THE STUDY ON THE DEVELOPMENT OF CHITTAGONG AIRPORT IN THE PEOPLE'S REPUBLIC OF BANGLADESH

FINAL REPORT

MAIN REPORT

SEPTEMBER 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the People's Republic of Bangladesh, the Japanese Government decided to conduct a study on the Development of Chittagong Airport and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a survey team headed by Mr. Shota MORITA of Pacific Consultants International from December 1988 to February 1989 and in July 1989.

The team held discussions with concerned officials of the Government of Bangladesh and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

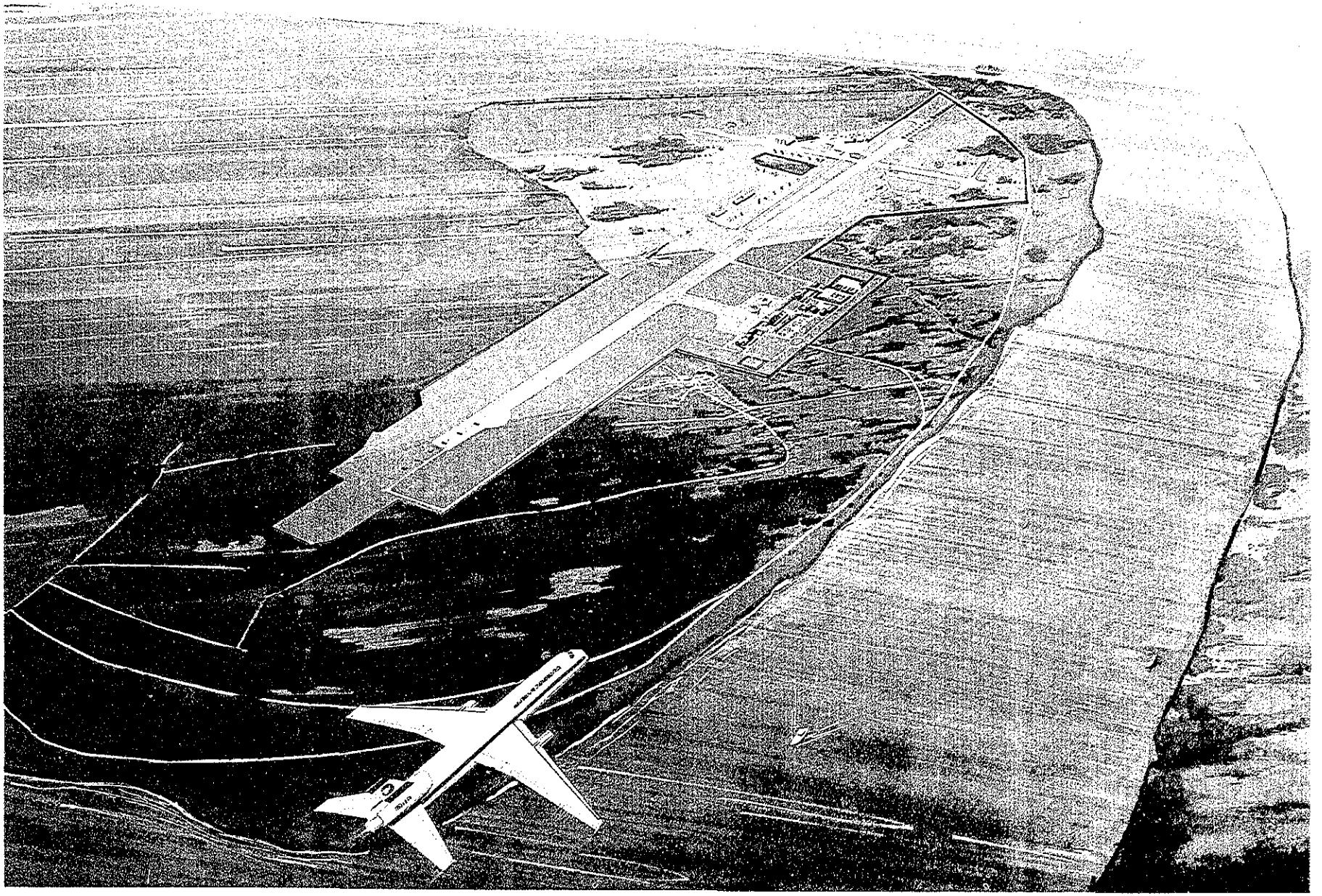
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincerest appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

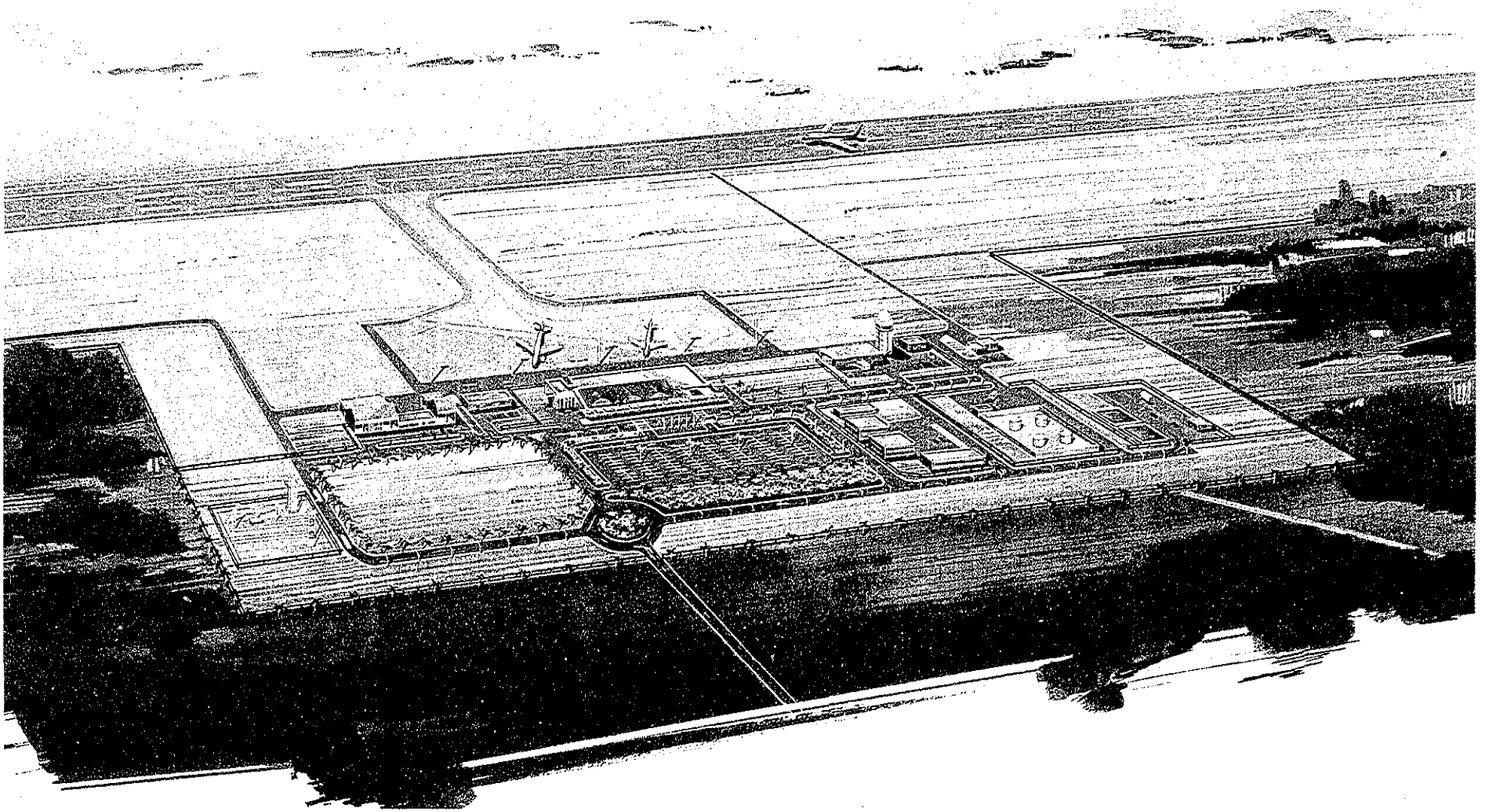
September 1989

Kensuke Yanagiya

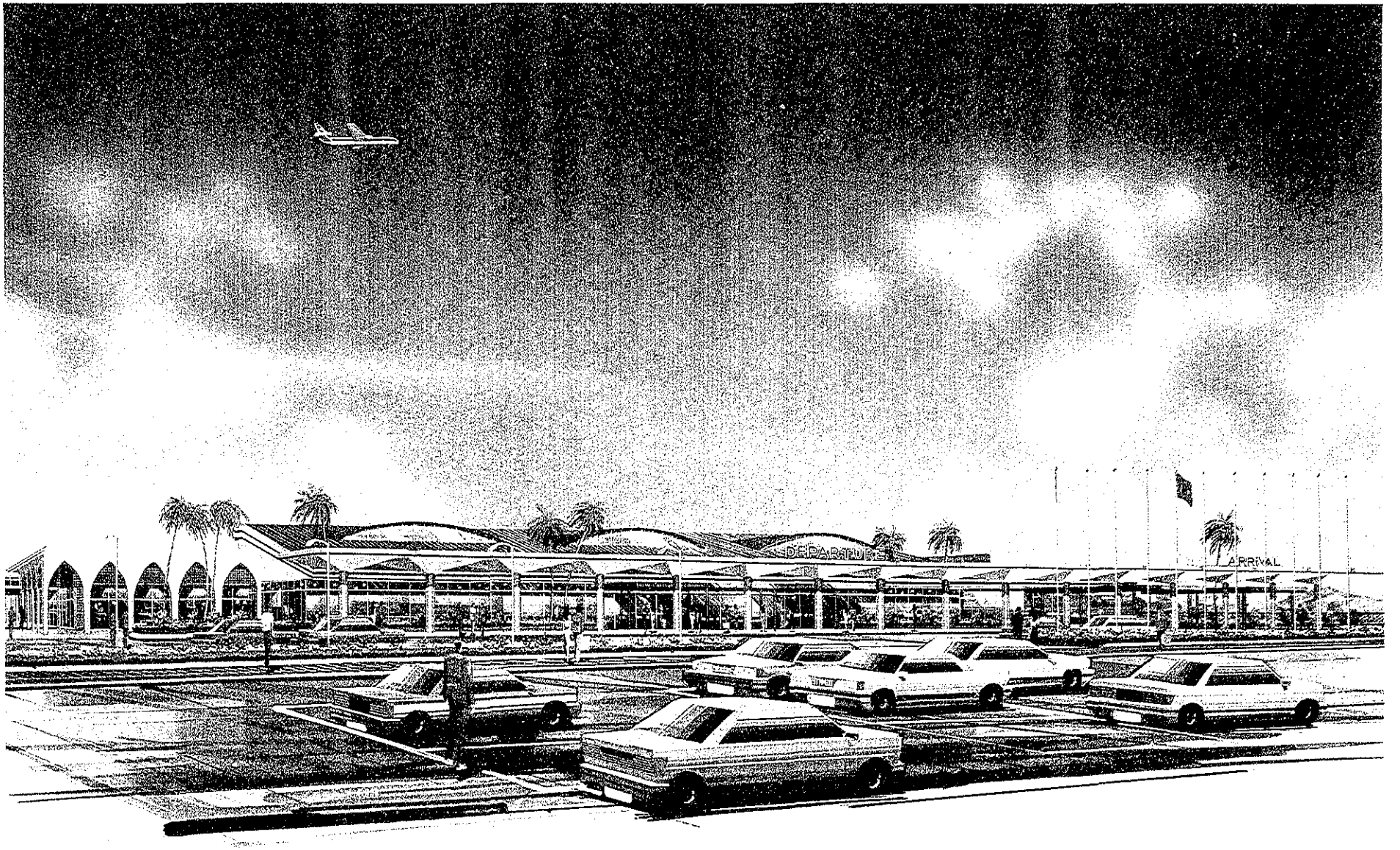
Kensuke Yanagiya
President
Japan International Cooperation Agency



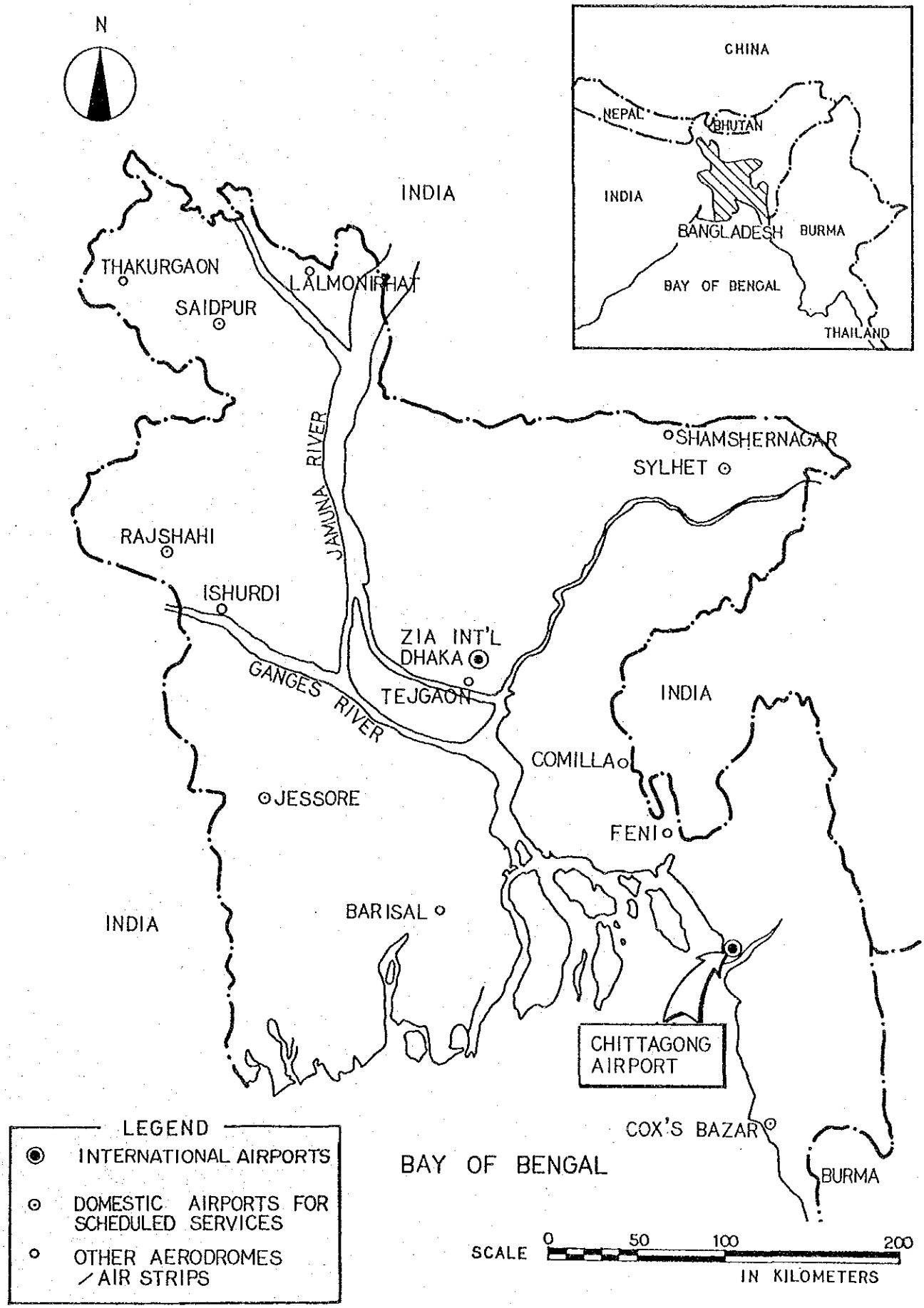
CHITTAGONG AIRPORT PHASE I DEVELOPMENT PLAN
TARGET YEAR 2000



NEW TERMINAL AREA



NEW PASSENGER TERMINAL BUILDING



PROJECT LOCATION MAP

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CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 General

Bangladesh is situated on the north of the Bay of Bengal, and stretches over 640 km north to south and about 490 km east to west, roughly between India and Burma. It contains the Gandes Delta and has a total area of about 144,000 sq.km with an estimated population of 106 million in 1988.

Due to a lack of sufficient surface transport, air transport plays an important role in smoothing socio-economic activities and in promoting structural change of the economy towards industrialization.

In Bangladesh, there are 14 airports, aerodromes and landing strips, including two airports for international services, i.e. Dhaka and Chittagong. Seven of the above airports are utilized for scheduled air services as indicated in the project location map and form a radial air route structure with Dhaka as its center.

Chittagong Airport is located 8 km south of Chittagong City is located at the mouth of Karnafuli River facing the Bay of Bengal. Chittagong City has a population of about 2 million in 1988 which is the second largest in the country. This city plays an important role as a gateway to Bangladesh for sea transport. More than 70% of import and export marine cargo is handled by the Port of Chittagong. Having the advantage of marine communication, Chittagong Region has grown to be a major industrial area which accounts for 12% of the industrial and commercial output of the country. Although this area has developed along with the expansion of heavy industries, high-value-added industries such as manufacturing of electrical parts have also located in the Chittagong Export Processing Zone in line with the country's policy which promotes foreign investment.

The existing airport is composed of a 3,048 m long runway, taxiway, apron, international and domestic terminal buildings and other

supporting facilities. However, the facilities are insufficient even for the present traffic and in obsolescent conditions. Terminal facilities are old and small and there is no room for expansion in the existing area. The existing runway strength is not sufficient for large aircraft such as DC-10's. These situations will limit the growth of air transport and result in a slowdown of regional development.

In addition to the capacity problem of the facilities, the ships sailing on Karnafuli River constitute an obstacle to the approach surface and air safety is threatened. This problem requires an immediate solution because the ensurance of the aircraft operational safety is the most fundamental requirement for users.

This airport has CIQ (Customs, Immigration and Quarantine) facilities for international passengers from/to foreign countries. At present, the only international destination directly connected with Chittagong Airport is Calcutta. However, about 3,000 international passengers mostly from/to Middle East Region undergo the government formalities at Chittagong Airport every month. They are carried by mixed domestic flights between Chittagong and Dhaka so as to be connected with international flights at Dhaka. Chittagong Airport is therefore considered to have enough traffic to be positively developed as a major international airport.

There is another important reason for Chittagong Airport to be developed as an alternate to Zia International Airport in Dhaka. This need was emphasized by the closure of the runway at Zia International Airport from September 2 to 6, 1988 when all the international flights diverted to Calcutta due to flood water. Since Chittagong Area is free from floods, Chittagong Airport is expected to contribute to the social welfare of Bangladesh by functioning as a distribution center and a relay point for disaster relief which will be sent from foreign countries to Chittagong Airport by air and to Chittagong Port by sea.

The importance of air transport services for Chittagong Area is also confirmed by the Export Processing Zone Authority in Chittagong since international air transport is an essential requirement for factory operations and expansion of foreign investment.

The Government of Bangladesh therefore recognized that unrestricted air transport services in Chittagong are indispensable for economic development and social welfare, and decided to develop Chittagong Airport immediately in order to ensure adequate air transport services with the international standards and recommended practices of ICAO (International Civil Aviation Organization) to which Bangladesh is a signatory member.

In response to the request of the Government of Bangladesh, the Government of Japan decided to conduct the Study on the Development of Chittagong Airport (hereinafter referred to as "the Study") in accordance with the Agreement on Technical Cooperation between the Government of Bangladesh and the Government of Japan.

Based on the decision, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), an official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, has been entrusted to carry out the Study.

1.2 Objectives and Scope of Work

The objectives of the Study are to prepare a long-term master plan for the phased and orderely development of Chittagong Airport and to plan a Phase I development project (hereinafter referred to as "the Project") which will be implemented to solve the present facility problems. Phase I development project is to be examined in terms of technical and economic feasibility.

The Study comprises the following 24 major work items:

[1] Review of Available Data
[2] Preparation of Inception Report
[3] Explanation and Discussion of Inception Report
[4] Site Investigation
[5] Collection and Analysis of Data and Information
[6] Analysis of Meteorological Data
[7] Topographic Survey and Soil Investigation
[8] Air Traffic Analysis and Demand Forecast
[9] Airport Facility Requirement Analysis
[10] Evaluation of the Existing Airport
[11] Airport Master Planning
[12] Preparation of Progress Report
[13] Explanation and Discussion of Progress Report
[14] Finalization of Airport Master Plan
[15] Establishment of the Phase I Development Project
[16] Preliminary Design
[17] Construction Schedule and Preliminary Cost Estimation
[18] Economic Analysis
[19] Financial Analysis
[20] Conclusion and Recommendation
[21] Preparation of Draft Final Report
[22] Explanation and Discussion of Draft Final Report
[23] Preparation of Final Report
[24] Submission of Final Report

1.3 Execution Method and Reporting System

The Study Team conducted the Study in accordance with the procedures outlined in the Inception Report, which was submitted immediately after the team's mobilization into Bangladesh in December, 1988.

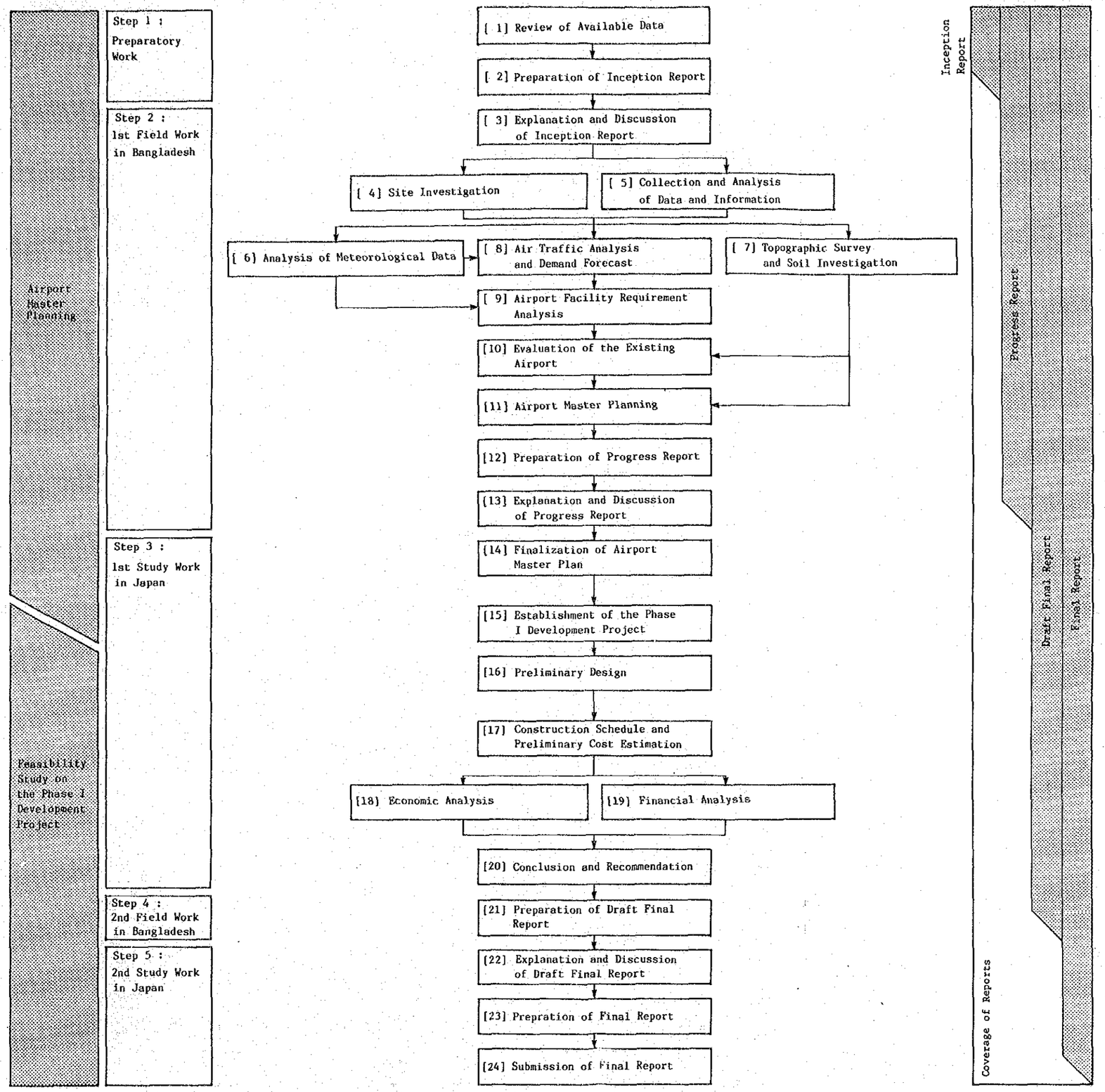

Figure 1.2.1 Main Work Flow Chart

The Inception Report was accepted by the Ministry of Civil Aviation and Tourism (hereinafter referred to as "MCAT") and the Civil Aviation Authority of Bangladesh (hereinafter referred to as "CAAB") and the Study Team immediately proceeded with data collection and site investigation of Chittagong Airport. The Study Team then carried out the field work including a topographic survey, obstacle survey, soil investigation, pavement investigation and traffic survey. Studies covering the air traffic analysis through airport master planning with close cooperation and participation of the Bangladeshi counterpart officials were also conducted. The result of these studies during a 3 month stay in Bangladesh was summarized in the Progress Report. It was submitted to MCAT/CAAB in February 1989, and accepted in principle by CAAB.

The Study Team after returning to Japan carried out the alternative study for the airport master plan and finalized the plan incorporating the comments on the Progress Report. The construction work items of Phase I development were determined within the framework of the airport master plan, and the preliminary design was prepared on the determined scope of the Project.

The economic and financial analyses were also executed based on the preliminary cost estimates of the airport master plan. The Draft Final Report summarized the comprehensive results of the Study on the Development of Chittagong Airport.

The Draft Final Report was submitted in July, 1989 and was accepted.

This Final Report is finalized incorporating MCAT/CAAB's comments on the Draft Final Report and consist of "Main Report" and "Summary".

1.4 Study Organization

The study was carried out by the Study Team organized by JICA under the supervision of the JICA Advisory Committee and with the close cooperation of their counterpart officials of MCAT/CAAB. The organization chart is shown in Figure 1.4.1.

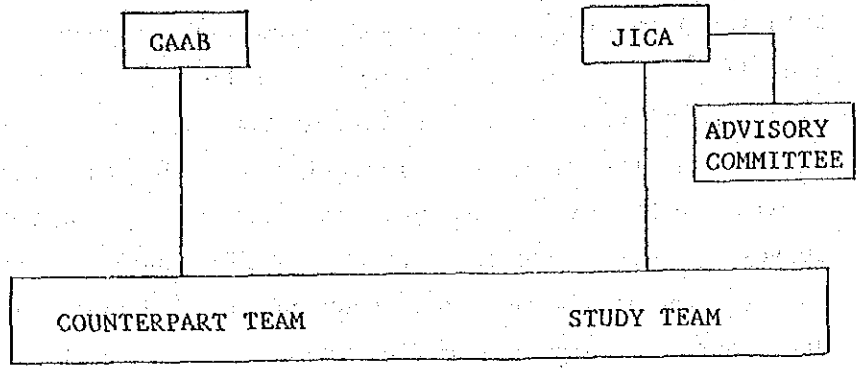

Figure 1.4.1 The Overall Organization Frame

The members of JICA Advisory Committee, Study Team and Bangladeshi counterpart officials are presented in the following list.

JICA ADVISORY COMMITTEE

Mr. Masato TAMURA (Chairman)	Director, Environmental Improvement Project Office, Civil Aviation Bureau, Ministry of Transport
Mr. Kiyoshi HOJI	Deputy Director, Kansai International Airport Division, Civil Aviation Bureau, Ministry of Transport
Mr. Akitoshi MORI	Chief, Radio Engineering Division, Civil Aviation Bureau, Ministry of Transport

JICA Staff

Mr. Hiroshi YAMAMOTO	1st Development Survey Division, Social Development Cooperation Department, Japan International Cooperation Agency

JICA STUDY TEAM

Mr. Shota MORITA	Team Leader
Mr. Niso WADA	Airport Planner/ Deputy Team Leader
Mr. Yoshiya NIINOMI	Navaids Planner
Mr. Hiroyuki UEDA	Airport Civil Engineer
Mr. Tadashi KABURAGI	Airport Architect
Mr. Masahito HONMA	Economist
Mr. Osamu NOGISHI	Topographic Surveyor/ Soil Investigator

MCAT

Mr. M. G. Kibria	Joint Secretary

CAAB

Air Commodore Moinul Islam (Retd.)	Chairman
Wing Commodore W. D. Ahmed (Retd.)	Member (Operations and Planning)
Group Captain Shamin Hossain (Retd.)	Member (Administration and Finance)
Mr. Mahtab Uddin Ahmed	Chief Engineer
Mr. Asaduzzaman Chowdhury	Superintending Engineer
Mr. Kamal Ahmed	Superintending Engineer
Mr. M. Fazle Ali	Director Planning
Mr. Abdul Haque Bhuiyan	Economist

CHAPTER 2 BACKGROUND OF THE PROJECT

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2.1 Socio-economic Conditions in Bangladesh

2.1.1 Population

The population of Bangladesh in March 1981 census stood at 89.91 million, of which 85% were rural inhabitants and 15% urban. The average annual population growth rate was 2.4% from 1974 to 1981, and 2.5% from 1981 to 1986. The Third Five Year Plan listed the reduction of the population growth rate to 1.8% in terminal year 1990 as one of its main targets.

Table 2.1.1 Historical Population Data of Bangladesh

Year	Population (Thousand)	Annual Growth Rate (%)
1961	55,222	
1974	76,398	2.5 (1961 - 1974)
1981	89,912	2.4 (1974 - 1981)
1986	101,700	2.5 (1981 - 1986)

Source: Statistical Yearbook of Bangladesh, 1987, BBS

2.1.2 Structure of the National Economy

The economy of Bangladesh is predominantly agriculture. About 50% of gross domestic product (GDP) is contributed by the agricultural sector, 10% by the industrial sector and 40% by the commercial and service sectors.

Annual average economic growth achieved from 1979/80 to 1985/86 was 3.9% per annum. Per capita GDP at current factor cost was 4,271 Taka or US$ 133 in 1985/86. The 3.9% growth rate was lower than the target rate of 5.4% in the Third Five Year Plan.

Table 2.1.2 Gross Domestic Product at Constant 1972/73 Price
(Million Taka)

Item	1979 - 80	1985 - 86
Agriculture	33,136 (49.4%)	39,094 (46.2%)
Mining and Quarrying	4 (-)	2 (-
Industry	7,210 (10.7)	8,282 (9.8)
Construction	2,509 (3.8)	4,169 (4.9
Power, Gas, Water	225 (0.3)	592 (0.7)
Transport, Communication	4,715 (7.0)	5,787 (6.8)
Trade Services	6,781 (10.1)	7,600 (9.0)
Housing Services	5,184 (7.7)	5,949 (7.0)
Public Administration and Defense	1,555 (2.3)	4,322 (5.1)
Banking and Insurance	1,139 (1.7)	1,951 (2.3)
Professional and Misc. Services	4,637 (6.9)	6,734 (8.0)
GDP at Constant Market Prices	67,095(100.0%)	84,482(100.0%)
(Subsidies)-(Indirect Tax)	3,509	4,690
GDP at Constant Factor Cost	63,586	79,792

Source : Statistical Yearbook of Bangladesh 1982, 1987, BBS

2.2 Socio-economic Conditions in Chittagong

2.2.1 Population and Density

Chittagong Region is the 8th largest region in Bangladesh. The region is 7,457 sq.km and accounts for 5% of the country. The population of Chittagong Region was 5,491,000 in the census year 1981, which shared 6.3% of the country. The population density in 1986 was 860 person/sq.km. Population growth rate from 1974 to 1986 was 3.4% per annum, which was higher than the average 2.4% of the country. However, it decreased and the growth rate now is equal to that of country's average rate at present. The population of Chittagong City (Statistical Metropolitan Area) is about 2 million at present.

Table 2.2.1 Population and Density of the Chittagong Region

Year	Population (000)	Average Annual Growth Rate	Density (per sq.km)
1974	4,315		579
1981	5,491	3.5%	736
1982	5,800	5.6%	778
1983	5,940	2.4%	797
1984	6,100	2.7%	818
1985	6,260	2.6%	839
1986	6,410	2.4%	860

Source : Zila Statistics Chittagong 1987, BBS
Statistical Yearbook of Bangladesh, BBS

2.2.2 Regional Economy

(1) Past Trend of GRP

The gross regional product of Chittagong Region was 41,689 million Taka in 1986 which shared about 10% of GDP.

The per capita GRP was 6,504 Taka in 1986 which was the highest among 21 regions and 1.5 times of the average of Bangladesh.

(2) Industrial and Commercial Product

In the Chittagong Region, industrial activities were developed earlier than other regions because of accessibility to the port. Heavy and medium industries are located in the region. Industrial and commercial product of the region was 30,000 million Taka in 1986 which was about 12% of the country.

Table 2.3.2 Gross Regional Product of Chittagong Region

Year	GRP (Million Taka at Current Price)	Per Capita GRP (Taka at Current Price)
1980/81	21,129	3,733
1981/82	23,751	4,095
1982/83	26,434	4,450
1983/84	33,156	5,435
1984/85	37,558	6,000
1985/86	41,689	6,504

Source : Statistical Yearbook of Bangladesh, 1987, BBS

(3) **Export Processing Zone**

The Export Processing Zone (EPZ) is located about 5 km north west of Chittagong Airport. The EPZ opened in 1983 for the purpose of technology transfer and to increase employment opportunities. The EPZ is expected to impact not only the regional economy but also the national economy. The relationship between EPZ and Chittagong Airport will be strengthened in the future through increase transfer of goods and air passengers traffic. The present situation and future expansion plan for the EPZ are summarized as follows:

a) Total area : 255 hectares, presently occupies 100 hectares

b) Number of industries/factories in operation and number of employees : 21 industries, 3,806 employees

c) Number of foreigners working : 44

d) Value of products exported from the EPZ is :

Year	Value (1,000 US$)
1983/84	164
1984/85	4,450
1985/86	7,400
1986/87	16,474
1987/88	13,809

e) Transportation mode : 90% by sea
10% by air

f) Number of visitors from foreign countries :
100 persons in 2000

g) Area of planned expansion up to 1990 : 155 hectares

h) Estimated number of future factories and employees:

Year	Factories	Employees
1989/90	31 (21+10)	2,040
1990/91	36 (21+15)	3,060
1991/92	51 (21+30)	6,120
1992/93	66 (21+45)	9,180

The Export Processing Zone Authority commented that the expansion of international air services at Chittagong Airport is an essential requirement for the promotion of foreign investment, and requested the provision of a direct air link with Bangkok and an exclusive cargo handling area for EPZ in the cargo terminal building at Chittagong Airport.

2.3 Air Transport in Bangladesh

There are seven airports presently used for civil aviation in Bangladesh, namely, Zia (Dhaka), Chittagong, Sylhet, Jessore, Saidpur, Rajshahi and Cox's Bazar. An outline of these airports is presented in Table 2.3.1.

Table 2.3.1 Outline of Airports Used for Commercial Transport in Bangladesh

Airport	Runway Dimension	Runway Surface	Largest Aircraft in Schedule Services
Chittagong	3,048m x 46m	Bitumen	F-28
Cox's Bazar	1,734m x 38m	Bitumen	F-27
Dhaka	3,200m x 46m	Concrete	B-747
Jessore	2,438m x 46m	Bitumen	F-28
Saidpur	1,524m x 46m	Bitumen	F-27
Sylhet	1,792m x 46m	Bitumen	F-28
Rajshahi	1,524m x 30m	Concrete	F-27

The air route structure for domestic scheduled services consists of six routes among which 5 routes connect Dhaka with Chittagong, Sylhet, Jessore, Saidpur and Rajshahi, and another that connects Chittagong with Cox's Bazar as shown in Figure 2.3.1.

International air routes are served in Dhaka from/to India, Nepal, Bhutan, Pakistan, Middle East, Europe, Burma, Thailand, Singapore and Hongkong. At Chittagong Airport, scheduled international flights to/from Calcutta are operated by Biman Bangladesh Airlines and Indian Airlines. Domestic air transport services are exclusively provided by Biman Bangladesh Airlines.

Although the only international destination directly connected with Chittagong is Calcutta, international passengers mostly from/to the Middle East Region go through the government formalities at Chittagong Airport and are carried by mixed domestic flights between Chittagong and Dhaka to connect with international flights at Dhaka.

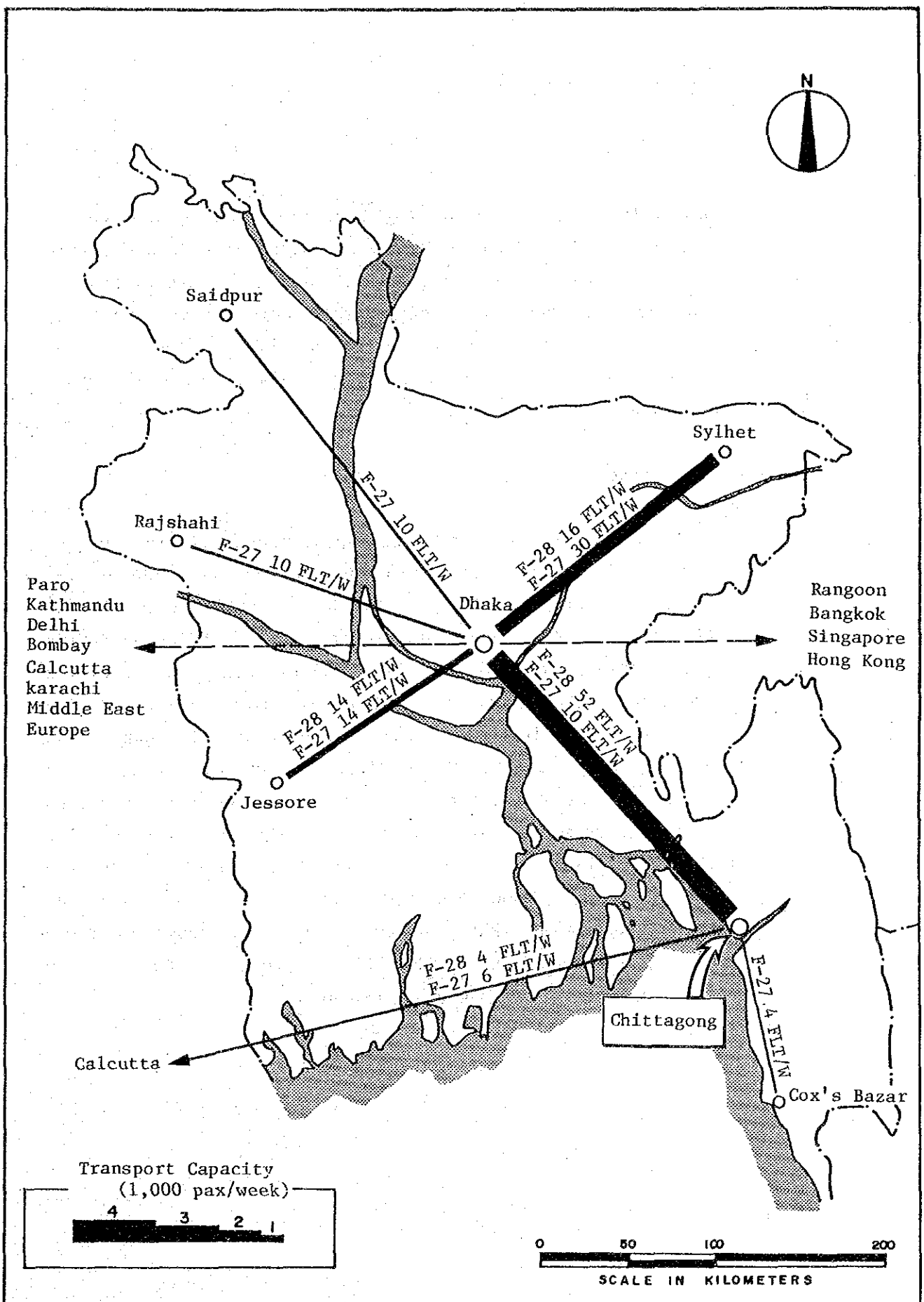

Figure 2.3.1 Domestic Air Routes in Bangladesh

2.4 Other Transport Systems

1) General

Bangladesh has 6,200 km of paved arterial and feeder roads, 2,800 km of railways and 8,400 km of inland waterways. Figure 2.4.1 shows the main arterial roads, the railway system and the inland waterway routes in Bangladesh. Jamuna River virtually divides this country into two parts, and the riverine character of the country makes the construction and maintenance of roads and railways difficult.

2) Road Transport

Road Transport is provided by both public and private sectors. In the public sector the main operator is Bangladesh Road Transport Corporation (BRTC). BRTC has a Bus Division with an active fleet of 465 buses and a Truck Division having an active fleet of 168 trucks. It provides services mainly in the cities of Dhaka and Chittagong and on a few inter-district routes. The private sector dominates the road transport in this country and accounted for 86% of mechanized road transport vehicles in 1984/85. As shown in Table 2.4.1, mechanized and non-mechanized vehicles increased by 70% and 26% from 1980 to 1985 implying 11.1% and 4.7% average annual growths respectively. On the other hand, road kilometreage under the jurisdiction of Road and Highways Department (RHD) in recent years is shown in Table 2.4.2. Total road length under RHD has grown by 80% over 1980 to 1985 but high type road has grown by 45%.

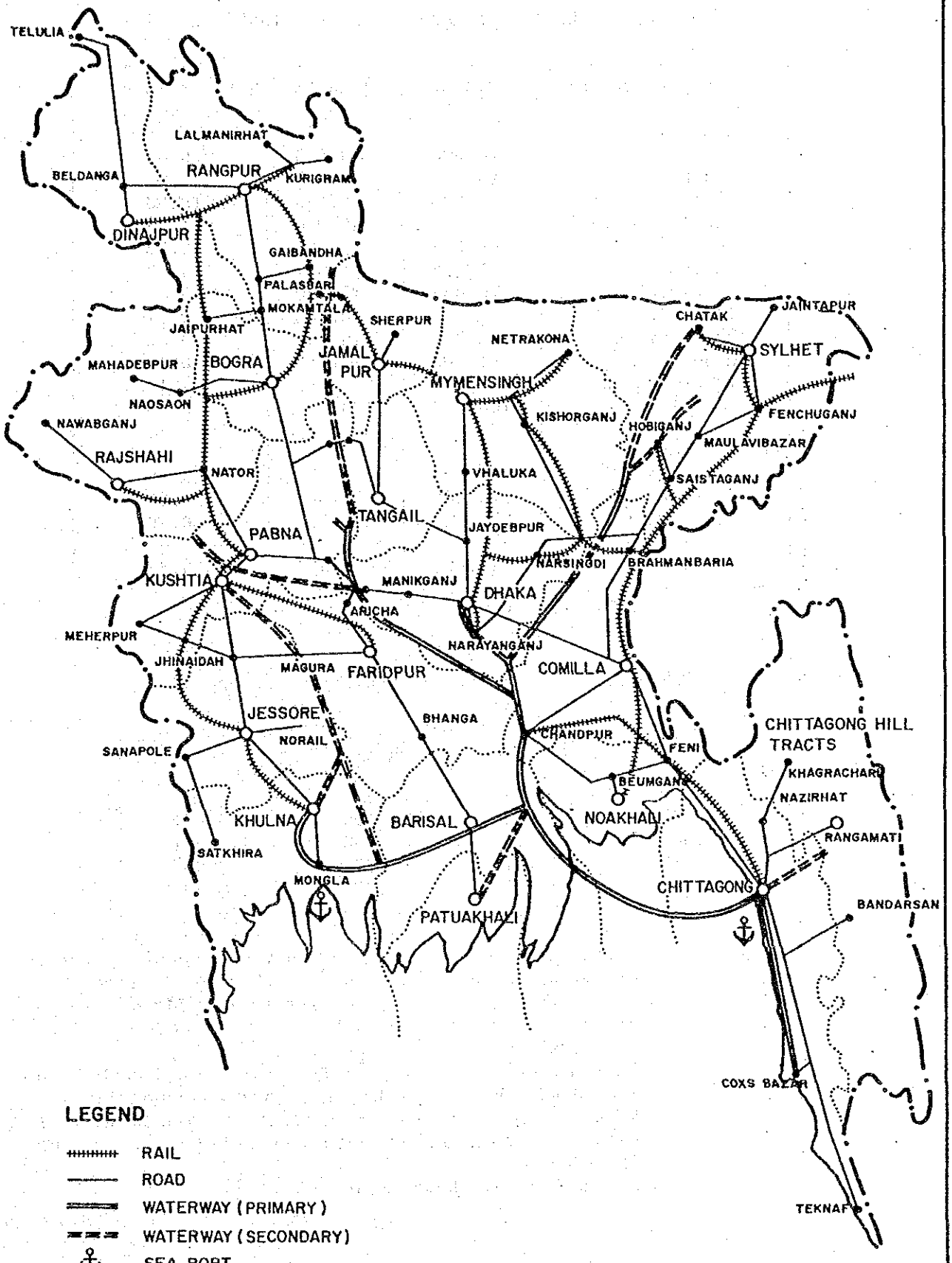

Figure 2.4.1 Surface Transport Systems in Bangladesh

Source : "Intermodal Transport Study" Final Report December 1985, ADB

Table 2.4.1 Growth of Road Transport (1980 - 1985)

Category of Vehicle	1979/80	1984/85	Rate of Increase
I Mechanized			
Bus	10,294	9,365	- 0.09
Truck	16,118	17,270	0.07
Minibus	370	6,165	15.66
Car (Private)	19,848	40,000	1.02
Jeep	8,321	9,000	0.08
Taxi Car	1,113	1,817	0.63
Auto-rickshaw	10,632	17,806	0.67
Truck Tractor	1,815	3,402	0.87
Motor Cycle	38,778	70,767	0.82
Other	1,602	2,282	0.42
Truck Trailor	939	2,050	1.18
Sub Total	105,782	179,924	0.70
II Non-Mechanize			
Rickshaw	163,000	200,000	0.23
Bullock Cart	216,043	276,000	0.28
Sub Total	379,043	476,000	0.26
III Total	484,825	655,924	0.35

Source : Transport Survey Wing, Planning Commission

Table 2.4.2 Road Kilometer by Type of Road *3

Year	High Type*1	Low Type*2	Total
1980	4,284	1,405	5,689
1981	4,323	2,268	6,591
1982	4,776	2,655	7,431
1983	5,131	2,866	7,997
1984	5,359	4,028	9,387
1985	6,215	4,159	10,374

Note : *1 'High type' refers to roads having cement, concrete bituminous concrete surface or bituminous surface.
*2 'Low type' refers to roads generally made of stones, bricks, gravel or ordinary earth, properly aligned with drainage structure provided.
*3 Road Kilometer covers only roads constructed and maintained by the Roads and Highways Department. Roads constructed and maintained by municipalities, district councils and other local bodies are not included here.

Source : Road and Highways Department.

3) Railways

The railway system is operated by Bangladesh Railway and consists of 980 km long broad gauge and 1,838 km long meter gauge (total 2,818 km).

The load of passengers and freight carried by Bangladesh Railway remained unchanged in recent years as shown in Table 2.4.3.

Table 2.4.3 Passengers and Freight Carried by Bangladesh Railway

Year	Passengers	Freight (ton)
1981/82	90,353,000	3,179,000
1982/83	105,639,000	2,951,000
1983/84	98,872,000	2,939,000
1984/85	90,323,000	3,009,000
1985/86	82,002,000	2,341,000

Source : Bangladesh Railway

The downward trend in freight traffic was mainly due to an inter-modal shift of traffic from railway to road because of an increase in the reliability, flexibility and availability of delivery service by road.

4) Inland Water Transport

The Inland water transport system has over 5,200 km of perennial waterways and another 3,200 km of seasonal waterways, and consititues the main link between the urban centers and rural areas, particularly in the southeast region of Bangladesh.

The Bangladesh Inland Water Transport Authority (BIWTA) is responsible for building and maintaining inland water ports, navigational channels, and etc.

On the other hand, another public body, the Bangladesh Inland Water Transport Corporation (BIWTC) has been operating 'Rocket' passenger services among major points, and operating coastal passenger-cum-cargo services for off-shore islands.

In this area, the private sector plays the main role. In 1979/80 there were 2,445 registered vessels operating in the waterways. Out of these, 1,845 were owned by the private sector.

Cargoes and passengers transported by BIWTC during the period from 1979/80 to 1984/85 are shown in Table 2.4.4.

Table 2.4.4 Traffic Carried by BIWTC

Year	Cargoes (ton)	Passengers
1979/80	2,046,000	2,738,000
1980/81	1,584,000	2,794,000
1981/82	1,328,000	2,986,000
1982/83	1,026,000	2,808,000
1983/84	1,059,000	4,502,000
1984/85	1,318,000	4,821,000

Source : Bangladesh Inland Water Transport Corporation (BIWTC)

The private sector dominates inland water transport comprising 84% of total mechanized vessels in 1984/85.

5) Sea Ports

Chittagong Port and Chalna Port have an important role in foreign trade. Cargo handled at the Chittagong and Chalna ports is shown in Table 2.4.5.

Table 2.4.5 Import and Export Handled from 1979/80 to 1984/85
(Unit : thousand tons)

Year	Chittagong Port.			Chalna Port.		
	Import	Export	Total	Import	Export	Total
1979/80	5,999	334	6,333	676	1,470	2,146
1980/81	5,015	547	5,562	741	886	1,627
1981/82	5,147	503	5,650	708	920	1,628
1982/83	4,963	454	5,417	802	1,098	1,900
1983/84	5,689	393	6,074	688	1,086	1,774
1984/85	6,828	330	7,158	577	2,086	2,663

Source : Chittagong and Chalna Port Authorities

The above table shows that the Chittagong Port dominates the import trade while the Chalna Port dominates export trade.

2.5 Existing Conditions of Chittagong Airport

2.5.1 Outline of Chittagong Airport

Chittagong Airport is located about 8 km south of the center of Chittagong City. It was constructed in the early 1940s. After piecemeal developments the airport now has a 3,048 m long runway, connecting taxiway, apron, international and domestic terminal buildings and other supporting facilities. The existing layout and outline of the airport are shown in Figure 2.5.1 and Table 2.5.1 respectively.

Chittagong Airport is administrated by Civil Aviation Authority of Bangladesh (CAAB) and jointly used by civil aviation and the Bangladesh Air Force (BAF). Airport property areas of CAAB and BAF are divided by the centerline of the runway, and occupy the southern part and the northern part respectively. The existing terminal area is located to the north of the runway in the BAF area.

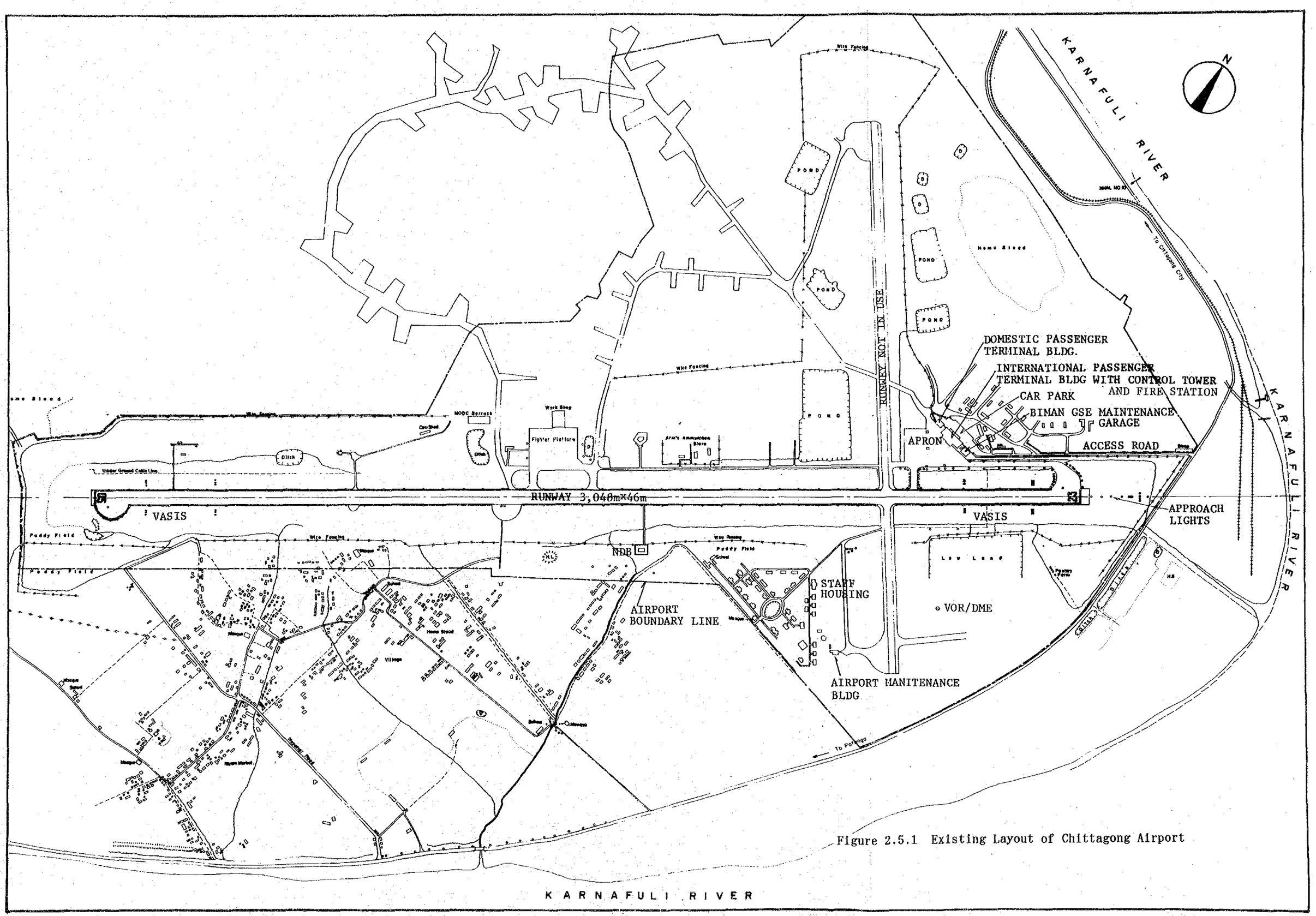

Figure 2.5.1 Existing Layout of Chittagong Airport

Table 2.5.1 Outline of Chittagong Airport

Items	Description
Aerodrome Data	
- Name of Airport	Chittagong Airport
- Domestic/International	Domestic and International
- ICAO Reference Code	4D
- Reference Point	N22°15'22", E90°49'30" (Intersection of runways)
- Distance and Direction from City	8km south of Chittagong City (15km by road)
- Elevation	3.66m (12ft)
- Reference Temperature	32.0°c (April)
- Magnetic Variation	55'W (1985) Annual change 2'W
- Operation Hours	Available to Meet Operational Requirements
- Seasonal Availability	All Seasons
- Administrative Authority	Civil Aviation Authority
- Transportation Available	Bus, Taxi and Auto-Rickshaw
Aircraft Operational Data	
- Wind Coverage	
- Cross-wind Component not exceeding 13 kt	91.6% (1986 - 1988)
- Cross-wind Component not exceeding 20 kt	98.4% (1986 - 1988)
- Operational Category	Non-Precision Instrument Approach
- Established Procedures	VOR/DME & NDB for RWY 05/23 OCA Straight-in 520ft Circling 650ft (Category -A & -B) 750ft (-C & -D)
- Transition Altitude	4,000 ft
- Local Flying Restriction	Nil
Facilities	
Runway	
- Designation	05/23
- True Bearing	049/229
- Dimension	3,048m x 46m
- Longitudinal Slope	0.0%
- Clearway	61m x 61m (RWY 05/23)
- Runway Strip	3,170m x 150m
- Surface	Bitumen
- Strength	7.0 ton/sq.ft
- Cross-wind Runway	1,692m x 46m (Closed for Landing & Take-off)

Table 2.5.1 Outline of Chittagong Airport (Cont'd)

Items	Description
Taxiway	
- Configuration	1 Connection with Apron Partial Parallel Taxiway (not used)
- Dimension	65m x 18m
- Surface	Bitumen
Apron	
- Aircraft Stands	F-28 x 2, B-707 x 1, Light Aircraft x 2 (Simultaneous Parking Capacity of Three F-28 Class Aircraft)
- Parking Configuration	Self maneuvering
- Area	16,200 sq.m
- Surface	Concrete and Bitumen
International Passenger Terminal Building	
- Floor Area	1,660 sq.m
- Ground Floor	Passenger Terminal Use : 880 sq.m Meteorological Department : 210 sq.m CAAB (Security Quarter & Canteen) : 20 sq.m Total : 1,110 sq.m
- First Floor	CAAB(Adm.and Ops.) : 350 sq.m VIP Use : 110 sq.m Total : 460 sq.m
- Second Floor	CAAB (Equip. Room and Workshop) : 50 sq.m
- Third Floor	Control Tower : 40 sq.m
- Structure	Reinforced Concrete
Domestic Passenger Terminal Building	
- Floor Area	320 sq.m
- Ground Floor	Passenger Terminal Use : 320 sq.m
- First Floor	Observation Deck
- Structure	Reinforced Concrete
Cargo Terminal Building	
- Nil	20 sq.m Customs Storage available in International Terminal Building

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- First Floor	Observation Deck
- Structure	Reinforced Concrete
Cargo Terminal Building	
- Nil	20 sq.m Customs Storage available in International Terminal Building

Table 2.5.1 Outline of Chittagong Airport (Cont'd)

Items	Description
Administration Building (Part of International Terminal Building)	
- Floor Area	CAAB : 460 sq.m MET : 210 sq.m
Car Park	
- Number of lots	International Passenger Terminal : 90 Domestic Passenger Terminal : 6
- Area	1,600 sq.m
Access Road	
- Width	5.5m
- Length	650m
- Surface	Bitumen
Air Navigation Systems	
- Control Tower	Third Floor of International Terminal (40 sq.m) Eye Level of Controller : 11.5m AGL.
- Radio Navigation System	C-VOR/DME NDB
- Telecommunication System	Air-Ground VHF Communications (2 Freq.) AFTN Message Exchange and Teletypwriters ATS Direct Speech VHF Communications with CPA Control Consoles
- Aeronautical Ground Lighting System	Simple Approach Lights (RWY 23) VASIS RWY 05/23, (2-bars) Runway Threshold/End Lights Runway Lights Taxiway Lights Apron Flood Lights Aerodrome Beacon Wind Direction Indicator Lights Landing Direction Indicator Lights
- Meteorological System	Observation Sensors Transmissiometer(unserviceable) Weather Facsimile Weather Teletypewriters
- Emergency Power Supply System	Emergency Generators (1,000 KW & 750 KW)

Table 2.5.1 Outline of Chittagong Airport (Cont'd)

Items	Description
Public Utilities	
- Power Supply System	400 KVA capacity 45,000 KWH/Month Consumption
- Water Supply System	Deep Wells and Elevated Water Tank CAAB : 50,000IG, BAF : 20,000IG 6,800 ton/Month Consumption
- Sewerage Disposal System	Natural Infiltration at Reservoirs
- Solid Waste Disposal System	Nil
- Telephone System	4 External Lines with 40 Extensions
Rescue and Fire Facilities	
- Fire Vehicles	3 Major Vehicles, 1 Fire Jeep, 2 Ambulances 1 Rapid Intervention Vehicle (1 Major vehicle is out of service) Water Tank Capacity : 10,900 l Type of Agents : Protein Foam Amount of Agents : 1,200 l
- Fire Station	300 sq.m. (Garage for 5 vehicles)
- Level of Protection	Category - 6
- Trained Personnel	25
Other Facilities	
- Airport Maintenance Facilities	Airport Maintenance Building (280 sq.m) Garage and Storage
- Airport Vehicles	2 Mini-buses,1 Jeep,1 Pick-up Van, 1 Truck
- Aviation Fuel Supply System	Fuel Depot Capacity : 12,000 IG (JET-A1) Consumption Biman : 7,340 l/day BAF : 11,450 l/day Hydrant System (3 Pits on Apron)
Staff Housing	
- Number of Houses	CAAB : 24 MET : 6
- Number of Families	CAAB : 92 MET : 15
- Number of Residents	500-600 people

2.6 Problems of Existing Chittagong Airport

The major problems of the existing Chittagong Airport are summarized in this section.

(1) Runway

- Oceangoing ships with masts more than 14.6 m high on Karnafuli River infringe the runway 23 approach surface and runway 05 take-off climb surface. Although these mobile obstacles are hazardous to the aircraft operation, no accidents such as a nearmiss have been reported. The existing measures to prevent collisions between an aircraft and a ships is not sufficient.

- Port Road which runs along Karnafuli River is a fixed obstacle to runway 23 approach surface.

- The pavement strength of the existing runway can accommodate up to B-707 class aircraft, however, it cannot support the load of large aircraft such as DC-10's which are anticipated in the future.

- There are many depressions on the surface of the runway.

- The 1.5 m wide existing shoulders do not comply with ICAO Recommendations.

- Runway end safety areas are not provided.

(2) Runway Strip and Obstacle Limitation Surfaces

- There are many obstacles on the runway strip or protruding upon the transitional surface. The actual strip width is only 150 m, which is merely adequate for a non-instrument runway.

- No measures to remove the existing obstacles or to restrict the creation of new objects have been taken.

(3) **Terminal Area**

- Expansion of the existing terminal facilities is difficult due to the limited availability of land area.

- The terminal facilities infringe the transitional surface of the 300 m wide runway strip and some of them are located on the runway strip.

(4) **Apron**

- Most of apron area is in the 300 m wide runway strip and all commercial aircraft parked on the apron are obstacles to the transitional surface from the same runway strip.

- Large aircraft such as DC-10 cannot be accommodated on the existing apron in terms of obstacle limitation, space and pavement strength.

(5) **Passenger Terminal Buildings**

- The existing international and domestic passenger terminal buildings are too small to handle even the present traffic.

- There is no adequate passenger queuing space at almost all check points in the passenger terminal buildings.

- The floor areas of departure lounges in the international and domestic buildings are 60 sq.m and 100 sq.m respectively which are not sufficient even for the present traffic.

- Passenger flow in the international passenger terminal requires many direction changes which may confuse passengers.

- No baggage claim facility and flight information system are provided for passengers.

- Security system is not sufficient.

- No fire alarm, fire hydrant or fire extinguisher is available.

- No restaurant, snack bar or shop is available in the terminal buildings.

- The building curb length is not sufficient.

- International passenger terminal building was built 46 years ago and is too obsolete to completely renovate.

- Parked cars and greeters always crowd at the curb of the terminal buildings due to absence of public space to accommodate a local characteristic of high greeter rate.

(6) **Cargo Terminal Building**

- No cargo terminal building is available.

(7) **Car Park and Access Road**

- The terminal road is a cul-de-sac and does not cater to vehicle circulation.

(8) **Air Navigation Systems**

- Most of the aeronautical telecommunication equipment and control consoles are obsolete.

- The control tower infringes the transitional surface and does not provide necessary sight to aircraft movement area.

- VOR/DME will soon have to be replaced.

- Aeronautical ground lighting system including control and power supply systems are obsolete.

- Equipment for the meteorological system is very old.

CHAPTER 3 AIR TRAFFIC ANALYSIS AND DEMAND FORECASTS

CHAPTER 3 AIR TRAFFIC ANALYSIS AND DEMAND FORECASTS

3.1 General

Air traffic demand is forecast up to 2010 at five year intervals to cover the following categories:

- Domestic passengers
- International passengers
- Domestic cargo
- International cargo
- Domestic aircraft movements
- International aircraft movements

The forecasts are made in the following steps:

(a) Analysis of the past air traffic demand in Bangladesh
(b) Analysis and estimation of the population and GDP in Bangladesh
(c) Forecast of air traffic demand in Bangladesh
(d) Estimation of the air traffic demand at Chittagong Airport based on the relevant indices
(e) Estimation of air traffic demand by air route
(f) Break-down of annual traffic demands into design peak hour traffic

3.2 Past Trend of Air Traffic

3.2.1 Domestic Passengers

Table 3.2.1 and Figure 3.2.1 show the actual records of domestic passenger traffic from 1980 to 1987, in both Bangladesh and Chittagong Airport. Domestic passenger traffic in Bangladesh decreased at an annual rate of 1.2% from 1980 to 1987.

The same tendency can be observed in domestic passenger traffic at Chittagong Airport, which showed a 20,000 passenger decrease from

Table 3.2.1 Past Trend of Domestic Passengers

Year	Chittagong	Zia	Other Airports	Total
1980	141,555	319,128	222,388	683,071
1981	119,461	289,792	208,683	617,936
1982	126,603	325,005	213,988	665,596
1983	130,077	322,777	182,440	635,294
1984	117,390	353,612	163,453	634,455
1985	129,920	388,609	183,494	702,023
1986	109,608	386,287	178,242	656,137
1987	109,153	342,412	175,971	627,536

Source : CAAB

Past trends of domestic passengers in neighboring countries are also illustrated in Figure 3.2.2 for reference.

3.2.2 International Passengers

Although domestic passenger traffic has been stagnant, total international air traffic in Bangladesh showed a remarkable rate of growth for the same period and exceeded the volume of domestic passengers in 1984. The number of international passenger at Chittagong Airport increased in 1983 and 1984 as indicated in Table 3.2.2 and Figure 3.2.3.

The past trends of international passengers in neighboring countries are illustrated in Figure 3.2.4 for reference.

3.2.3 Air Cargo Traffic

Total Air cargo traffic in Bangladesh has been steadily increasing since 1983 as shown in Table 3.2.3 and Figure 3.2.5.

In 1987, the total air cargo volume in Bangladesh was 34,000 tons, of which 90% was international cargo.

The air cargo volume at Chittagong Airport was 550 tons in 1987 and was only 1.6% of the total country's traffic due to limited cargo transport capability of the F-28 and F-27 which presently operate at Chittagong Airport.

Table 3.2.2 Past Trend of International Passengers

Year	Chittagong	Zia	Sylhet	Total
1980	7,695	358,266 (14,481)	-	365,961 (14,481)
1981	5,125	376,178 (15,973)	-	381,303 (15,973)
1982	3,398	394,986 (16,771)	-	398,384 (16,771)
1983	20,465	507,565 (18,448)	-	528,030 (18,448)
1984	49,486	693,542 (219,284)	34,424	777,452 (219,284)
1985	53,222 (696)	820,344 (106,994)	49,358	922,924 (107,690)
1986	57,334	844,587 (160,694)	54,076	955,997 (160,694)
1987	66,599	846,168 (134,622)	52,425	965,192 (134,622)

Source : CAAB
Note : Figures in parentheses indicate transit passengers

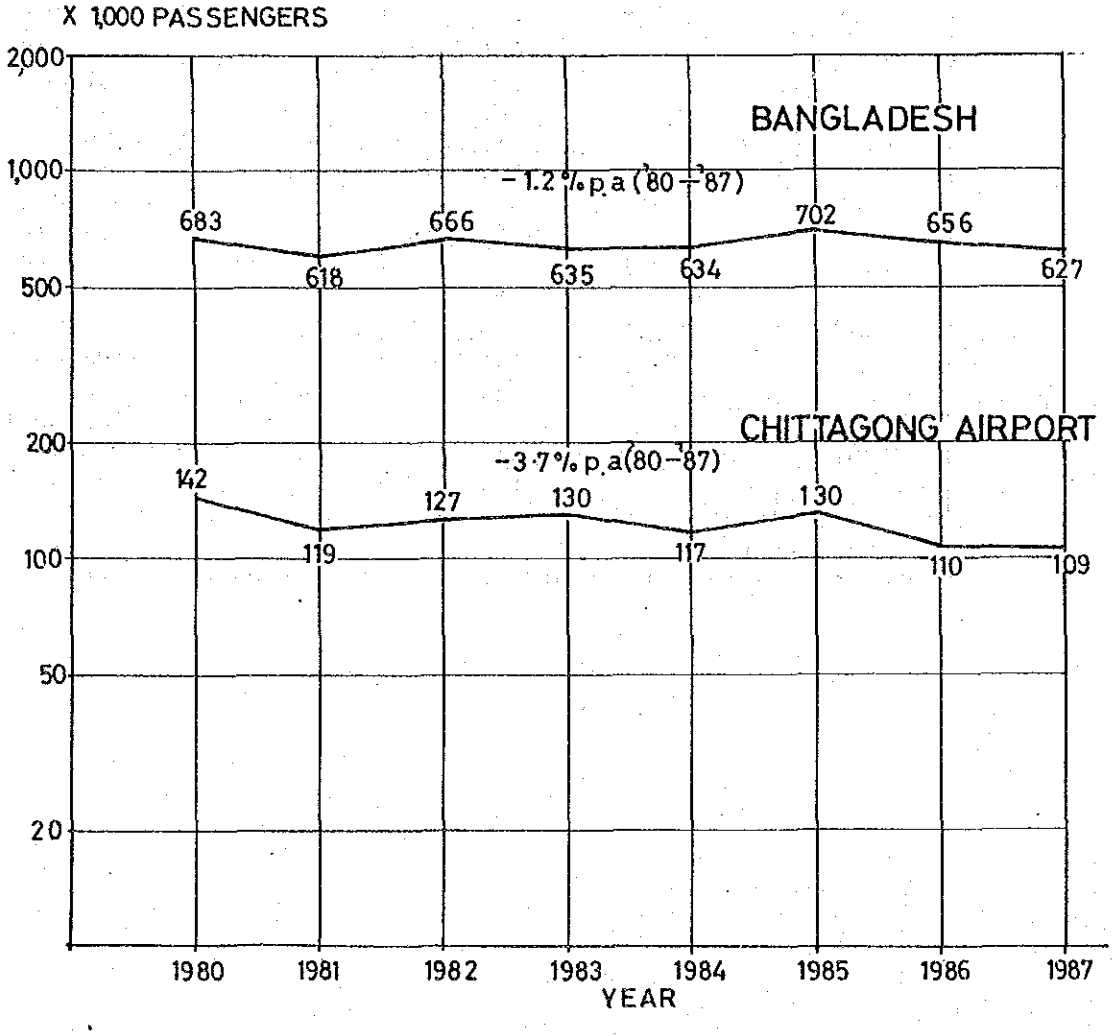
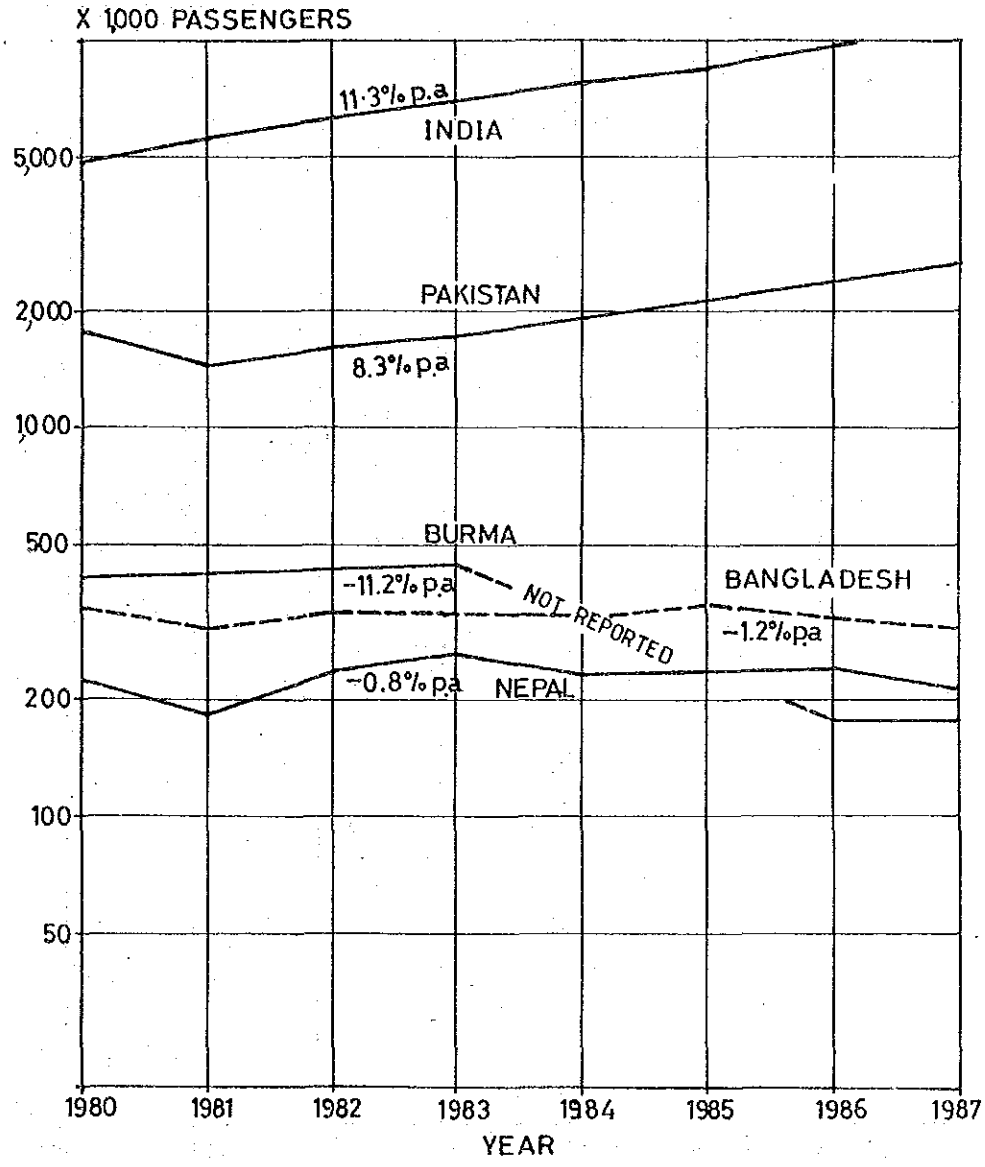


Figure 3.2.1 Past Trend of Domestic Passengers in Bangladesh and Chittagong Airport



SOURCE : 'CIVIL AVIATION STATISTICS OF THE WORLD'
I C A O

Figure 3.2.2 Past Trend of Domestic Passengers in Neighboring Countries

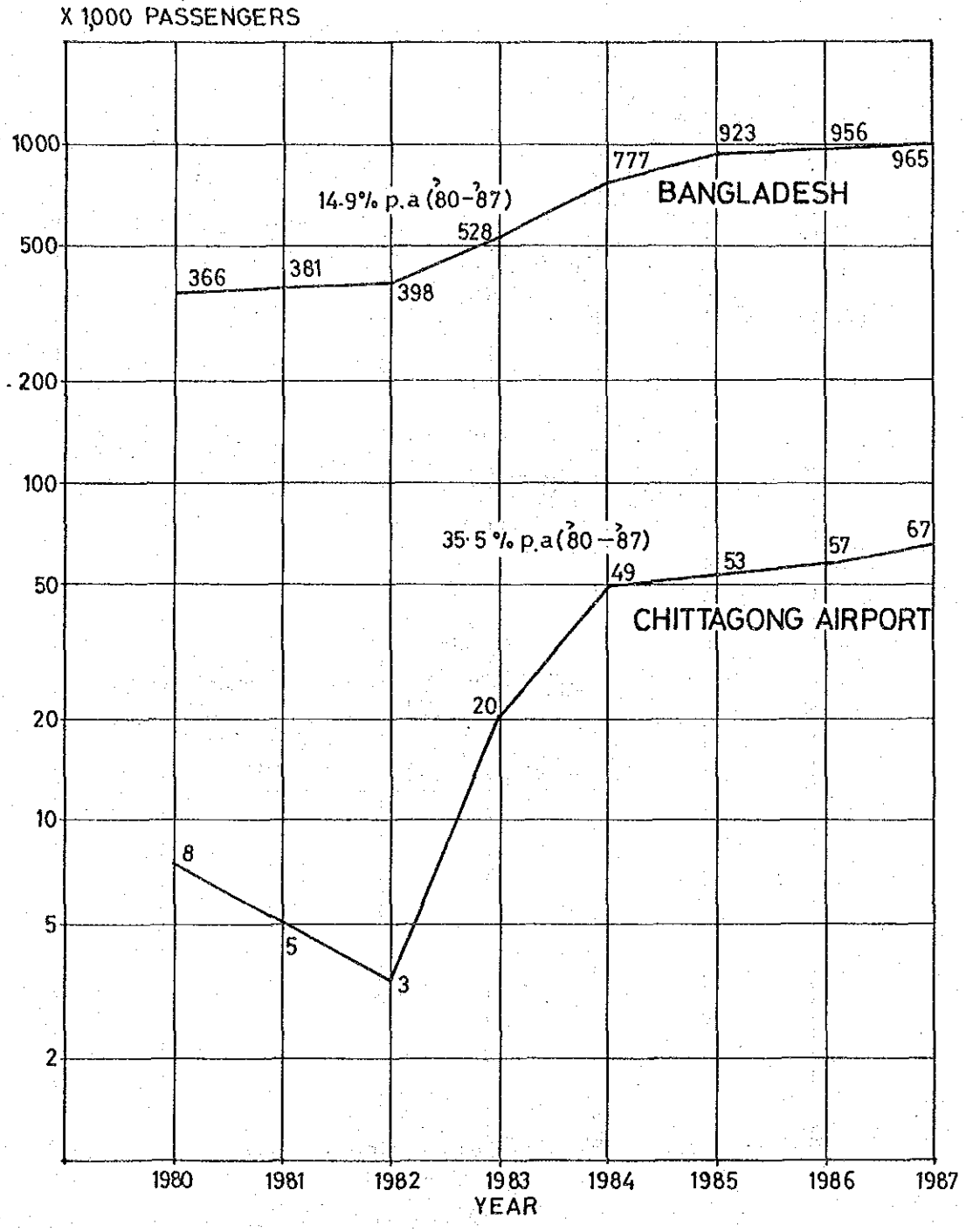
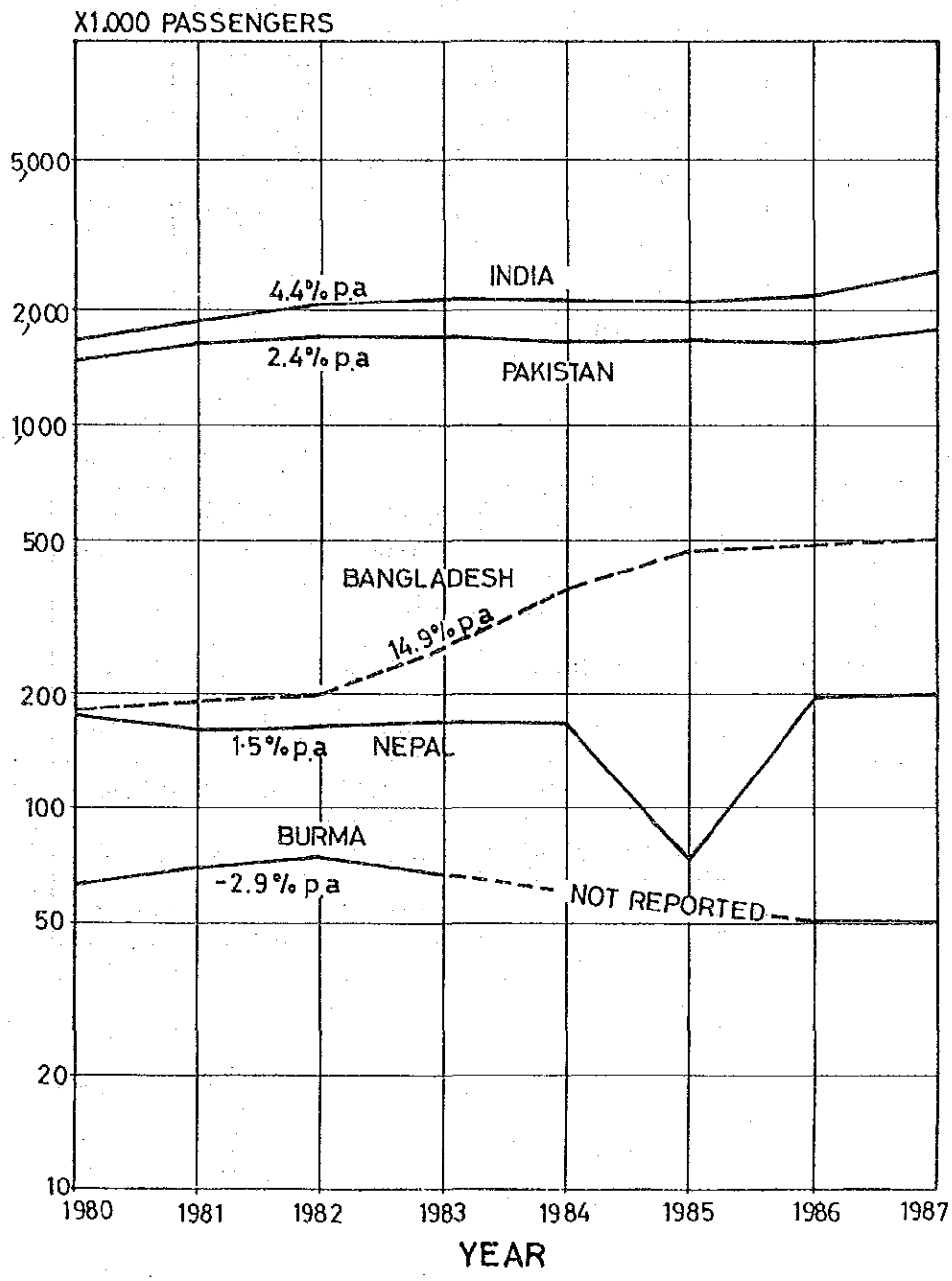


Figure 3.2.3 Past Trend of International Passengers in Bangladesh and Chittagong Airport



SOURCE : 'CIVIL AVIATION STATISTICS OF THE WORLD'
I C A O

Figure 3.2.4 Past Trend of International Passengers in Neighboring Countries

Table 3.2.3 Past Trend of Cargo Movement (1)

(Unit: ton)

Year	Chittagong Airport	Bangladesh
1980	1,570	16,051
1981	492	15,361
1982	367	15,252
1983	363	16,557
1984	422	22,695
1985	438	27,660
1986	446	33,182
1987	550	34,320

Source : CAAB

Table 3.2.3 Past Trend of Cargo Movement (2)

(Unit: ton)

Year	Category	Chittagong Airport	Bangladesh
1986	Domestic Cargo	160.35	4,237.22
	International	285.46	28,944.48
	Total	445.81	33,181.70
1987	Domestic Cargo	278.33	3,707.56
	International	271.44	30,611.95
	Total	549.77	34,319.51

Source : CAAB

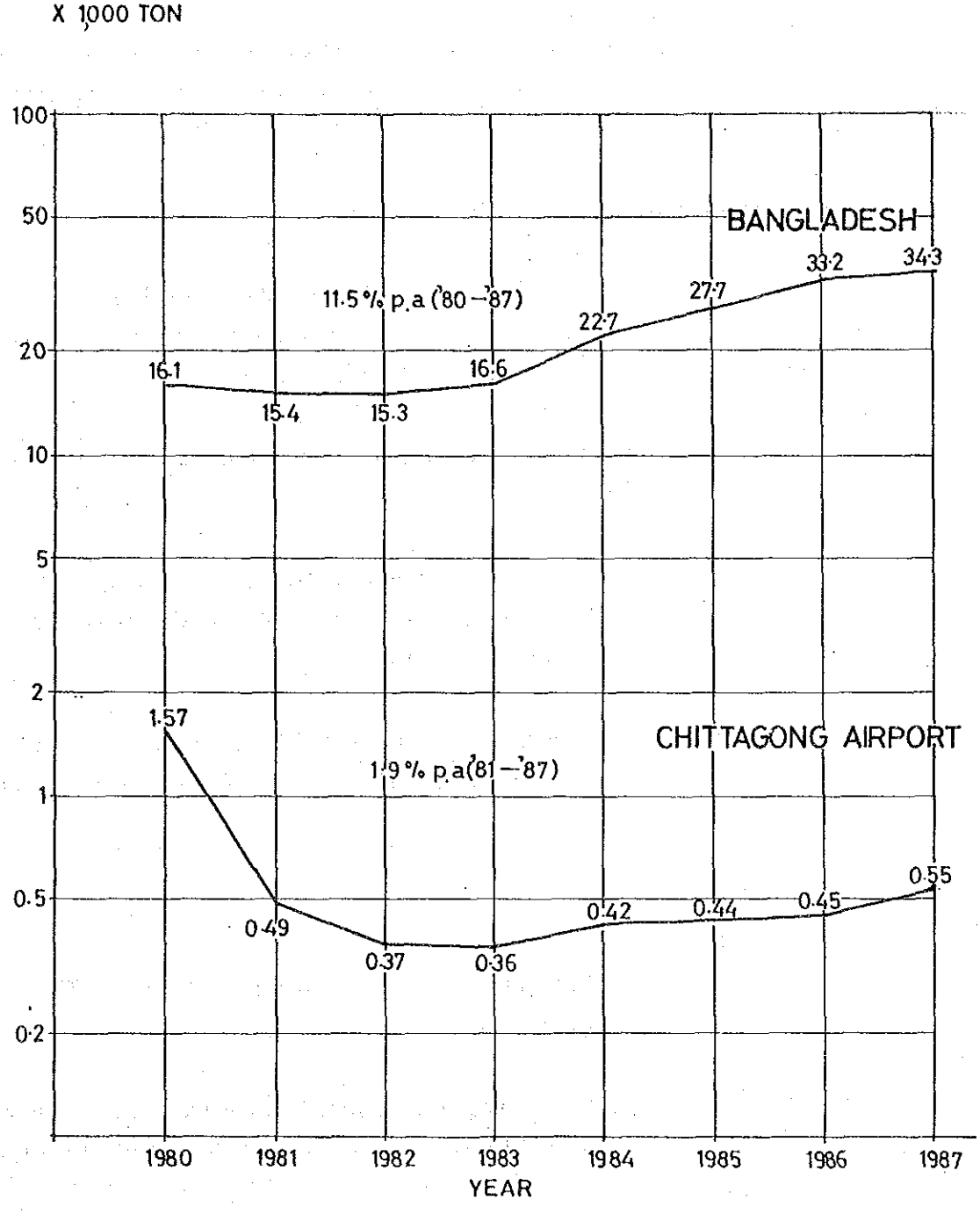


Figure 3.2.5 Past Trend of Cargo in Bangladesh and Chittagong Airport (Total of Domestic and International Cargo)

3.3 Estimation of Economic Indices

The future population and economic growth are estimated based on information collected in order to prepare bases for forecasting air traffic demand.

3.3.1 Estimation of Population

As shown in Table 3.3.1, the population of Bangladesh grew at 2.5% annual average rate from 1980 to 1987. Estimation methods of future population up to 2010 are explained as follows:

(1) 1987 - 1990 : 2.0%-1.8% annual growth rates presented in the Third Five Year Plan.

(2) 1990 - 2000 : 1.7% annual growth rate which will result in 130.3 million population in 2000 as estimated by the Planning Commission.

(3) 2000 - 2010 : 1.6% annual growth rate taking into account the decreasing trend of growth projected for the above two periods.

3.3.2 Estimation of GDP

(1) High Case ..... 5.4% annual growth rate presented in The Third Five Year Plan.

(2) Medium Case .... 3.9% average annual growth rate achieved actually for 7 year period from 1980 to 1987.

(3) Low Case ..... 3.0% annual growth rate achieved in 1987/1988

The results of the estimations are shown in Tables 3.3.1 and 3.3.2.

Table 3.3.1 Estimation of Future Population

Year	Population (x Million)	Average Annual Growth Rate	Remarks
1980	87.7		
1981	89.6		(Actual)
1982	92.1		
1983	94.4	2.5%	Source : Statistical Yearbook of Bangladesh 1987
1984	96.8		
1985	99.2		
1986	101.7		
1987	104.1		
1990	110.51	2.0% *	* The Third Five Year Plan
1995	120.0		
2000	130.3 **	1.7%	** Planning Commission
2005	141.0		
2010	152.6	1.6%	

Table 3.3.2 Estimation of Future GDP and Per Capita GDP
(At 1972/73 Constant Factor Cost)

Year	GDP (In Million)			Per Capita GDP		
	Low Case	Medium Case	High Case	Low Case	Medium Case	High Case
1980	63,586	3.9% p.a (Actual)*		725.0	1.4% p.a (Actual)*	
1987	83,292			800.1		
1995	105,512 3.0	113,117 3.9	126,861 5.4	879.3 0.9	942.6 2.2	1057.2 3.7
2000	122,317 %	136,964 %	165,018 %	938.7 %	1051.1 %	1266.4 %
2005	141,799 p.a	165,838 p.a	214,652 p.a	1005.7 p.a	1176.2 p.a	1522.4 p.a
2010	164,384	200,799	279,214	1007.2	1315.9	1829.7

* Source : Statistical Year Book of Bangladesh 1987, BBS

3.4 Annual Passenger Forecast

3.4.1 Forecast of Annual Domestic Passengers

(1) Domestic Passengers in Bangladesh

Regression analysis shown in Table 3.4.1 is undertaken to decide the formula for estimating the total domestic passengers in Bangladesh.

Table 3.4.1 Results of Regression Analyses for Domestic Passengers

Passengers	CASE No.	Explanatory Variable				
		GDP	Per Capita GDP	Fare	Correlation Coefficient	Adapted Case
Domestic Passengers (Whole Country)	1	+			0.361	
	2		+		0.150	
	3		+	-	0.903	#

Note, + : Positive Parameter
- : Negative Parameter

As a result of air traffic analysis, the past trend of domestic passengers could not be explained simply by the factors such as population and GDP. A correlation equation with the substantial fare and Per capita GDP has been calculated to best explain the past trend of the total domestic passengers in Bangladesh. This equation is presented below:

$$DPW(t) = 275.42\ PGDP(t-1)^{1.51} \times FARE(t)^{-0.48},\ R = 0.903$$

Where, DPW(t) : Total domestic passengers in year (t)
PGDP(t-1) : Per capita GDP at 1972/73 constant price in year (t-1)
FARE(t) : Substantial fare level in year (t)

Figure 3.4.1 is prepared in order to clearly explain the relationship between the changes in domestic passenger traffic, per capita GDP and substantial fare.

In forecasting the future air traffic demand, the substantial fare level is assumed to be maintained for the following reasons. This assumption means the airfare will be raised at a rate of the price escalation as seen in the past.

a) Substantial fares after deflated with GDP deflators varied in a narrow range while the nominal fares were higher corresponding to the general price level variation.

b) On the other hand, as per capita GDP will go up in the future, the increase in substantial fare will be offset by the increase in per capita income.

The results of the total domestic passenger forecast in Bangladesh are shown in Table 3.4.2.

Table 3.4.2 Forecast of Domestic Passengers in Bangladesh
(Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	628 ┐	628 ┐	628 ┐	Actual
1995	810 2.5 %	880 3.8%	1,030 5.9%	
2000	890 p.a.	1,040 p.a.	1,350 p.a.	
2005	990 ┘	1,240 ┘	1,790 ┘	
2010	1,100 ┘	1,470 ┘	2,370 ┘	

(2) **Domestic Passengers at Chittagong Airport**

Domestic passengers as a percentage of Chittagong Airport traffic in the past years are as follows:

Year	Share	Year	Share
1980	20.7%	1984	18.5%
1981	19.3%	1985	18.4%
1982	19.0%	1986	16.7%
1983	20.5%	1987	17.4%
		Average	18.8%

The present share of domestic passengers at Chittagong Airport is estimated to increase to the average of these past shares (18.8%) in 1995. As a result, domestic passenger demand at Chittagong Airport will reach 200,000 in 2000, as shown in Table 3.4.3 and Figure 3.4.2.

Table 3.4.3 Forecast of Domestic Passengers at Chittagong Airport
(Unit : 1,000 passengers)

Year	Low Estimate		Medium Estimate		High Estimate		Remarks
1987	109		109		109		Actual
1995	150	2.9 %	165	4.3%	190	6.4%	
2000	170	p.a.	200	p.a.	250	p.a.	
2005	190		240		340		
2010	210		290		450		

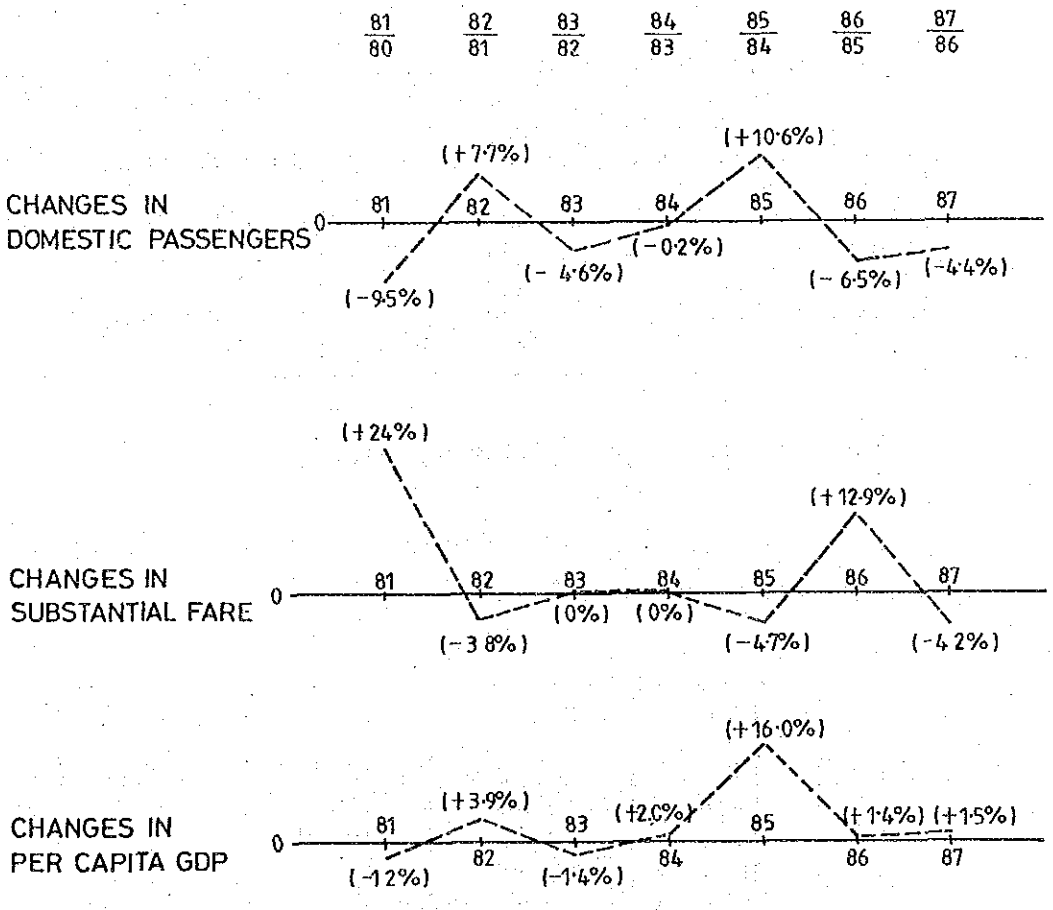


Figure 3.4.1 Relationship between Domestic Passenger, Fare and per Capita GDP

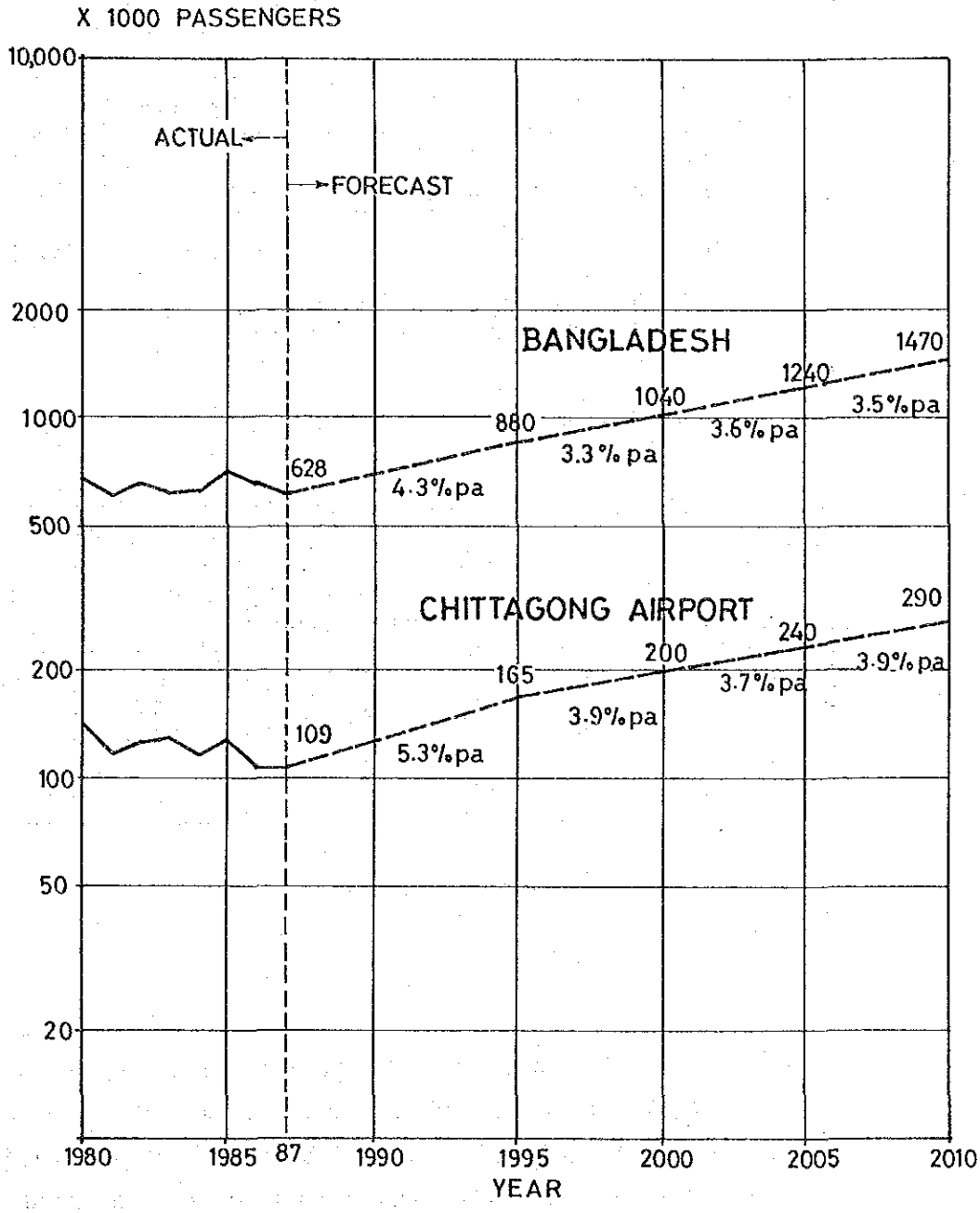


Figure 3.4.2 Domestic Passenger Forecast

(3) **Domestic Passengers by Route**

Domestic passengers from/to Chittagong Airport in the future are divided into routes based on the present movement pattern shown below:

Routes	Passengers
Chittagong - Dhaka	135,663 (97.5%)
Chittagong - Cox's Bazar	3,507 (2.5%)
Total	139,170 (100.0%)

Source : Bangladesh Biman Airlines
"Traffic Statistics 1987/88"

Results are as follows:

Table 3.4.4 Forecast of Domestic Passengers by Route
(Unit : 1,000 passengers)

Year	Chittagong <------> Dhaka	Chittagong <-->Cox's Bazar	Total	Remarks
1987/88	135	3.5	139	Actual
1995	161	4.0	165	
2000	195	5.0	200	
2005	234	6.0	240	
2010	283	7.0	290	

(4) **Competition Between Modes of Transport**

a) General

Air traffic demand between Dhaka and Chittagong is a main air route comprising about 40% of the total domestic air passengers in Bangladesh. Other transportation modes connecting these two largest cities are railway and road. However, the road transport has bottle necks at the crossing of Meghna and Gumti Rivers. In order to directly link between Dhaka and Chittagong through the road, Meghna bridge construction project is now ongoing. Gumti Bridge is planned to be constructed after the completion of Meghna bridge.

The completion of two bridges is expected to provide substantial benefit to road transport and will consequently influence other transport modes.

In this section, effects of the completion of two bridges on modal choice between air, railway and road is examined by a simple method.

b) Travel Time and Cost by Mode

Time and cost required to travel between Dhaka and Chittagong are summarized in Table 3.4.5.

Table 3.4.5 Travel Time and Fare by Mode Between Dhaka and Chittagong.

Items	Sections	Bus	Rail	Air
Travel Time	Line haul	12.5 hrs.*1	6.5 hrs.*2	0.75 hrs. *3
	Access time	15 min.	30min.+30min.	30min.+30min.
	Waiting Time	10 min.	45 min.	30 min.
	Total	12.92 hrs.	8.25 hrs.	2.25 hrs.
Fare	Line haul	100 TK	250 TK *2 (First class)	565 TK *4 + 50 TK (Tax)
	Access cost	-	3 TK + 3 TK	5 TK + 5 TK
	Total	100 TK	256 TK	625 TK

Source: *1 "Intermodal Transport Study" Final Report Vol. II, Dec. 1985
*2 "Working Time Tables" Bangladesh Railway, April 14, 1988
*3 Domestic Schedule, January 1989, Biman
*4 Legends of Domestic Fares in Bangladesh

c) Model Split

Total travel cost of a mode (i) can be expressed in the following formula:

$$S_i = C_i + WT_i$$

where, S_i : Total travel cost (or generalized cost) by mode (i)
C_i : Fare by mode (i)
T_i : Travel time by mode (i)
W : Travel time value (TK/hour)

The above formula indicates the total travel cost to be paid by a traveler including both money cost and time cost which is a product of travel time and time value W.

Total travel cost by mode between Dhaka and Chittagong is calculated as shown below and in Figure 3.4.3 based on the travel time and fare in Table 3.4.5.

$S_B = 100 + 12.92\ W$ (Bus)
$S_R = 256 + 8.25\ W$ (Railway)
$S_A = 625 + 2.25\ W$ (Air)

Figure 3.4.3 indicates a present situation without two bridges and explains that if travelers are assumed to choose a travel mode so as to minimize the total travel cost including time cost, traveler's choice of mode depends on their respective time value of W. Travelers whose value of time is;

1) under 33.4 TK/hour will choose bus,
2) between 33.4 - 61.5 TK/hour will choose railway,
3) over 61.5 TK/hour will choose air.

It is estimated in "Feasibility Study on Meghna, Meghna-Gumti Bridges Construction Project, Final Report, March 1985, JICA" that the travel time by road will be reduced by 86 minutes (or 1.43 hr.) after the completion of the two bridges.

In this situation, the cost curve of bus will be inclined closer to S'_B as illustrated in Figure 3.4.4.

Figure 3.4.4 indicates that even after the completion of two bridges the share of air traffic demand will not be changed. Competition will be observed between bus and railway and travelers whose value of time is 33.4 to 48.1 TK will transfer from railway to bus.

In addition to the above results, the future increase in income level due to economic growth will increase the solvency to pay fares and the time value and then result in the preference of the faster transport even if the cost is higher. Passengers will be willing to pay more to save more time because of high value of time. Therefore, the future share of air transport, particularly for long distance trips, is considered to increase in accordance with the economic development.

3.4.2 Forecast of Annual International Passengers

(1) International Passengers in Bangladesh

In order to forecast the number of international passengers, passenger traffic is classified into Bangladeshi and foreigners in order to express their respective trends of air traffic growth in the future. Regression analyses are carried out for both passenger categories and the results are presented in Table 3.4.6.

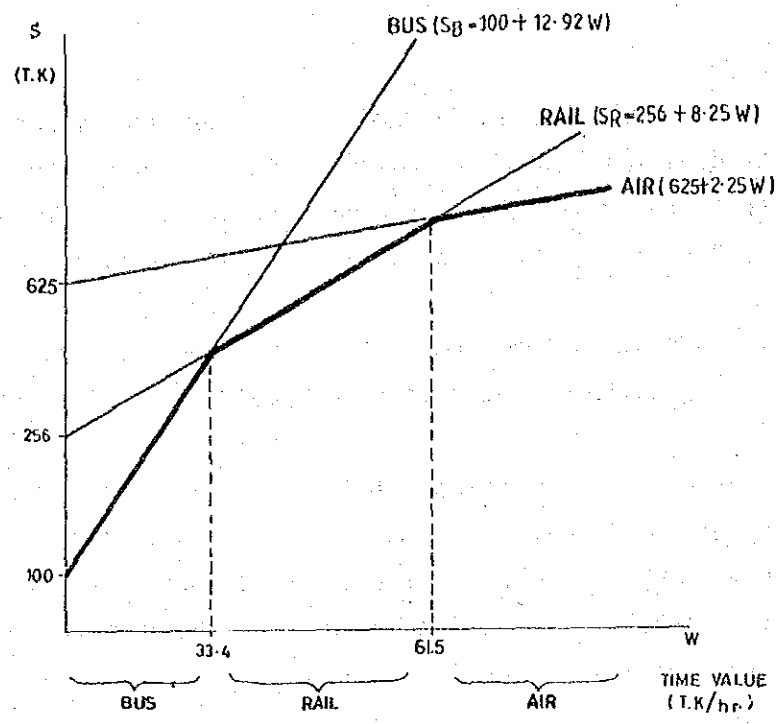


Figure 3.4.3 Competition between Modes of Traffic (Without Two Bridges Case)

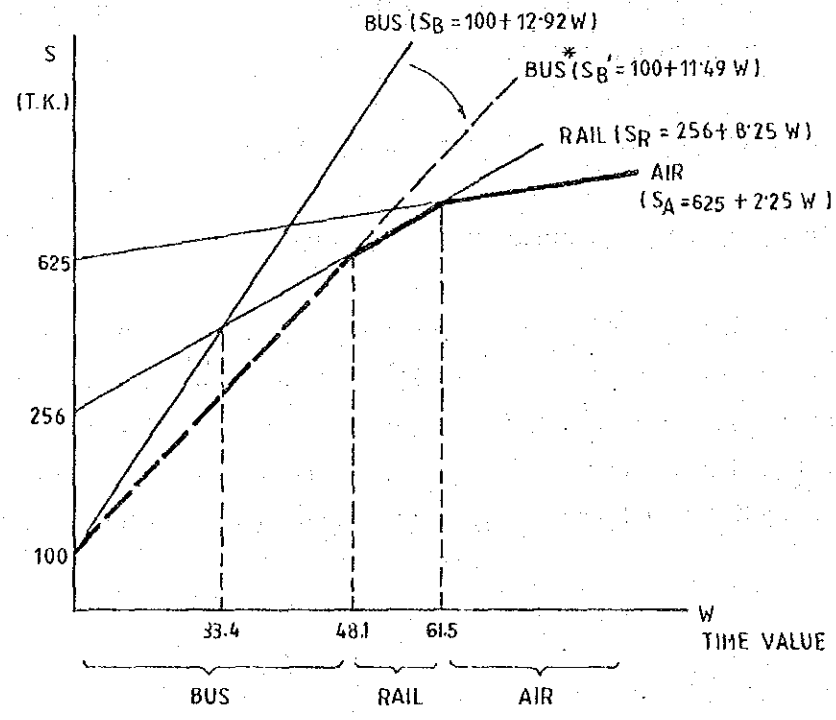


Figure 3.4.4 Competition between Modes of Traffic (With Two Bridges Case)

Table 3.4.6 Results of Regression Analyses for International Passengers

Passengers	CASE No.	Explanatory Variable					
		Population	GDP	Per Capita GDP	Industrial & Commercial Product	Correlation Coefficient	Adapted Case
Bangladeshi International Passengers	1		+			0.956	#
	2				+	0.922	
	3			+		0.848	
	4	+	−			0.973	
	5	+		−		0.971	
Foreign International Passengers	6		+			0.811	#
	7				+	0.733	
	8			+		0.688	
	9	+	−			0.762	
	10	+		−		0.755	

Note, + : Positive Parameter
− : Negative Parameter

The following equations are considered to be most adequate to forecast the future international air traffic demand because of relatively high correlation coefficients.

INTB (t) = − 1,831,699 + 32.84 GDP (t−1), R = 0.956

Where, INTB (t) : Bangladeshi international passenger demand in year (t)
GDP(t−1) : GDP in bangladesh at 1972/73 constant factor cost (Tk) in year (t−1)

INTF(t) = − 287,293 + 5.817 GDP (t−1), R = 0.811

Where, INTF (t) : Foreign international passenger demand in year (t)

The forecast results are shown below:

Table 3.4.7 Forecast of International Passengers in Bangladesh

(Bangladeshi) (Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	788	788	788	Actual
1995	1,530 6.6%	1,740 7.9%	2,120 9.9%	
2000	2,070 p.a	2,500 p.a.	3,310 p.a.	
2005	2,690	3,410	4,860	
2010	3,410	4,510	6,870	

(Foreigner) (Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	177	177	177	Actual
1995	310 5.7%	350 7.0%	410 8.9%	
2000	400 p.a	480 p.a.	620 p.a.	
2005	510	640	900	
2010	640	840	1,250	

(Total) (Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	965	965	965	Actual
1995	1,840 6.4%	2,090 7.7%	2,530 9.7%	
2000	2,470 p.a.	2,980 p.a.	3,930 p.a.	
2005	3,200	4,050	5,760	
2010	4,050	5,350	8,120	

(2) **International Passengers at Chittagong Airport**

Chittagong Airport handles 6.9% of the total international passengers in Bangladesh in 1987. On the other hand, the Chittagong and Chittagong H.T. Regions as the catchment area of Chittagong Airport have now GRP (Gross Regional Product) share of 12.3% and population share of 7.2% of the country's total in 1986. These shares to represent the regional potential for air traffic demand. Chittagong Airport's share of international passengers is therefore expected to increase in the future. In this forecast, GRP share of 12.3% is applied to estimate the foreign international passengers and 7.2% is applied to Bangladeshi passengers. This is because the GRP is considered to be an attractive factor to foreigners and the population to be demand generating factor of Bangladeshi. The future international passenger demand at Chittagong Airport is

presented in Table 3.4.8 and Figure 3.4.5.

Table 3.4.8 Forecast of International Passengers at Chittagong Airport

(Unit : 1,000 passengers)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	67	67	67	Actual
1995	150 7.1%	160 8.5%	200 10.4	
2000	200 p.a.	240 p.a.	320 p.a.	
2005	260	330	460	
2010	330	440	650	

(3) **International Passengers by Route**

International passengers from/to Chittagong Airport in the future are estimated by the following method:

a) Chittagong - Culcutta

This route's volume will increase in proportion to the total international passenger growth at Chittagong Airport.

b) Via Dhaka or Directly from Chittagong to Foreign Countries

Future international passenger demand is divided by the present routes from/to Dhaka. As a result of analysis on the possible direct connection from/to Chittagong Airport, Middle East route and Bangkok route are expected to be opened in the future. Passengers on the other routes such as Kathmandu or Singapore will utilize ZIA as a port of entry or exit of Bangladesh although government formalities are carried out at Chittagong Airport.

The results are given in Table 3.4.9.

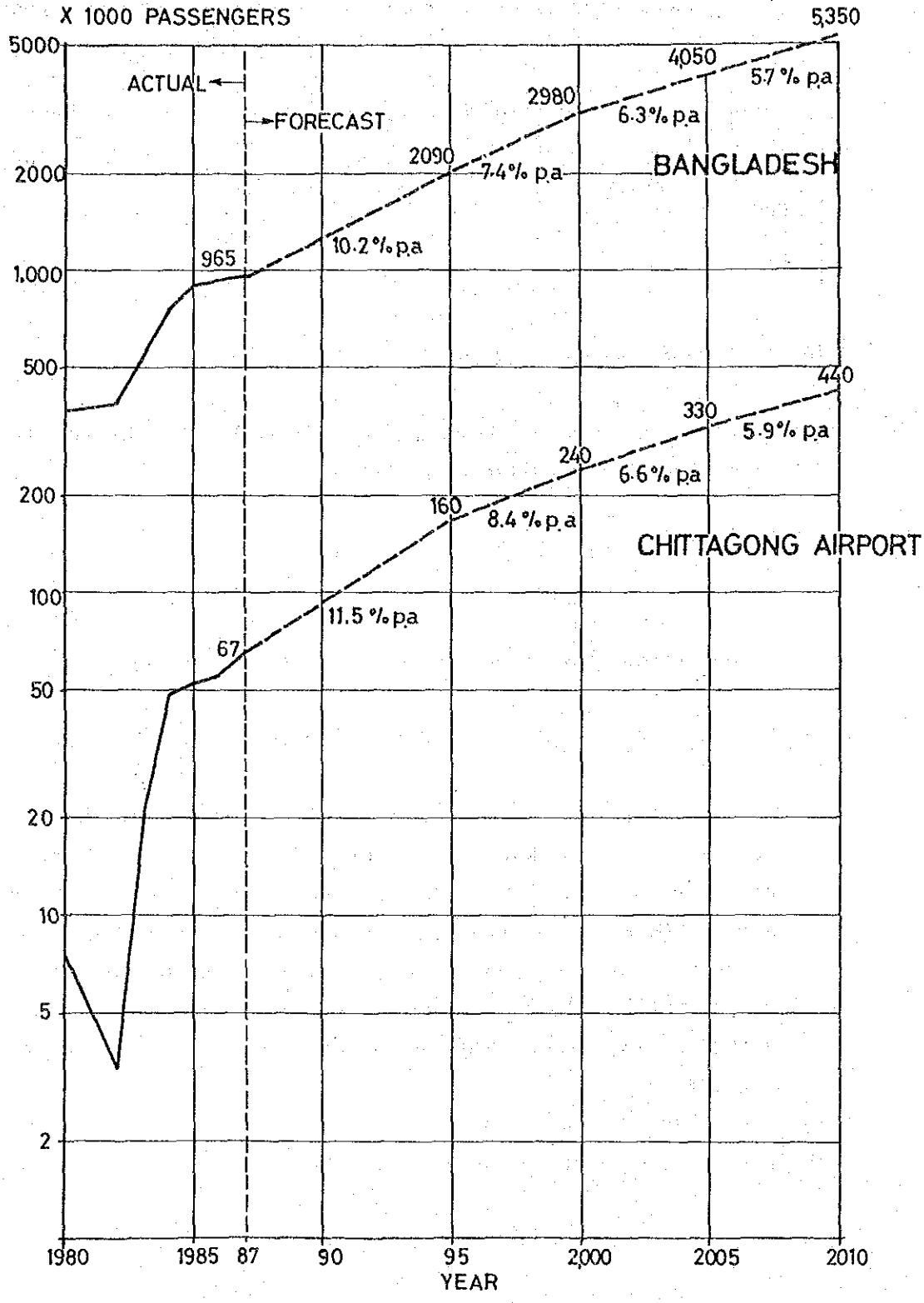


Figure 3.4.5 International Passenger Forecast

Table 3.4.9 Forecast of International Passengers by Route

Year	Chittagong ←→Middle East	Chittagong ←→Bangkok	Chittagong ←→ Calcutta	Others Via Dhaka
1995	50,000	19,000	40,000	51,000
2000	74,000	28,000	61,000	77,000
2005	100,000	39,000	84,000	107,000
2010	134,000	53,000	113,000	140,000

In this estimation, a distribution pattern is prepared based on the following data:

Origin	Destination	Passengers	(%)
Dhaka	Abu Dhabi	8,463	3.2
	Bahrain	11,881	4.5
	Bangkok	55,452	21.2
	Bombay	4,643	1.8
	Calcutta	87,156	-
	Dhahran	11,848	4.5
	Doha	9,817	3.8
	Jeddah	26,912	10.3
	Karachi	26,954	10.3
	Kathmandu	19,309	7.4
	Kuwait	20,149	7.7
	London	42,590	16.3
	Muscat	10,730	4.2
	Singapore	12,389	4.8
	Total	261,137 (Excl. Calcutta)	100.0%

Source : On-Flight Origin and Destination, ICAO
Year Ending 30 Sept. 1987

3.5 Annual Air Cargo Forecast

3.5.1 Forecast of Air Cargo in Bangladesh

Total air cargo traffic in all of Bangladesh (total of international and domestic cargo) is firstly forecast by the following equation:

$$CRGO(t) = -67{,}162.8 + 1.27494\ GDP\ (t-1),\ R = 0.941$$

Where, CRGO(t) : Total domestic and international cargo in Bangladesh in year (t)

GDP(t-1): GDP in Bangladesh at 1972/73 constant factor cost in year (t-1).

The next step in the forecast is to divide the total air cargo estimated by the above equation into domestic and international cargoes in Bangladesh based on the present ratio of domestic 10% and international 90%.* This estimation is made because individual data for domestic cargo and international cargo are not available except for 1986 and 1987.

Domestic and international cargo in Bangladesh are forecast as shown in Tables 3.5.1 and 3.5.2.

Note * : Refer to Table 3.2.3(2).

Table 3.5.1 Forecast of Domestic Cargo in Bangladesh

(Unit: ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	3,700	3,700	3,700	Actual
1995	6,300 5.8%	7,200 7.1%	8,600 9.0	
2000	8,400 p.a.	10,000 p.a.	13,200 p.a.	
2005	10,800	13,600	19,200	
2010	13,600	17,900	27,000	

Table 3.5.2 Forecast of International Cargo in Bangladesh

(Unit: ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	30,600	30,600	30,600	Actual
1995	57,100 6.2	64,000 7.5%	77,700 9.4%	
2000	75,800 p.a.	90,000 p.a.	119,200 p.a.	
2005	97,500	122,400	173,200	
2010	122,700	161,300	243,500	

The commodity type of the future air cargo at Chittagong Airport will depend on the future socio-economic conditions of the Chittagong Region , for example, progress of EPZ which will produce high value-added products and may export them by air,trend of diversion of perishable marine foods from sea to air,etc. But because of insufficient information on the above mentioned conditions, the forecast of air cargo by commodity type is difficult. Therefore, total ammount of air cargo is forecast in this Study.

Although the forecast is not conducted by commodity type,the share of marine foods was estimated about 30 % of total international air cargo by the following calculation :

$$R = (Mb - Mc) / Ta = (24,672 - 16,640) / 28,944 = 0.28 = 30\ \%$$

Where,

Mb : Total marine foods exported from Bangladesh in 1986.
(24,672 ton *)

Mc : Total marine foods exported from Chittagong and Chalna Ports in 1986. (16,640 ton *)

Ta : Total international air cargo in Bangladesh in 1986
(28,944 ton Refer to Table 3.2.3(2))

* : Source ; Statistical Yearbook of Bangladesh

The volume of future international air cargo at Chittagong Airport were forecast assuming that the present composition of commodity type of whole Bangladesh will continue.

3.5.2 Air Cargo Traffic Demand at Chittagong Airport

At Chittagong Airport, about 271 tons of international cargo were handled in 1987.* That is only 1% of Bangladesh's total. The reasons for this low share of international air cargo traffic at Chittagong Airport are that only one international air route to Calcutta is operated by small aircraft and most of air cargo related to Chittagong region is presently transported by road or railway via Dhaka. Due to this restriction, the international cargo traffic demand is not considered to express the high potential of Chittagong Area which shares 12.3% and 7.2% of the industrial/commercial product and the population of the country's total respectively.

Note * : Refer to Table 3.2.3(2).

The share of international cargo demand at Chittagong Airport is estimated to gradually reach its potential in the future and assumed to reach 7.2% of total cargo traffic in Bangladesh in 2000 with an interpolated share of 4.8% in 1995 based on the population share of Chittagong and Chittagong H.T. Regions. The industrial product share of 12.3% is considered to overestimate the air cargo traffic demand because it contains the portion of products such as the heavy industrial products which are not usually shipped by air.

On the other hand, the present share of domestic cargo at Chittagong Airport was 7.5% in 1987. This share is almost same as population share mentioned above. Therefore, the present share is estimated to continue in the future.

Cargo traffic is forecast as shown in Table 3.5.3.

Table 3.5.3 Forecast of Domestic and International Cargo at Chittagong Airport

<Domestic Cargo> (Unit: ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	278	278	278	Actual
1995	500 5.7%	500 6.9%	600 9.0%	
2000	600 p.a.	800 p.a.	1,000 p.a.	
2005	800	1,000	1,400	
2010	1,000	1,300	2,000	

<International Cargo> (Unit: ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	271	271	271	Actual
1995	2,700 16.3%	3,000 17.7%	3,700 19.9%	
2000	5,500 p.a.	6,500 p.a.	8,600 p.a.	
2005	7,000	8,800	12,500	
2010	8,800	11,600	17,500	

<Total> (Unit: ton)

Year	Low Estimate	Medium Estimate	High Estimate	Remarks
1987	549	549	549	Actual
1995	3,200 13.3%	3,500 14.7%	4,300 16.8%	
2000	6,100 p.a.	7,200 p.a.	9,600 p.a.	
2005	7,800	9,800	13,900	
2010	9,800	13,000	19,500	

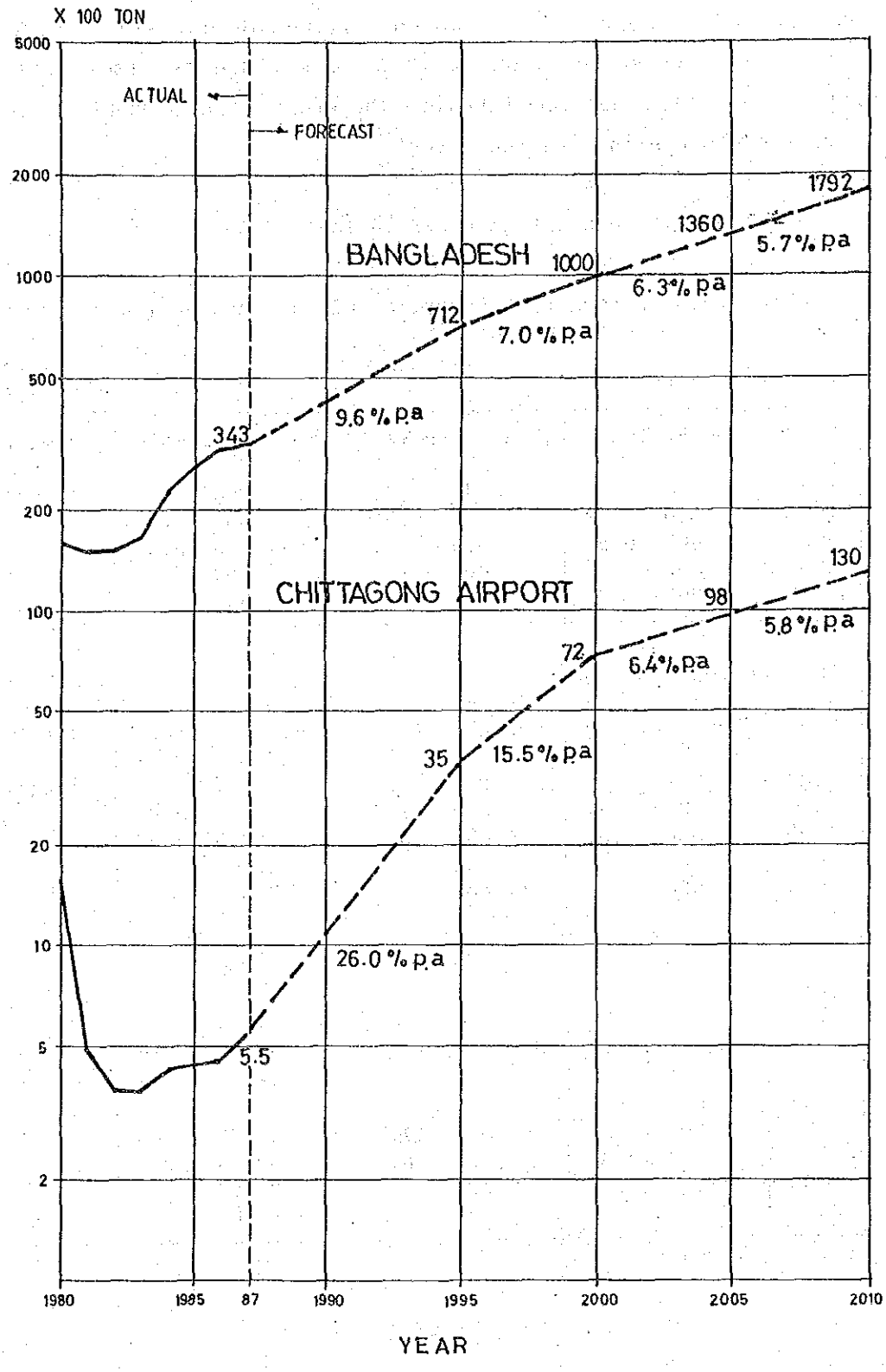


Figure 3.5.1 Air Cargo Forecast

3.6 Peak Hour Forecast

3.6.1 Design Basis

Airport facilities should be planned on the design traffic which is determined so that the facilities may not unnecessarily provide for peak traffic. Peak hour traffic of an average day of the peak month, which is the most common design basis for airport facilities is utilized in this Study. A flow chart of air traffic break-down is shown in Figure 3.6.1

3.6.2 Peak Month, Peak Month Ratio and Design Day Ratio

The peak month for domestic passenger traffic occurred in January or March and the international passenger traffic in April or May between 1984 and 1987. Peak month ratios (peak month passengers/annual passengers) as a planning value are established as shown in Table 3.6.1 taking the average value between 1984 and 1987.

Table 3.6.1 Peak Month Ratio

Year	Domestic		International	
	Month	Peak Ratio	Month	Peak Ratio
1984	Mar.	1/10.2 (9.85%)	May	1/9.8 (10.24%)
1985	Jan.	1/10.5 (9.50%)	May	1/10.4 (9.63%)
1986	Jan.	1/9.6 (10.45%)	Apr.	1/8.7 (11.55%)
1987	Jan.	1/9.9 (10.12%)	Apr.	1/8.7 (11.40%)
	Average	1/10.0 (9.98%)	Average	1/9.3 (10.71%)

The design day ratio is calculated as follows by multiplying peak month ratio by the average day ratio of 1/30.5.

Design Day Ratio for Domestic Passengers

= 1/10.0 x 1/30.5 = 1/305

Design Day Ratio for International Passengers

= 1/9.3 x 1/30.5 = 1/285

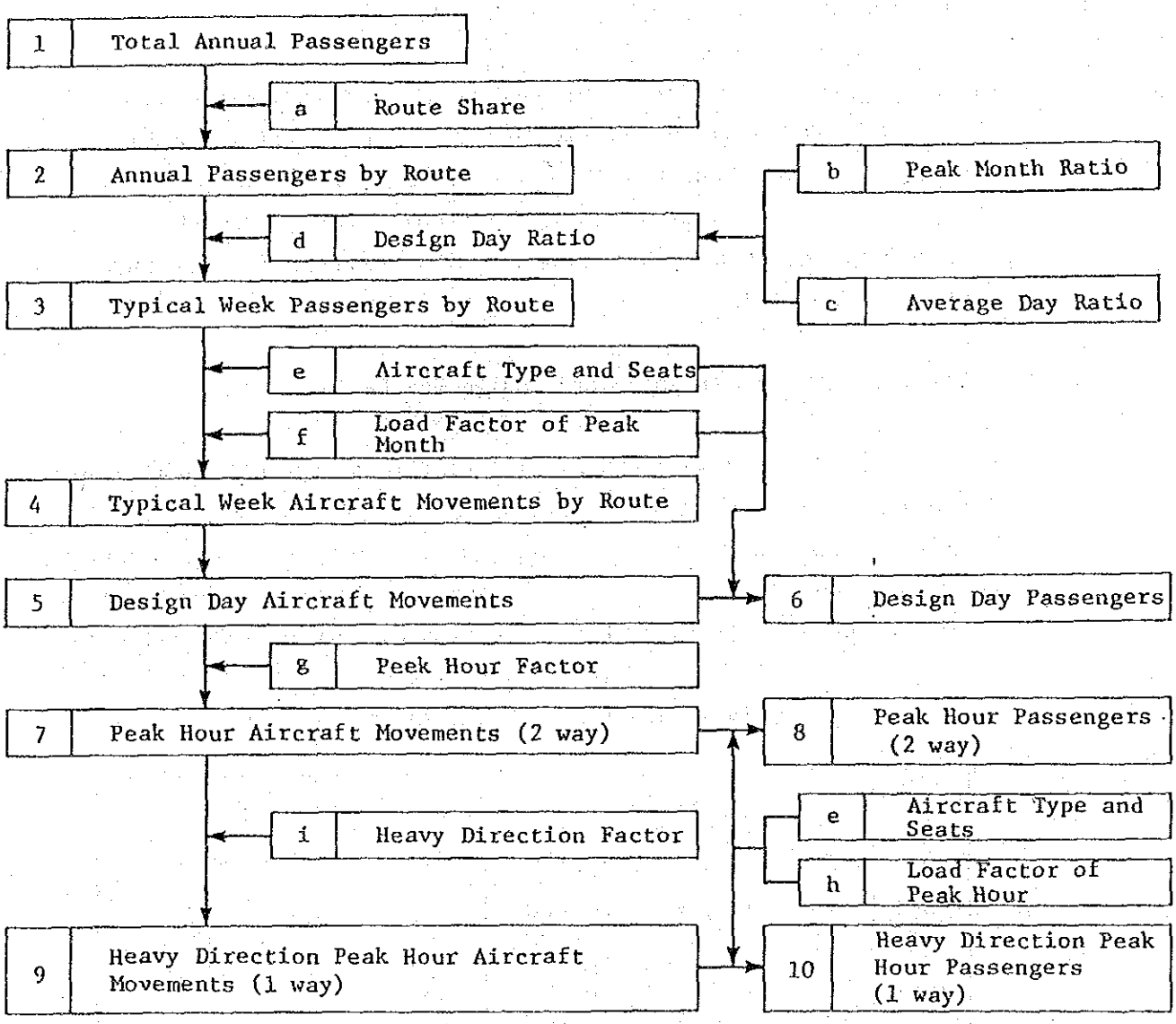


Figure 3.6.1 Flow Chart of Air Traffic Break-Down

3.6.3 Passenger Traffic by Routes of the Typical Week

As flight schedules will be established on weekly base for low traffic routes, aircraft movements are projected for each route of the typical week of the peak month. Typical week passengers are calculated by multiplying the annual traffic by 7 times of the design day ratio as shown in Table 3.6.2.

Table 3.6.2 Passenger Traffic by Routes of the Typical Week

Routes \ Year	1995	2000	2005	2010
Domestic				
Dhaka	3,700	4,480	5,370	6,500
Cox's Bazar	90	110	140	160
Subtotal	3,790	4,590	5,510	6,660
International				
Dhaka *	1,250	1,890	2,630	3,440
Middle East	1,230	1,820	2,460	3,290
Calcutta	980	1,500	2,060	2,780
Bangkok	470	690	960	1,300
Subtotal	3,930	5,900	8,110	10,810
Total	7,720	10,490	13,620	17,470

Note * : International passengers on domestic flights

3.6.4 Aircraft Classification and Seat Capacity

Aircraft seat capacity by aircraft category is projected as shown in Table 3.6.3 based on Biman's present fleet, aircraft types at ZIA and the trend of new aircraft.

The existing fleets of Biman Bangladesh Airlines are 4 DC-10s (270 seats), 2 F-28s (85 seats) and 3 F-27s (44 seats). Among the above the F-27s are to be replaced by new technology turbo props such as F-50 (54 seats), DHC-8-300 (54 seats) or ATP (64 seats) from the end of 1989 at the earliest.

Table 3.6.3 Aircraft Type and Seat Capacity

Aircraft Category	Seat Capacity	
	Present - 2000	2001 - 2010
J (Jumbo)	400 *1	500 *2
WD (Wide Body)	270 *3	300 *4
NB(Narrow Body)	150 *5	150 *5
SJ/TP (Small Jet/ Turbo Prop)	70 *6	70 *6

Note, *1 : B-747-200B for international use.
*2 : Average seat capacity is assumed to increase by the introduction of aircraft type with higher seat capacity such as B-747-400.
*3 : Present Biman DC-10-30.
*4 : Average seat capacity is assumed to increase by the introduction of aircraft type with higher seat capacity such as MD-11.
*5 : B-747-300, A-320, MD-80 series etc. are assumed.
*6 : Average of F-28, F-50 and ATP.

3.6.5 Passenger Load Factor

The annual average passenger load factor of Biman Bangladesh Airlines was 72% for domestic services in 1986/87 and 82% in 1987/88. The same figure for international services was 69% in both 1986/87 and in 1987/88.

It is assumed that the existing high load factor of domestic flights will decrease to 70% by the improvement of service and that the load factor of international services will be maintained at 70% in the future. Average passenger load factor during the peak month is assumed to increase to 80% for both domestic and international flights. This assumption corresponds to the design day ratios of 1/350 for domestic aircraft movements. The design day ratio for international aircraft movements will be 1/325.

3.6.6 Typical Week and Design Day Traffic

Based on the aforementioned conditions, aircraft movements of the typical week of the peak month are projected by routes as shown in Table 3.6.4. Among the routes, Dhaka route is projected so that the daily flight schedule will not change through the week taking into account its relatively high demand.

Table 3.6.4 Aircraft Movements of the Typical Week (2 ways)

	1989 (Actual)	1995	2000	2005	2010
Domestic					
Dhaka	F-28:28/W F-27:24/W	SJ/TP:12/D -	SJ/TP:16/D	SJ/TP:12/D NB : 4/D	SJ/TP:8/D NB :8/D
Cox's Bazar	F-27: 4/W	SJ/TP: 4/W	SJ/TP: 4/W	SJ/TP: 6/W	SJ/TP:6/W
Subtotal	56/W	88/W	116/W	118/W	118/W
International					
Middle East		WD: 8/W	WB:12/W	WB:12/W	WB :16/W
Calcutta	F-28: 4/W F-27: 6/W	SJ/TP:18/W	SJ/TP:10/W NB: 8/W	NB:18/W	NB :24/W
Bangkok		WB: 4/W	WB: 6/W	WB: 8/W	WB :10/W
Subtotal	10/W	30/W	36/W	38/W	50/W
Total	66/W	118/W	152/W	156/W	168/W

Note 1 : "/W" indicates weekly number of aircraft movements
2 : "/D" indicates daily number of aircraft movements
3 : Aircraft movements of Cox's Bazar route are calculated by 35 seat capacity taking into account the existence of about 50% transit passengers at present.
4 : Aircraft movements of Middle East route are calculated by 75% of seat capacity assuming that 25% of the passengers will be transit passengers to/from Dhaka.
5 : Aircraft movements of Bangkok route are calculated by 50% of seat capacity assuming that 50% of the passengers will be transit passengers to/from Dhaka.

In this table, it is assumed B-737 class aircraft (NB) will be introduced in Dhaka route in 2005 and Calcutta Route in 2000 to cope with increasing demand.

DC-10 class aircraft (WB) is the most probable for Middle East and Bangkok routes. B-747 class aircraft (J) will not operate at least up to 2010 judging from the size of the demand and infrequent operations at ZIA at present.

Design day aircraft movements are estimated in Table 3.6.5 as about 1/7 of the typical week movements. Passenger traffic of the design day is calculated as shown in Table 3.6.6 based on the above aircraft movements, aircraft seat capacity and load factor of 80%. Domestic and international passengers on the Dhaka route are estimated respectively by using the same proportion of typical week passengers on the Dhaka route.

Table 3.6.5 Design Day Aircraft Movements

	1995	2000	2005	2010
Domestic				
Dhaka	SJ/TP:12	SJ/TP :16	SJ/TP:12	SJ/TP: 8
		-	NB : 4	NB : 8
Cox's Bazar	SJ/TP: 2	SJ/TP : 2	SJ/TP: 2	SJ/TP: 2
Subtotal	14	18	18	18
International				
Middle East	WB : 2	WB: 2	WB: 2	WB: 2
Calcutta	SJ/TP : 4	SJ/TP: 2	NB: 4	NB: 4
	-	NB: 2	-	-
Bangkok	-	WB: 2	WB: 2	WB: 2
Subtotal	6	8	8	8
Total	20	24	26	26

Table 3.6.6 Design Day Passengers

	1995	2000	2005	2010
Domestic				
Dhaka	502	630	773	921
Cox's Bazar	56	56	56	56
Subtotal	558	686	829	977
International				
Dhaka	170	266	379	487
Middle East	325	325	397	397
Calcutta	224	352	480	480
Bangkok	-	216	264	264
Subtotal	719	1,159	1,520	1,628
Total	1,277	1,845	2,349	2,605

3.6.7 Peak Hour Traffic

Peak hour aircraft movements (two ways) are estimated using a relationship between daily aircraft movements and peak hour factor. A peak hour factor indicates a ratio of peak hour aircraft movements to the design day aircraft movements.

The above relation for domestic aircraft movements are investigated for each airport in Bangladesh, and shown together with the average characteristics of domestic airports in Japan in Figure 3.6.2. As is found from this figure, peak hour characteristics of airports in Bangladesh can be expressed by the following equation which is used for planning domestic airports in Japan.

$$A = 1.51/B + 0.1151$$

Where, A : Peak Hour Factor
B : Daily Aircraft Movements

Peak hour domestic aircraft movements are calculated by multiplying the daily aircraft movements by the peak hour factor derived from the above equation. The peak hour for domestic traffic in 2000 through 2010 will be generated by 3 aircraft movements from/to Dhaka

and the arrival or departure of a flight from or to Cox's Bazar as observed in the present absolute peak hour. (Present flight schedule at Chittagong Airport is shown in Appendix 3.1.)

The peak hour for international traffic after the introduction of large aircraft in 1995 will be generated by an arrival or a departure movement of DC-10 class aircraft (WB) for the Middle East route and an arrival and departure of flights from/to Calcutta.

The overall peak hour for domestic and international traffic will occur during the international peak hour with the above 3 international aircraft movements plus an arrival and a departure of domestic flights from/to Dhaka.

Passenger traffic is estimated by multiplying the peak hour aircraft movements, the aircraft seat capacity and the passenger load factor of 80%. In this estimation international passengers on domestic flights and the existence of transit passengers are neglected in order to accommodate for future possible changes in the route structure in the facility planning. Tables 3.6.7 and 3.6.8 summarize the estimated peak hour aircraft movements and number of peak hour passengers respectively.

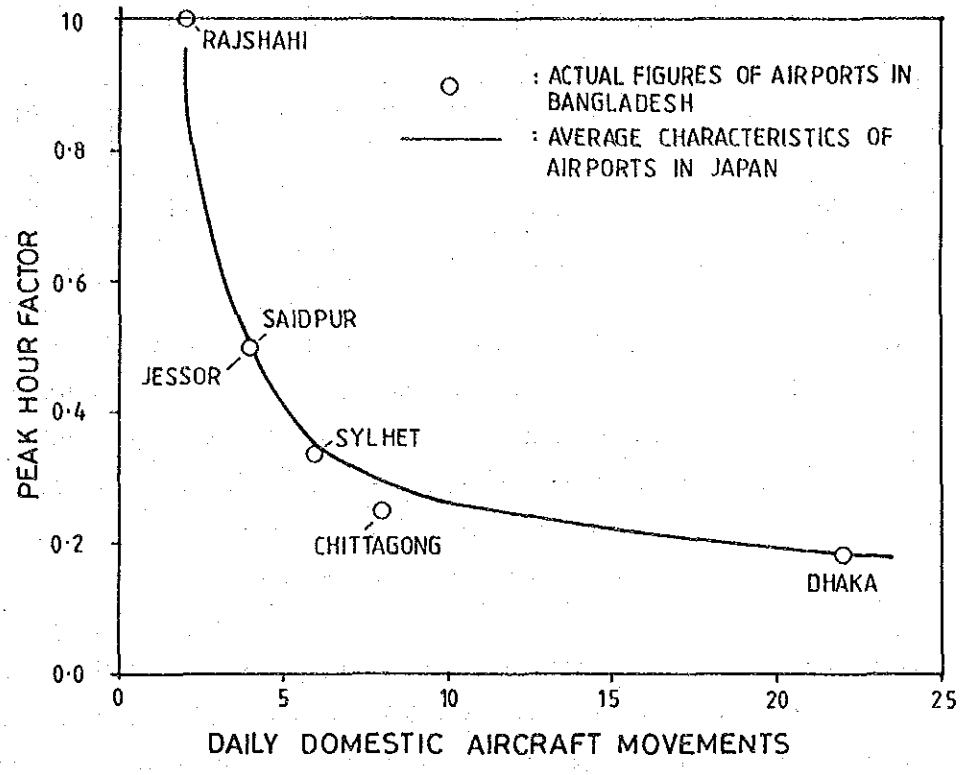


Figure 3.6.2 Peak Hour Factor and Daily Aircraft Movements

Table 3.6.7 Peak Hour Aircraft Movements (2 ways)

	1995	2000	2005	2010
Domestic				
ST/TP	3	4	3	2
NB	-	-	1	2
Total	3	4	4	4
International				
WB	1	1	1	1
SJ/TP	2	-	-	-
NB	-	2	2	2
Total	3	3	3	3
Overall				
SJ/TP (DOM.)	2	2	2	1
NB (DOM.)	-	-	-	1
WB (INT.)	1	1	1	1
SJ/TP (INT.)	2	-	-	-
NB (INT.)	-	2	2	2
Total	5	5	5	5

Table 3.6.8 Peak Hour Passengers (2 ways)

	1995	2000	2005	2010
Domestic	168	224	288	352
International	328	456	504	504
Overall	440	568	616	680

Heavy direction peak hour traffic, which is the traffic volume of one way traffic (arrival or departure) during the peak hour is also necessary for planning. A heavy direction factor which indicates the ratio of one way traffic to two way traffic is used to estimate heavy direction traffic. In this study, a general planning value of 1/2 to 2/3 is adopted for the aircraft movements.

Passenger traffic is estimated by multiplying heavy direction peak hour aircraft movements, aircraft seat capacity and a passenger load factor of 80%. The estimated heavy direction aircraft movements and passengers are shown in Tables 3.6.9 and 3.6.10.

Table 3.6.9 Peak hour Aircraft Movements (1 way)

	1995	2000	2005	2010
Domestic				
ST/TP	2	2	1	1
NB	-	-	1	1
Total	2	2	2	2
International				
WB	1	1	1	1
SJ/TP	1	-	-	-
NB	-	1	1	1
Total	2	2	2	2
Overall				
SJ/TP (DOM.)	1	1	1	-
NB (DOM.)	-	-	-	1
WB (INT.)	1	1	1	1
SJ/TP (INT.)	1	-	-	-
NB (INT.)	-	1	1	1
Total	3	3	3	3