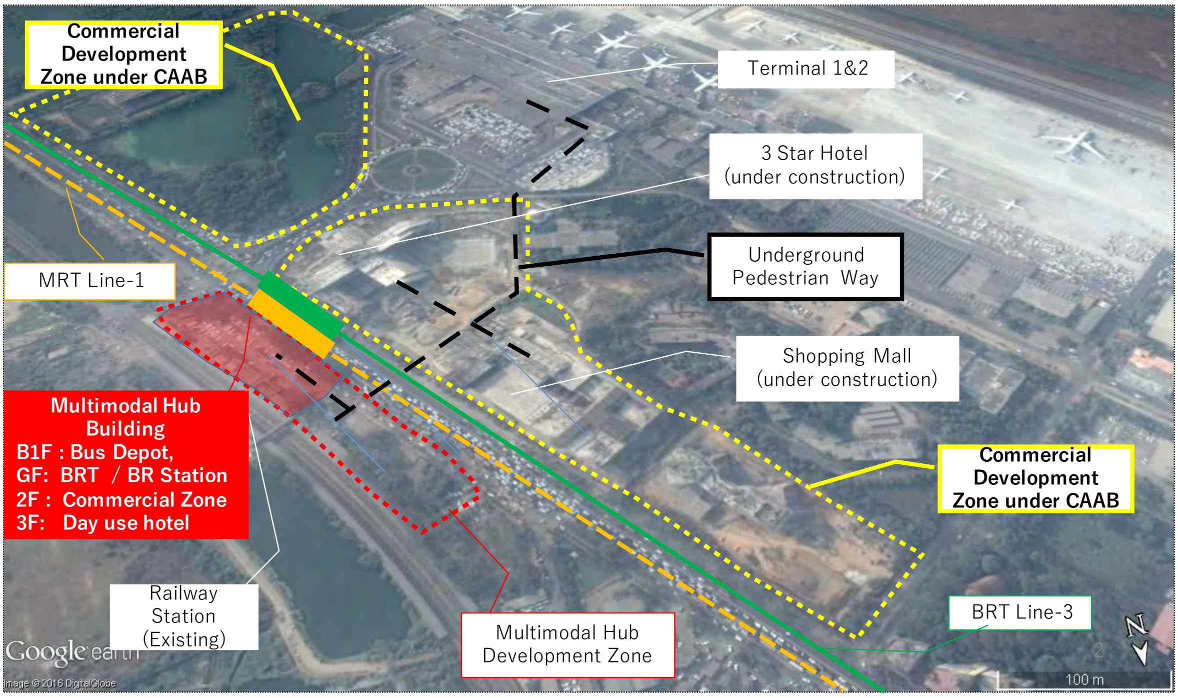
A multimodal transport hub has been considered in the Greater Dhaka Sustainable Urban Transport Project (GDUSTP) (BRT, Airport-Gazipur) to facilitate easy and smooth transfer from one mode to another, especially between BRT and rail. These multimodal transport hub facilities, as envisaged in the Development Project Program (DPP) of the BRT Line-3 Project, were planned to be constructed on a public-private partnership (PPP) basis, premised on including revenue generating facilities at the hub. A pre-feasibility study prepared under GDSUTP (BRT, Gazipur-Airport) has been submitted for consideration of the Ministry of Railways. BR owns land nearby the airport, out of which more than 7,000 m^2 of land could be utilized to develop this multimodal hub, although part of this area is already utilized by the existing railway station.

The outline of the multimodal hub facilities is as follows:

- B1F: Depot for 30 buses, waiting room for railway passengers, and shopping mall
- GF: BRT station and U-turn facility, rest space for operators, and railway signal operation room
- 2nd Floor: Commercial space
- 3rd Floor: Hotel (for international passengers, 2-3 star class).

In the plan, MRT Line-1, planned for future construction, is also considered to connect to the hub facilities. MRT Line-1 is planned as an underground station and will connect with the multimodal building through an underground pedestrian tunnel is to be constructed to connect to the commercial zone in the airport landside and to the existing terminal building.

In summary, the multimodal transport hub plan at the existing Airport Railway Station yard will be integrated with the BR line, BRT Line-3, MRT Line-1, and existing Terminal 1 and Terminal 2 of the airport as well.



Source: JICA Study Team based on the plan of BR and RSTP

Figure 9-4 Current Multimodal Hub Development Plan

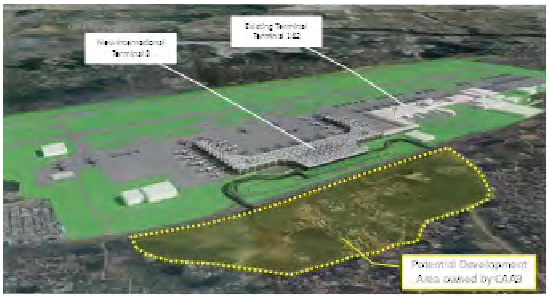
The review points on the multimodal hub facility development are summarized as follows:

- Current location of the proposed multimodal hub facility is too far for pedestrian access to the new Terminal 3.
- BR is planning to develop 3rd and 4th tracks of BR Dhaka (Kamalapur) – Airport Station – Tongi, and additional platform will be required at the Airport Station.
- BR is considering to relocate Airport Railway Station southward, as the current platform is located on a curved portion and not suitable from the safety viewpoint.

- BRT Line-3 is about to start implementation and obliged to change operation plan as depot for 30 buses is expected to be provided in the multimodal hub facilities.
- PPP scheme is not realistic at this moment, as no private investors are interested in financing. Restructuring the development plan is essential for implementation.

9.4.2 Distribution of Airport Users Due to the Relocation of International Terminal

There is a huge plot owned by CAAB in front of the new terminal of HSIA on the opposite side of the Airport Road. The total area is 9.4 ha, which is currently used as residential area of CAAB staff. The land use plan is formulated in the master plan in February 2015, in which the area is still planned as residential area of CAAB staff and for the maintenance aspects such as education and airport supporting complex.



Source: CAAB Master Plan, Feb.2015

Figure 9-5 General View of CAAB Land

The proposed structure plan of the land in front of Terminal 3 is summarized as follows:

- Concept of Structure Plan
  - Planning Population: 21,500
  - Pop. Density: 515 persons/ha
  - 40% land to distribute as residential area of CAAB staff.
  - 20% land to distribute as park and 20% for public facilities,
  - 8% land to distribute central commerce and 12% for support facilities to boost economy around Dhaka International Airport.

The Land Use Plan may not consider the development potential of Airport Front Area

Source: JICA Study Team

Figure 9-6 Existing Land Use Plan of CAAB Area in front of Terminal 3

On the other hand, the land in front of the new terminal might have high development potential, and may be not suitable as residential area because of the following reasons:

- The area can be identified as International Gateway City of Bangladesh, as the location is directly in front of the international terminal. There are many other examples of development of gateway city nearby the international airport, such as Bangkok, New Delhi and so on.
- Airport accessibility through public transportation should be taken into account. It is not convenient for the airport users to use the proposed multimodal hub facilities at the existing BR Airport Station. New stations for BRT and MRT are anticipated to be located in front of the international terminal for easy access. BRT/MRT access are secured in almost all major international airports, such as Delhi, Bangkok, Kuala Lumpur, Haneda, and so on. A part of the residential area can be used for multimodal access to the international airport.
- Residential purpose in front of the international terminal would not be suitable in view of environmental, noise pollution, and security aspects.
- Taking the above into account, it is recommended to review the land use plan in front of the international airport terminal.

9.5 Proposed Plan for Multimodal Hub Function at HSIA

Based on the above studies and analysis through the demand forecast, traffic counting survey, and so on, the following measures are proposed related to the multimodal hub function at HSIA:

9.5.1 Separate Functions on BR's Multimodal Hub Facilities and Public Access Mode on HSIA Terminal 3

Considering the following, it is proposed that the BR's multimodal hub facilities would contribute to the better access to HSIA, particularly for the new international Terminal 3. It is therefore recommended that the BR multimodal hub facility shall be considered separately from the airport access development function, and not to be considered in the Airport Expansion Project.

- BR railway is heavily congested and scheduling is not frequent, making it difficult to use BR railway with heavy luggages.
- The distance between the BR Airport Railway Station and existing airport terminal is too close to use taxi/CNG, but too far for pedestrian traffic with heavy luggages. Therefore, there will be few airport users using the railway.
- It is quite difficult to cross over the Airport Road between the Airport Railway Station and existing airport terminal. The road is always heavily congested and no pedestrian bridge with escalator over the Airport Road is available.
- BR Airport Railway Station is functioning as multimodal hub for commuters in northern Dhaka. The passengers are not airport users but residents of northern Dhaka for commuting to central and southern Dhaka City.

9.5.2 Provision of Public Transportation Access to HSIA

Provision of public transportation mode is very important and should be considered in the Airport Expansion Project. Conceivable public transportation access would be by BRT, MRT, city buses and taxi in addition to private vehicles. Particularly, MRT would be the most important access mode for HSIA by public transportation because traffic congestion in Dhaka City is very severe and the impact on time savings by using MRT would be significant compared to road transportation. It often takes one to two hours from the airport to major terminals in the city by car, taxi, or bus, but it will take only 15 minutes from Kamalapur Railway Station to Terminal 3 via MRT. BRT and airport bus services should also be developed to supplement public access where MRT cannot have coverage.

Table 9-3 Comparison of Airport Access Mode of Asian International Airports

City	Kuala Lumpur		Singapore		Delhi		Dhaka	
Access Mode	Time	Fare	Time	Fare	Time	Fare	Time	Fare
Railway	28 min	MYR35	30 min	SGD 2.2	20 min	INR 100	15 min	-
Airport Bus	60 min	MYR 10	30-60 min	SGD 9.0	50 min	INR 75	60-120 min	-
Taxi	60 min	MYR 70-90	20-40 min	SGD 20-40	50 min	INR 400-500	60-120 min	-

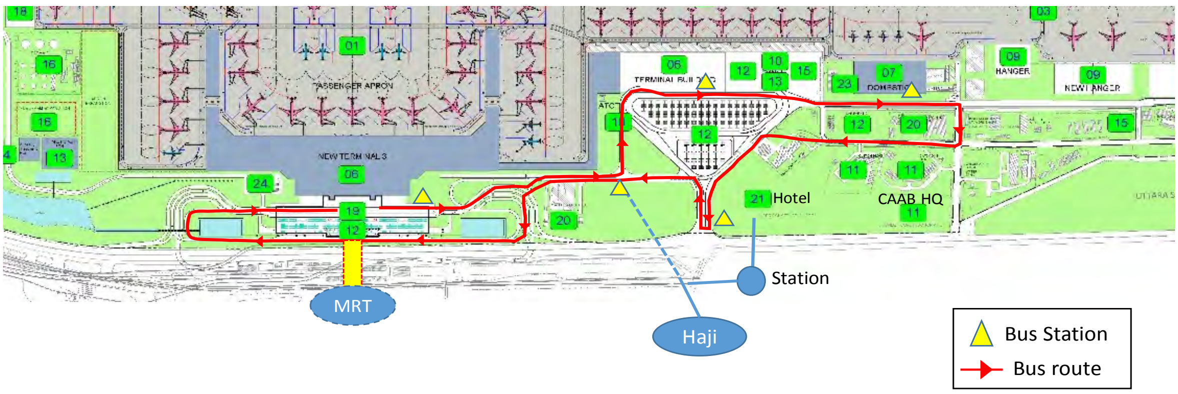
Source: Travel information through internet for Kuala Lumpur, Singapore, and Delhi; JICA Study Team estimation for Dhaka

9.5.3 Provision of Airport Bus Services and Planning for Bus Stops

Airport bus service from/to airport and major places in the city, such as railway station, bus terminal, major hotels and so on, shall be planned by CAAB. This mode would be the most convenient for international visitors, who are not familiar with the Dhaka City area. The airport bus should be basically exclusive to transport airport users carrying luggages to/from major transport hubs in Dhaka and hotels. The considered destinations are as follows:

- Major Bus Terminals (Saidabad, Gabtoli, Mohakhali, others)
- Railway Station (Kamalapur (BR), Airport Station (BR), Uttala Center (MRT6))
- Ferry Terminal (Sadar Ghat)
- Hotels (Major hotels in the city)

Airport shuttle bus connecting Terminals 1, 2, and 3 is also required. The route shall be within the airport land. The bus stops at nearby BR Airport Station in the airport area should be provided if necessary.



Source: JICA Study Team

Figure 9-7 Airport Shuttle Bus Station and Route

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