社会開発協力部報告書

THE PEOPLE'S REPUBLIC
OF
BANGLADESH

REPORT
OF
FEASIBILITY STUDY ON ESTABLISHMENT
OF
RAILWAY CARRIAGE AND WAGON MANUFACTURING
PLANT

NOVEMBER 1985

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

PREFACE

In response to the request of the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a feasibility study on the Project for Establishment of a Railway Rolling Stock Manufacturing Plant and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team headed by Mr. Shuichi Sawano, the Japan Railway Technical Service for one and a half months in November and December 1984.
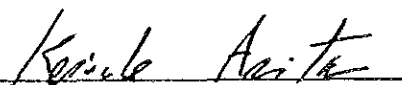
The team exchanged views on the Project with the officials concerned of the Government of Bangladesh, including those of the Bangladesh Railway and conducted a field survey and collected reference materials.

After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

November, 1985

Keisuke Arita
President
Japan International
Cooperation Agency

November, 1985

Mr. Keisuke Arita
President
Japan International Cooperation
Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We have the pleasure of submitting to you herewith the final report on a feasibility study on the Establishment of a Railway Rolling Stock Manufacturing Plant in the People's Republic of Bangladesh.
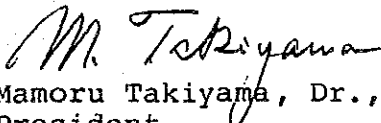
The Study was conducted during the period from November 1984 to October 1985, including the field and site surveys carried out from Novermber to December 1984.

The Study investigated the demand forecast up to 2020, formulated the production capacity and site selection, and got a conclusion that this Project is worthy of implementation through economic and financial analysis on construction and operation plan.
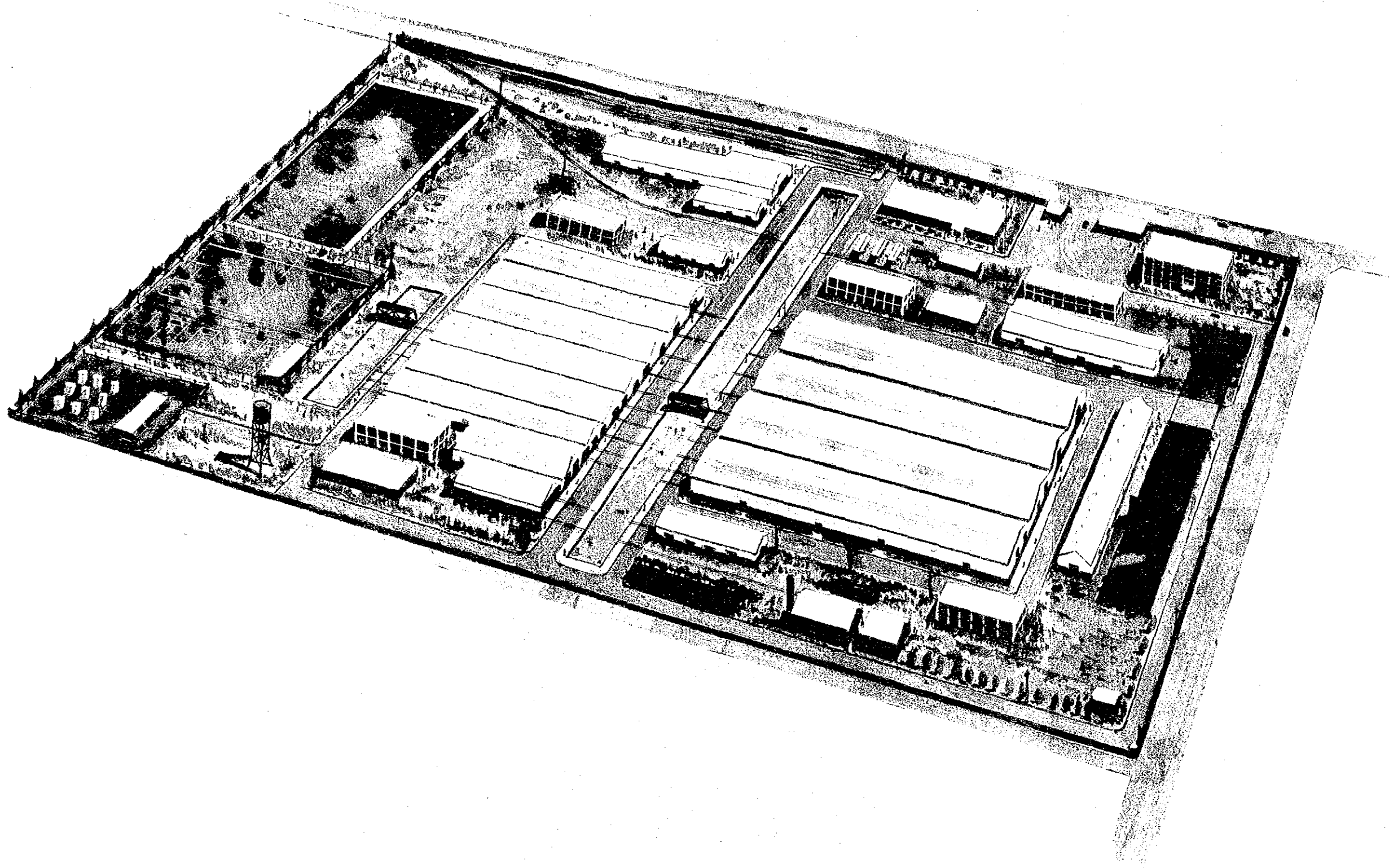
We hope that the Study will serve as the access to future implementation of the Project and accordingly contribute to nationwide development of the People's Republic of Bangladesh through improvement of railway transport.

We wish to express our sincere gratitude to the officials of your Agency, Advisory Committee, the Embassy of Japan in Bangladesh as well as to those concerned of the Government of the People's Republic of Bangladesh for their kind assistance and cooperation extended to the Study Team.

Very truly yours,

Mamoru Takiyama, Dr., Eng.
President
Japan Railway Technical Service

BIRD'S EYE VIEW OF CARRIAGE
AND WAGON MANUFACTURING PLANT

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PRINCIPAL STATISTICS

1.	Route – miles	1,793.65 miles
2.	Track – miles	2,824.04 miles
3.	Railway stations	516
4.	Locomotives owned	410
5.	Coaching vehicles owned	1,732
6.	Freight wagons owned	16,976
7.	Passengers carried	105,639,000
8.	Passenger – miles	3,993,632,000
9.	Freight wagons loaded	206,911
10.	Tonnes of freight carried	2,950,879 ton
11.	Tonne – miles	497,727,225 ton-miles
12.	Passenger, mixed and other coaching train run	124,986
13.	Train – miles, passenger, mixed and other coaching	7,732,279 miles
14.	Coaching vehicle – miles	137,887,000 miles
15.	Freight trains run	23,791
16.	Freight train – miles	1,071,006 miles
17.	Freight wagon – miles on freight and mixed trains	54,285,000 miles
18.	Fuel consumed :	
	Coal	16,021 ton
	Furnace oil	18,384 ton
	Diesel oil	38,879 ton
19.	Gross earnings	1,496.26 million Taka
20.	Operating ratio	94.4%
21.	Persons employed	57,829
22.	Cost of employees	606.78 million Taka

LIST OF ABBREVIATION

(A) AWM : Additional Works Manager
    AIJ : Architectural Institute of Japan

(B) BBS : Bangladesh Bureau of Statistics
    BG : Broad Gauge
    BM : Brick Masonry
    BR : Bangladesh Railway

(C) CKD : Complete Knocked Down
    CME : Chief Mechanical Engineer

(E) EIRR : Economic Internal Rate of Return
    EOJ : Embassy of Japan
    ETC : Education and Training Centre

(F) FIRR : Financial Internal Rate of Return

(G) GDP : Gross Domestic Product
    GL : Grand Level
    GNP : Gross National Product
    GOB : Government of Bangladesh

(I) IPR : Import Permit Rate

(J) JICA : Japan International Cooperation Agency
    JIS : Japanese Industrial Standard

(M) MAPI : Machinery and Allid Products Institute
    MG : Metre Gauge
    MOC : Ministry of Communication

(N) NPV : Net Present Value

(O) OJT : On-the-Job Training

(P) POH : Periodical Overhaul
    PDB : Power Development Board

(R) RC : Reinforced Concrete
    RM : Raw Material

(S) SFYP : Second Five Year Plan
    SKD : Semi-Knocked Down

(T) TFYP : Third Five Year Plan

(U) UN : United Nations

BANGLADESH SHOWING RAILWAYS
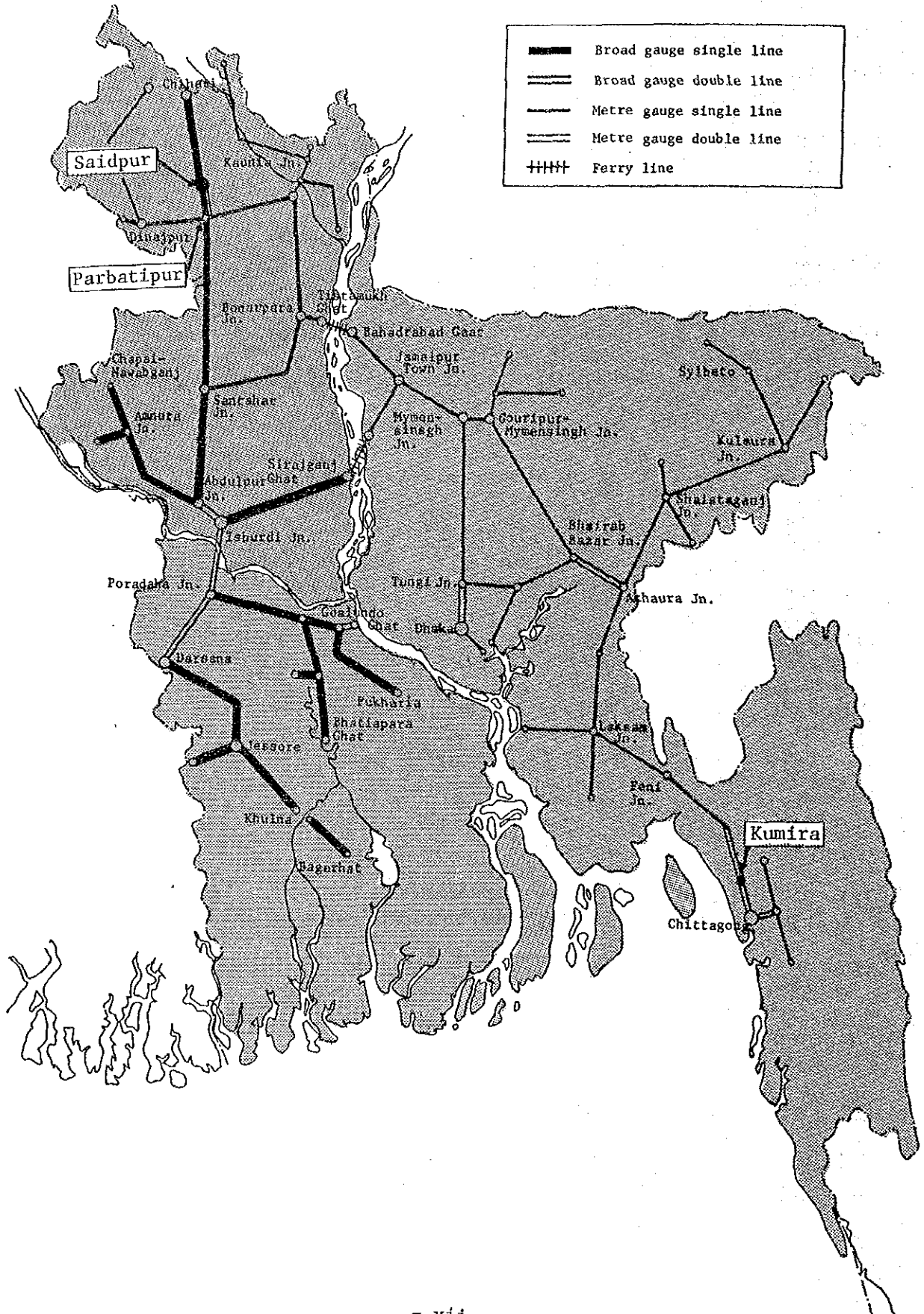
CHAPTER 1 INTRODUCTION

Since achieving independence in 1971, the People's Republic of Bangladesh has embarked on an ambitious series of efforts to achieve the national goals of uplifting round the country and growth towards a thriving economy. Future progress and prosperity depend heavily upon the well harmonized implementation of the various developmental plans and programmes for a major infrastructure. It is said that smooth and reliable services provided by the national railway (Bangladesh Railway, hereinafter referred to as BR) would greatly contribute to the growth of all sectors.

Given these circumstances, various improvements are being sought to increase the capacity of BR. Despite such efforts, however, the present operating conditions and service could hardly be characterized as efficient or adequate. A shortage of rolling stock has been identified as the underlying cause of the railway's traffic difficulties and service deficiencies.

To alleviate the shortage of rolling stock, the Government of Bangladesh (hereinafter referred to as GOB) intends to increase the number of serviceable carriages and wagons. However, any efforts to add to the supply of rolling stock involve a host of other considerations, among which is the impact on the national economy (a key factor).

Domestic carriage and wagon production, functioning in tandem with the partial procurement of some components, will substantially reduce rolling stock procurement expenses. This is a potential government project.

Emphasis on domestic production would offer savings in foreign currency outlays, as well as increased employment opportunities derived from the development of domestic industries. Improved regional development may also result. As a first step, a Working Group was set up in 1980 to investigate various approaches towards actualizing the primary stated goal - the manufacture of carriages and wagons for BR. It submitted a report to the GOB, setting the stage for future steps.

The GOB sent a request for related technical cooperation to the Government of Japan. In response, the Government of Japan decided to undertake this Feasibility Study for the Establishment of a Railway Carriage and Wagon Manufacturing Plant (herinafter referred to as "the study"), through Japan

International Cooperation Agency (hereinafter referred to as "JICA"), which is an official agency implementing the technical cooperation of the Government of Japan.

As a preliminary step in conducting the Study, a Scope of Work was agreed between the GOB and the Japanese Preliminary Mission that was sent to Bangladesh in February 1984. Following the agreement, a Study Team was dispatched to Bangladesh last November, primarily for site survey and interviews with relevant personnel.

During the three fortnight stay in Bangladesh, the Study Team reaped a very fruitful harvest in data collection from its visits to the proposed sites at Parbatipur, Kumira, and Saidpur, and its visits to relevant industries, as well as from its interviews and discussions with government officials concerned.

Based on the data collected, including information obtained through interviews with officials, the Study Team gathered its thoughts into the Interim Report which was published in March 1985.

After scrutinizing the Interim Report especially the production capacity and site selection, the Study Team undertook the technical planning for the plant construction, vis-a-vis the plant managing system, i.e. staffing and technical transfer.

Grounded on the plant construction plan and operation plan, the feasibility of the Project is concluded by means of Economic Analysis and Financial Analysis, results of which are described in the Draft Final Report.

Considering the comments obtained through the discussion on the Draft Final Report held in August, 1985, this Final Report is made in October, 1985 with some revision on the Draft Final Report.

CHAPTER 2 SOCIO-ECONOMIC FRAMEWORK AND DEMAND FORECAST

2-1 General

Bangladesh is subtropical, being situated within 21° $\sim$ 27°N latitude and 88° $\sim$ 93°E longitude. This country is bordered on the west, the north, and the majority of the east by India, and on part of the east by Burma. An area of about 144 thousand km^2 supports a population of about 87 million (Census of 1981). The population density of 600 persons/km^2 is the highest in the world, except for such city-states as Hongkong and Singapore.

The GNP of Bangladesh in fiscal 1982/83 was 275,000 million Taka (US$ 11,000 million at the exchange rate of US$1.00 = 25 Taka). This is approximately 1.1% of Japan's GNP.

Agriculture is the leading industry (providing about 50% of the GNP), taking the form of rice monoculture. Among other industries, jute production is remarkable, and the development and production of natural gas has increased significantly in recent years.

2-2 Socio-Economic Framework

2-2-1 Analysis of Actual Situation

(1) Population

1) National population trends

The national population of Bangladesh, as shown in Fig. 2-2-1, made a transition at a comparatively stable rate of increase until 1960, but grew rapidly after that. The annual increase exceeded 3% since 1960, and only became calm again recently. It was approximately 2.9% in 1982/1981 and 2.3% in 1983/1982, according to the Statistical Pocket Book of Bangladesh 1983 (issued by the Bangladesh Bureau of Statistics). Although lower now, the growth rate is still high.
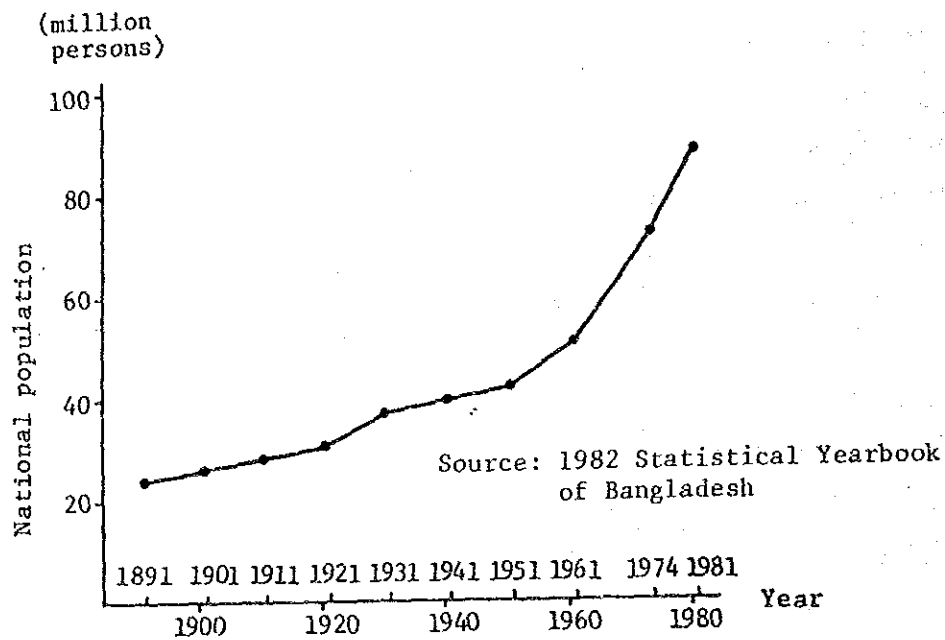
Fig. 2-2-1 National Population Trends

2) Population by district

Figure 2-2-2 shows the population of whole districts and urban areas.
Figure 2-2-3 indicates the population of urban areas with more than
50,000 inhabitants. In addition, Table 2-2-1 lists the total in each
whole district and the number in its urban centres (mainly municipal
cities) of more than 10,000 inhabitants.

The figures and table show the high urbanization of Dhaka, Chittagong,
and Khulna. Dhaka, Chittagong, and Khulna have about 3.5 million, 1.4
million, and 620 thousand inhabitants respectively. Rajshahi, Barisal
Sylhet, Mymensingh, and the other districts have more than 100 thousand
each.

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Table 2-2-1 National Population and Urban Area Population

(Thousand persons)

	Population of district	Urban area population	Urban centre population
Chittagong	5,491	1,710	1,418
Chittagong H.T.	751	213	49
Comilla	6,881	559	334
Noakhali	3,816	412	91
Sylhet	5,656	495	242
Dhaka	10,014	3,857	4,049
Faridpur	4,764	331	180
Jamalpur	2,452	214	142
Mymensingh	6,568	659	311
Tangail	2,444	185	127
Barisal	4,667	558	366
Jessore	4,020	435	269
Khulna	4,329	970	735
Kushtia	2,292	333	180
Patuakhali	1,843	166	62
Bogra	2,728	203	182
Dinajpur	3,200	274	154
Pabna	3,424	399	312
Rajshahi	5,270	545	333
Rangpur	6,510	710	430
Total	87,120	13,228	9,966

Source: 1982 Statistical Yearbook of Bangladesh

Source: 1982 Statistical Yearbook
of Bangladesh

Fig. 2-2-3 Population of Urban Areas
(more than 50,000)
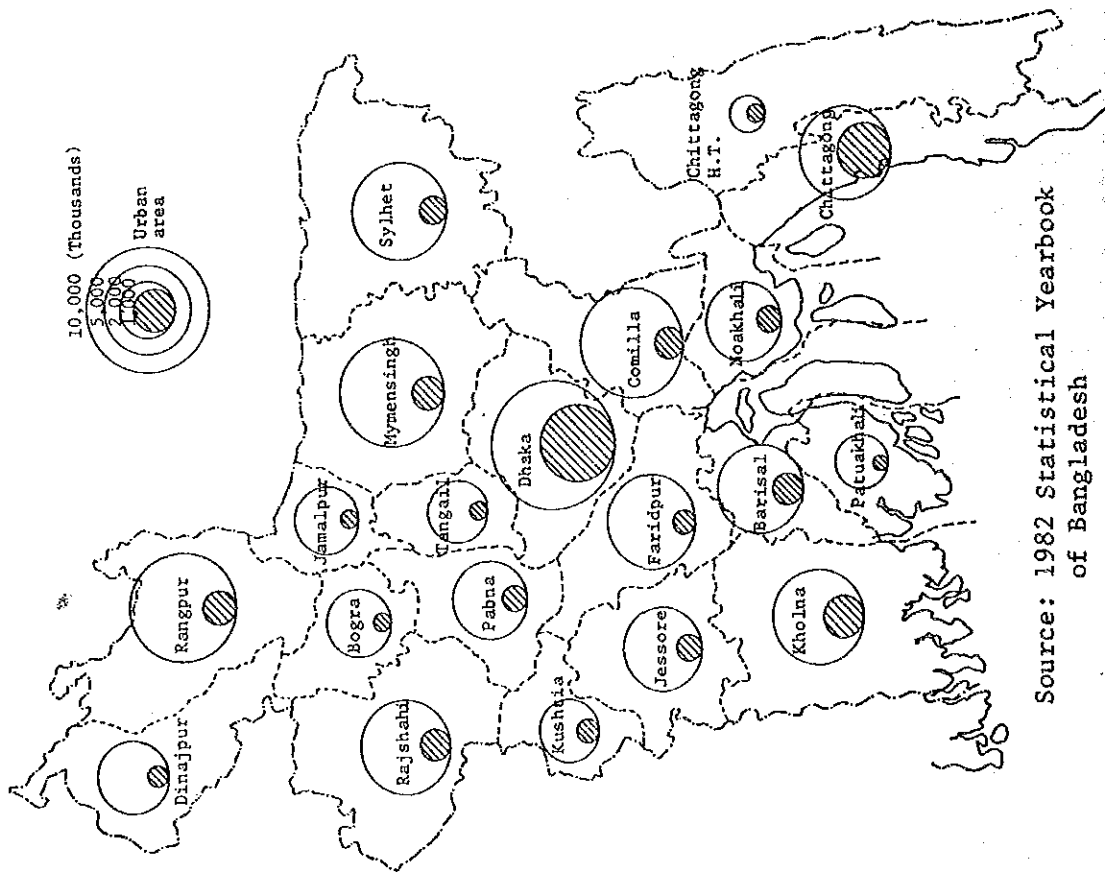
Source: 1982 Statistical Yearbook
of Bangladesh

Fig. 2-2-2 National Population and
Urban Area Population (1981)

(2) Actual economic situation

Table 2-2-2 shows the GNP and other relative economic indices for
Bangladesh. GNP in fiscal 1983/84 was about 310 billion Taka (tentative
value equivalent to US$12.4 billion). The net annual increase since
fiscal 1977/78 averaged 3.7%. Consequently, the economic scale in 1983/84
is about 1.24 times that of 1977/78. Meanwhile, the increase in average
GNP per capita during said period was limited to less than 10%, becoming
about 800 Taka at 1972/73 prices, or 3,200 Taka (about US$130) at 1983/84
prices.

Table 2-2-2 Economic Indices for Bangladesh

	GNP at current factor cost (Million Taka)	Growth rates per annum	GNP at constant prices (1972-73) (Million Taka)	Growth rates per annum	Net national product (Income) at constant prices (1972-73)		Popu- lation (Million)	Per capita income GNP at F.C. at constant prices (1972-73)	Index (1977 -78 =100)
1977-78	140,433	%	60,772	%	56,594	%	83.7	726	100
		18.0		4.5		4.6			
79	165,751		63,519		59,175		85.7	742	102
		15.3		2.0		1.9			
80	191,106		64,763		60,270		87.7	738	102
		18.1		7.0		1.1			
81	225,619		69,299		64,541		89.9	771	106
		13.9		1.1		1.7			
82	256,947		70,034		65,633		91.6	765	105
		10.3		5.1		4.7			
83	283,296		73,613		68,726		93.6	786	108
		8.5		2.4		2.2			
84	307,304		75,366		70,208		95.7	788	109

Source: 1982 Statistical Yearbook of Bangladesh

Table 2-2-3 shows the trends in GDP shares per sector. Primary industries
(such as agriculture) still occupy more than a 45% share, though they
have tended to decrease. Secondary industries (such as mining, manufactur-
ing and construction) and tertiary industries (such as services) occupy
about 16% and 38% respectively, having raised their shares.

Fig. 2-2-4 — 6 show the gross district product by industry sector for
1981/82. Regarding agricultural production, the districts with such

great inland cities as Mymensingh, Rangpur, Comilla, and Sylhet show high figures, having a production scale that seems to be proportional to the district area.

On the other hand, Dhaka and Chittagong show extremely high figures of production in secondary industries, followed by Khulna, Comilla, and Sylhet (almost on an equal level).

Regarding the services in tertiary industries, Dhaka surpasses other districts, with about 15% of the national total.

Table 2-2-3 Trends in GDP Shares by Sector

(Million Taka)

Sector \ Year	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83
1. Primary industries	80,092 (54.7)	91,352 (52.8)	99,502 (50.2)	108,953 (46.7)	121,689 (45.9)	130,330 (45.7)
2. Secondary industries	19,434 (13.3)	25,499 (14.8)	28,876 (14.6)	35,952 (15.4)	41,571 (15.7)	45,395 (15.9)
2-1 Mining and quarrying	10	10	9	3	6	6
2-2 Industry	13,363	15,831	19,558	22,861	25,702	28,070
2-3 Construction	6,061	9,658	9,309	13,088	15,863	17,319
3. Tertiary	46,839 (32.0)	55,968 (32.4)	69,607 (35.2)	88,558 (37.9)	101,734 (38.4)	109,342 (38.4)
Total	146,365 (100.0)	172,819 (100.0)	197,985 (100.0)	233,463 (100.0)	264,994 (100.0)	285,067 (100.0)

Source: 1982 Statistical Yearbook of Bangladesh

Source: 1982 Statistical Yearbook of Bangladesh

Fig. 2-2-5 Output of Secondary Industries by District (1981/82)
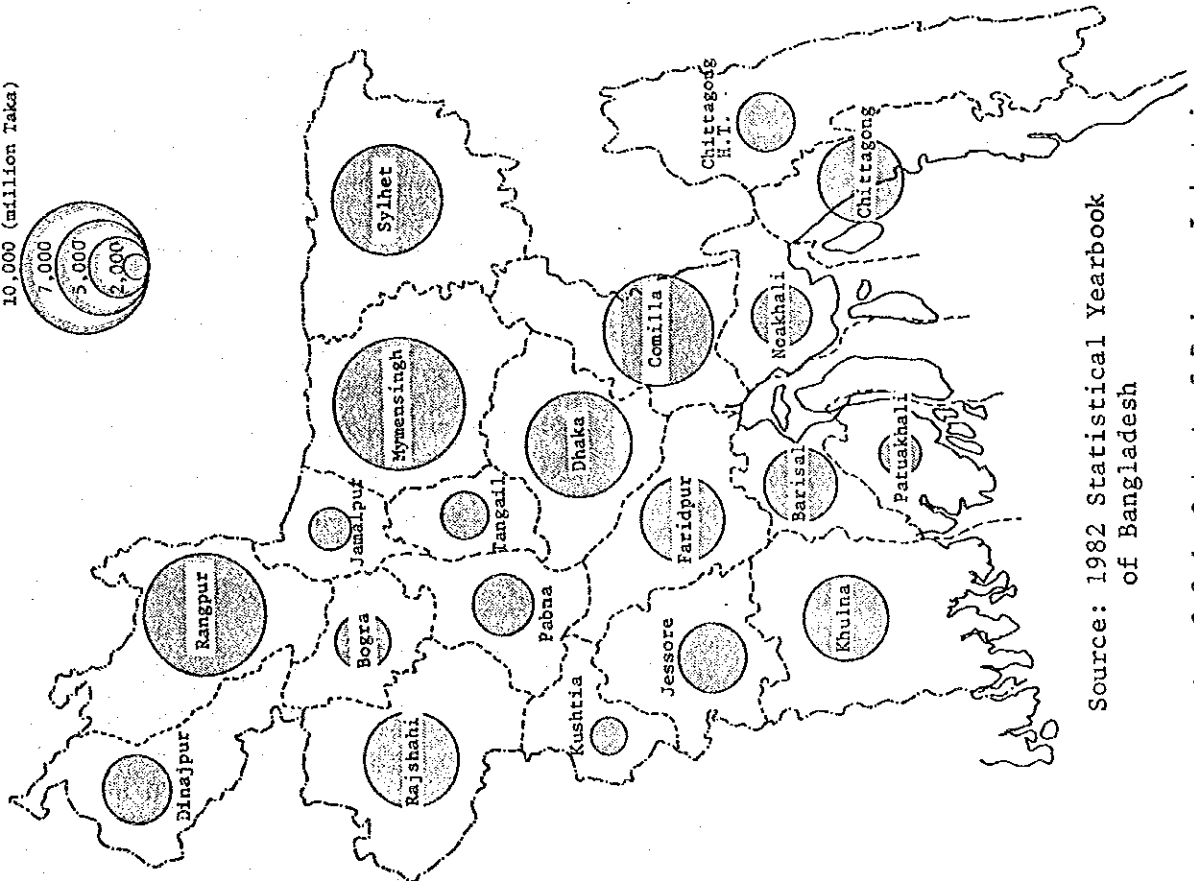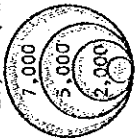
Source: 1982 Statistical Yearbook of Bangladesh

Fig. 2-2-4 Output of Primary Industries by District (1981/82)

(million Taka)

10,000
7,000
2,000

Sylhet

Mymensingh

Dhaka

Comilla

Chittagong H.T.

Chittagong

Noakhali

Jamalpur

Tangail

Faridpur

Barisal

Patuakhali

Bogra

Pabna

Jessore

Khulna

Rangpur

Kushtia

Dinajpur

Rajsnahi
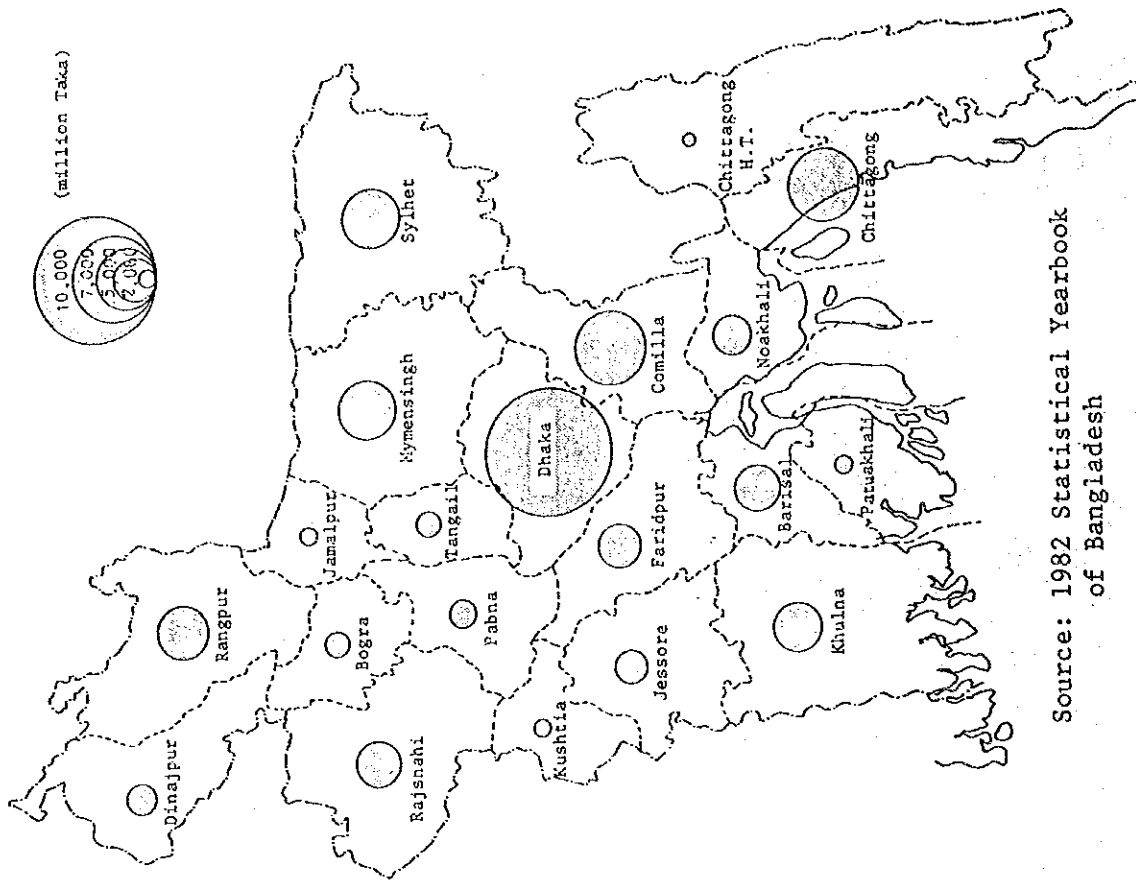
Source: 1982 Statistical Yearbook
of Bangladesh

Fig. 2-2-6 Output of Tertiary Industries
by District (1981/82)

2-2-2 Socio-Economic Frame

i) Summary of the socio-economic plan for Bangladesh

The socio-economic plan for Bangladesh, the Second Five Year Plan (SFYP),
with goals for 1984/85, has already been established. The Third Five
Year Plan (TFYP), beginning in 1985/86 and ending in 1989/90, has been
published as Draft Guidelines.

The focal point of the TFYP is the execution of policies for decentraliz-
ing the administration and standardizing its quality. The goals and
objectives are as follows:

- To attain a noticeable improvement in the standard of living of the
  common people through the expansion of opportunities for productive
  employment and the reduction of the unemployment level.

- To attain self-sufficiency in food production through the broadening
  and deepening of the technological base of agriculture.

- To accelerate the growth of the economy through the efficient use of
  natural resources, manpower, and accumulated technology.

- To promote balanced regional growth through the optimum exploitation
  of local development potential, with the necessary resources and tech-
  nological support.

- To further reduce the population growth rate.

- To ensure universal primary education and to promote mass literacy and
  basic health care services.

- To promote self-reliance through the development of exports along with
  competitive import industries.

The TFYP sets up the Socio-Economic Frame shown in Table 2-2-4, pursuant
to the above-mentioned policies.

Table 2-2-4 Socio-Economic Frame
Established by the TFYP

Indicators items	Achievement 1979-80 (actual)	Revised target 1984-85	Proposed target 1989-90
1. GDP growth rates (% per annum)	3.5	5.4	6.8
2. Population growth (% per annum)	2.6	2.4	2.2
3. Per capital GDP (Tk. in terminal year) a) At 1972-73 prices b) At 1979-80 prices	747 2,837	865 2,469	1,878 3,074
4. Food production (million tons in terminal year)	13.35	17.50	20.78
5. New employment (million in terminal year)	n.a.	3.65	5.65
6. Primary education (million in terminal year)	7.00	13.00	16.40
7. Development outlay (Tk. in million for the plan)	49,840	172,000	284,810
8. Self reliance: Foreign aid (net) as % of plan outlay	81.10	41.20	35.00
9. Domestic savings as % of GDP (Terminal year)	4.3	7.4	10.3
10. Tax GDP ratio (Terminal year)	8.0	9.5	11.2

Source: Guidelines for the Third Plan, Planning Commission.

(2) Establishment of target years

In this survey, the target years for the future Socio-Economic Framework and for the traffic demand forecast mentioned later, have been set at 1992 (1991/92) -- the year when this project will start -- and 2020, based on the project life.

(3) Establishment of population frame

1) National population frame

Such organizations as the Bangladesh Bureau of Statistics (BBS) and the United Nations (UN) have forecast the future population through 1985. Dr. A.K.M. Ghulam Rabbani and Md. Shahadat Hossain forecast the population through 2025 (by quinquennial group) in their book "Population Projections of Bangladesh (1975-2025) BBS Feb. 1981." These forecast values are plotted in Fig. 2-2-7, which shows that actual values approximate the forecast ones in recent years.
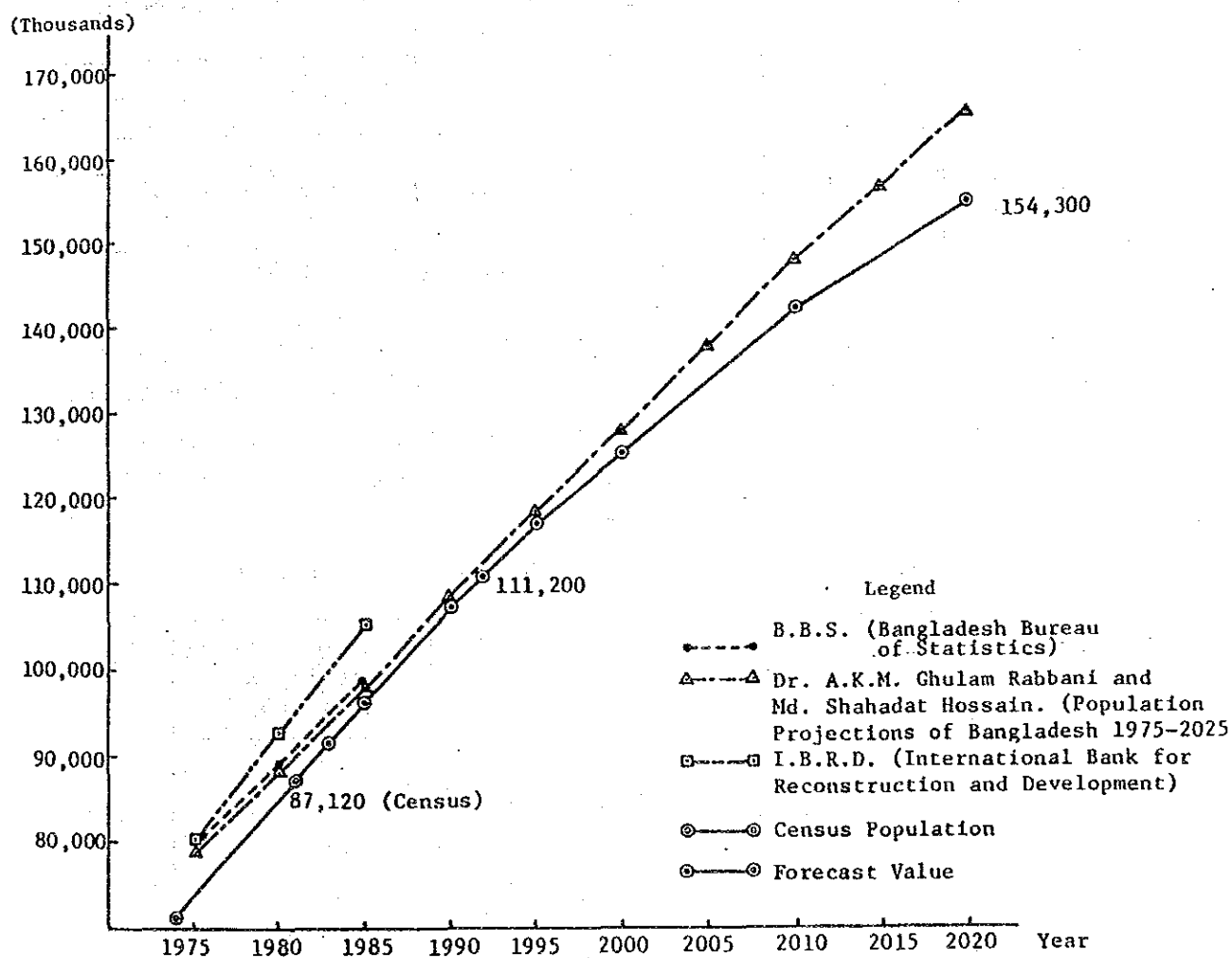
Fig. 2-2-7 National Population (Present and Projected)

The Draft Guidelines of the TFYP, the master plan of national development projects for the coming 5 years, established the rate of population growth as shown below.

	Achievement 1979-80 (actual)	Revised target (1984/85)	Proposed target (1989/90)
Population growth rate (% per annum)	2.6	2.4	2.2

Furthermore, the "Outline of the National Perspective Plan (1980 - 2000)" establishes the rate of population growth at check point years below.

	1979 ∿ '80	1984 ∿ '85	1987 ∿ 90	1994 ∿ 95	1997 ∿ 2000
Population growth rate (% per annum)	2.6	2.4	2.2	1.8	1.3

Source: 1982 Statistical Yearbook of Bangladesh (p. 670)

Based on the above forecast data, this study establishes the population as 111.2 million in the target year 1992 and 154.3 million in the target year 2020. This is derived from the 1981/82 national population of 87.12 million, using the following growth rates.

Table 2-2-5 Population Growth Rates and National Population

Year	Rate	Factor	National population in final year (millions)
1981	–	1,000	87.12
1982 ∿ 1983	2.6%/Year	1,053	91.7
1984 ∿ 1985	2.4	1,049	96.2
1986 ∿ 1990	2.2	1,115	107.3
1991 ∿ 1992 ⎫ ∿ 1995 ⎬ 1.8	⎫ ⎬ 1,093	111.2 117.2
1996 ∿ 2000	1.3	1,067	125.1
2001 ∿ 2010	1.1	1,116	139.6
2011 ∿ 2020	1.0	1,105	154.3

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2) Population frame by district

• Population by district

Population by districts was established as shown in Appendix 2-1
through two steps: first by extrapolating each district population
based on the trend lines which were derived from the three Census
population in 1961, 74 and 81, then by adjusting the total of each
district to the control total value of the nation described in para-
graph 1) above.

• Urban area population

In the Census of 1981, any area with more than 5,000 inhabitants and
such public facilities as a simple aqueduct was defined as an urban
area. It is considered that the population in such an area increases
along with superficial expansion of the area. Figure 2-2-8 shows
the correlation between the national population and the percentage
of the urban population. In the railway traffic demand forecast
made in this study, the study team established urban population
percentages below.

	1981	1991/92 (Forecast)	2019/20 (Forecast)
Urban Area population percentage	15.18	20.9	32.5

These estimates reflect the proportion of inhabitants who may use
the railway for transportation.
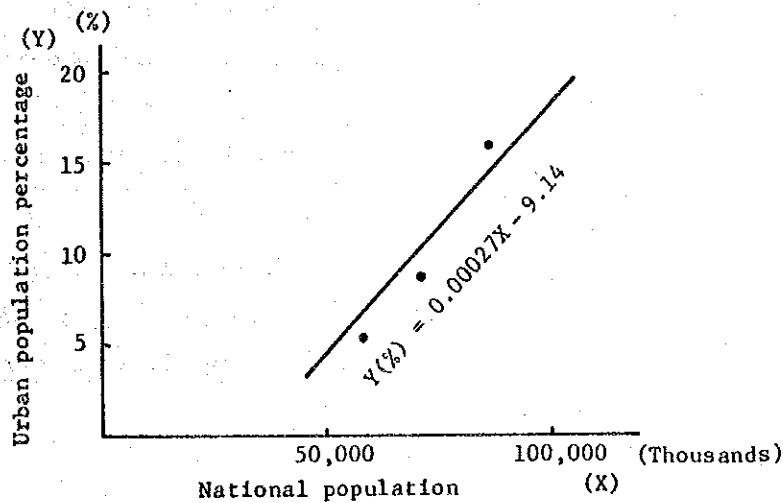
Fig. 2-2-8   Correlation between National Population
and Urban Population Percentage

3) Establishment of urban population

· Traffic routes and city formation in Bangladesh

The south zone of Bangladesh faces the Bay of Bengal. The three great rivers Jamuna, Pabma, and Meghna flow into this Bay after merging in the centre of the country. Therefore, the development of cities and traffic routes has been largely influenced by these geographical features which are described in general.

Chittagong and Khulna are representative port cities. Narayanganj (port for Dhaka), Kushitia, Pabna, Rajshahi (alongside the Pabna River) are cities which have developed by making use of the great rivers. Meanwhile, Dhaka (capital of the country), Comilla, Mymensingh, Sylhet, Jessore, Dinajpur, and Rangpur owe their development to railway construction, with the majority of the headquarters of these districts based on railway communication. Comparatively populous cities (such as Tangail and Sherpur) are networked all over the country by roadways alone.

As mentioned above, many cities in Bangladesh seem to have grown by the influence of the railway. Therefore, when forecasting the railway traffic demand in this survey, a method based on the indices (population, etc.) of these cities was adopted.

. Estimation of urban population

The urban area population indicated above is totaled for each district in the Yearbook. The inhabitants who may use the railway seem to live around the stations and in the neighboring cities.

In this study, these cities are supposed to be within the sphere of the railway influence and their populations which were picked up from the "Population of Urban Centres" in the Yearbook were summed up by districts. These sums in each district were set as a potential number utilizing the railway.

Regarding the future population of these cities, the study team estimated it as shown in Table 2-2-6, according to the forecast flow chart shown in Fig. 2-2-9 and considering the concentration ratio of population in urban areas.

Table 2-2-6 Future Urban Area Population per District

(thousands)

District \ Year	1981/82	1991/92 (Forecast)	2019/20 (Forecast)
Chittagong	1,388	3,060	6,750
Chittagong H.T	-	-	-
Comilla	324	960	2,010
Noakhali	91	720	1,500
Sylhet	203	730	1,540
Dhaka	3,849	6,890	15,580
Faridpur	103	330	680
Jamalpur	142	370	790
Mymensingh	292	1,080	2,310
Tangail	-	-	-
Barisal	-	-	-
Jessore	171	510	1,130
Khulna	662	1,560	3,390
Kushtia	167	580	1,310
Patuakhali	-	-	-
Bogra	182	360	780
Dinajpur	154	490	1,090
Pabna	187	420	910
Rajshahi	321	940	2,080
Rangpur	430	1,260	2,730
Total	8,666	20,260	44,580

Population of 1961,
1974 and 1981 censuses

Demographic trend
by district

Estimated national
population in 1992
and 2020
Control Total

Population of
urban areas

Population of
urban centres

Estimated population
by district in 1992
and 2020

Urban area
population as
percentage of the
total population

Urban centre
population as
percentage of
the urban area
population

Assumed populations
by district in 1992
and 2020

Future demo-
graphic percent-
age of urban areas

Estimated population
of urban areas by
district

Total population of
urban areas in 1992
and 2020
Control Total

Urban area population
by district in 1992
and 2020

Urban centres popu-
lation by district
in 1992 and 2020

Fig. 2-2-9 Flow Chart of Population Forecast
by District and by Urban Centres

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(4) Economic frame

1) National economy

The economic growth percentage set up in the TFYP is 6.8%, as shown in Table 2-2-4. The net economic growth rate as of today, during the SFYP, is about 3.7% (GNP basis), as shown in Table 2-2-2. Hence, when defining the future economic scale, net values must be fully investigated, in addition to the consideration of target values. In this case, the following difficulties are forecast in maintaining the target rates of the TFYP (because of actual economic situation in Bangladesh):

- In the agricultural sector (which occupies about 50% of the GNP), it is difficult to keep a growth rate near 7%, in view of the actual value of approximately 1.5%.

- In the promotion of industrialization, a major target for Bangladesh, it also seems to be difficult to maintain a high growth rate (replacing the dominant agricultural sector), in view of actual national investment and domestic consumption scales, as well as the economic growth rate.

As a result of the above analysis, the long-term average economic growth rate is set at 4% in this survey, fundamentally pursuant to the actual values in the past.

According to the above, the study team established an economic scale based on the GNP in 2020 (at 1981/82 prices) as follows. The growth rate of the GDP is considered to be similar to that of the GNP here.

(Million Taka)

	1981/82 (Actual)	1991/92	2019/20
GNP	256,947	380,300	1,140,000
GDP	264,994	390,600	1,176,000
Index	100	147	444

2) Output per industry

The estimated values shown in the "Outline of the National Perspec-
tive Plan (1980 - 2000)" are used to determine the output share per
industrial sector.

Table 2-2-7   Forecast of GDP Share per Sector   (%)

	1982/83	Values fixed by outline of the national perspective plan			
		1987∿90	1992	1995	2000
Structure of GDP	100.0	100.0	100.0	100.0	100.0
Share of agriculture	45.7	45.3	43.6	41.2	36.9
Share of industries	16.0	18.4	20.6	23.8	34.3
Share of other sectors	38.3	36.3	35.8	35.0	28.8

(Note)   In this table, the values shown in the "Out-line of the
National Perspective Plan" are modified, with the under-
standing that the industrial sector includes construction.

Nevertheless, the output shares per sector in 2020 are supposed to
be the same as in 2000 as follows:

Table 2-2-8 Estimated Values of Total Output per Sector

(million Taka)

	Actual values in 1981/82		Estimated values in 1992		Estimated values in 2020	
	At constant (1972/73) prices	Current prices	At constant (1972/73) prices	1981/82 prices	At constant (1972/73) prices	1981/82 prices
GDP of Bangladesh	72,227 (100.0)	264,994	106,900 (100.0)	392,000 (100.0)	320,600 (100.0)	1,176,000 (100.0)
Agriculture	35,225 (48.8)	121,689	46,600 (43.6)	170,900 (43.6)	118,300 (36.9)	434,000 (36.9)
Industries	10,728 (14.8)	41,571	22,000 (20.6)	80,800 (20.6)	110,000 (34.3)	403,000 (34.3)
Other sectors	26,274 (36.4)	101,734	38,300 (35.8)	140,300 (35.8)	92,300 (28.8)	339,000 (28.8)

3) Output per district

The output per sector in each district is calculated based on the actual output, using as a control total the estimated value per sector in 1992 and 2020 (shown in Table 2-2-8).

2-3 Traffic Demand Forecast

2-3-1 Present Situation

(1) Network

The traffic network over the territory of Bangladesh consists of railways, roadways, airways, and waterways. Fig. 2-3-1 shows the network of these four ways. The Bangladesh Railway has an extended route of about 2,870 km (broad gauge 970 km, meter gauge 1,900 km), and the highways extend to about 4,700 km. The airway network centres around Dhaka, connecting Chittagong and other main cities. Waterways are as important as road traffic in this country, and nationwide water transportation service is available, to and from inland river ports on the Jamuna, Padma, and Meghna Rivers.
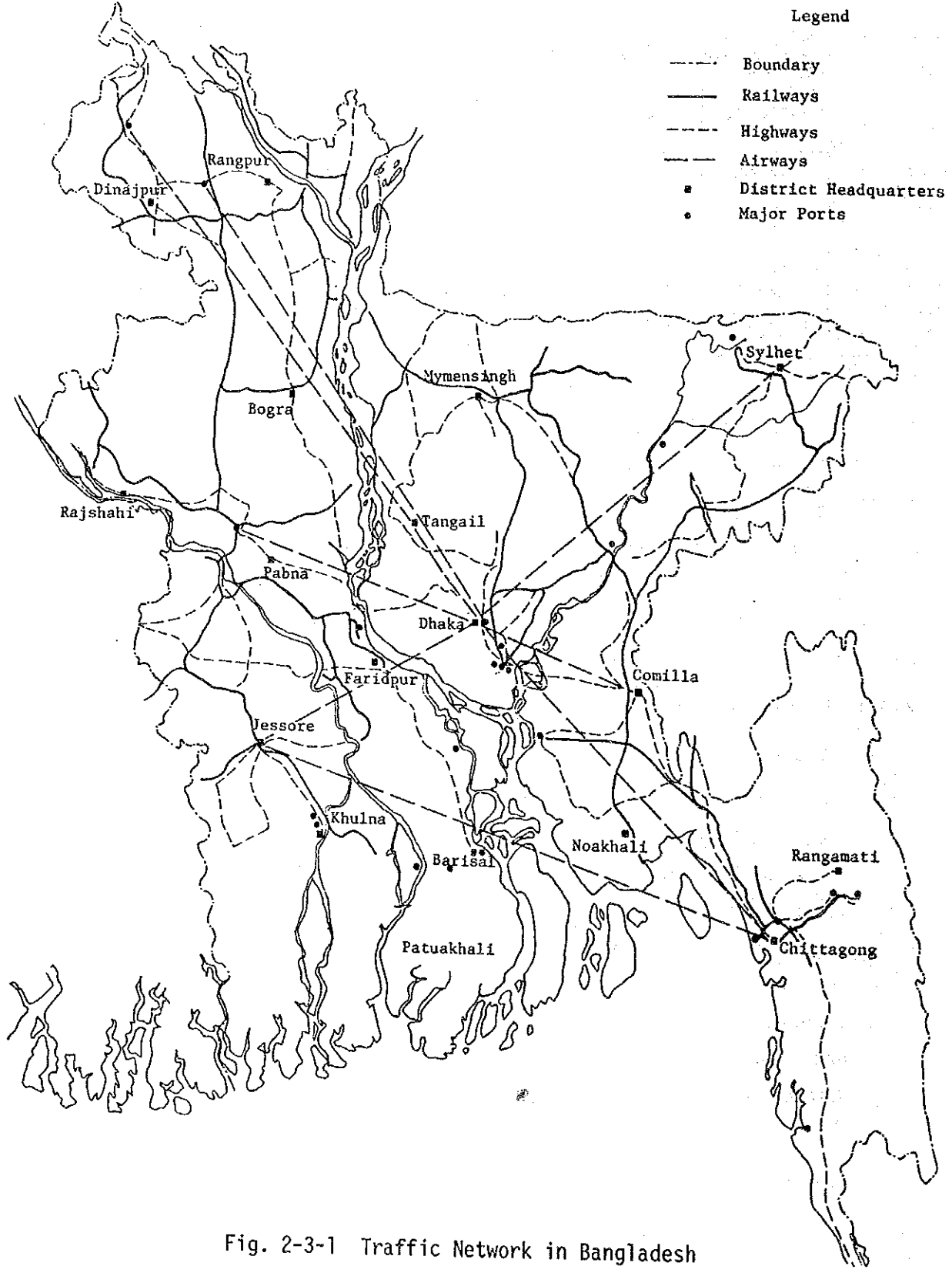
Fig. 2-3-1 Traffic Network in Bangladesh

(2) Present Situation of Transportation

1) Railway

As shown in Fig. 2-3-2, railway passenger transportation has pro-
gressed from a level of 250,000 persons/day (during seven years from
1975/76 to 1981/82) to 290,000 persons/day (in 1982/83), showing a
growth of 17%.

Regarding goods traffic, nationwide volume tended to increase in
recent years, but railway transport remained at a level of about 3
million tons. Consequently, its share is 3.88%, as shown in
Fig. 2-3-3.

2) Roadway and water transport

As shown in Fig. 2-3-4, the registration of motor vehicles in
Bangladesh tended to move consistently upward. Observing the type
of vehicles, motor cars, jeeps, station wagons, and trucks have in-
creased remarkably in recent years, while the number of buses (assumed
to be public transport) is now leveling off.

However, as shown in Fig. 2-3-3, road transport shows an upward
tendency, paralleling that of total goods, while water transport is
almost invariable, maintaining a level of about 15 millions tons.
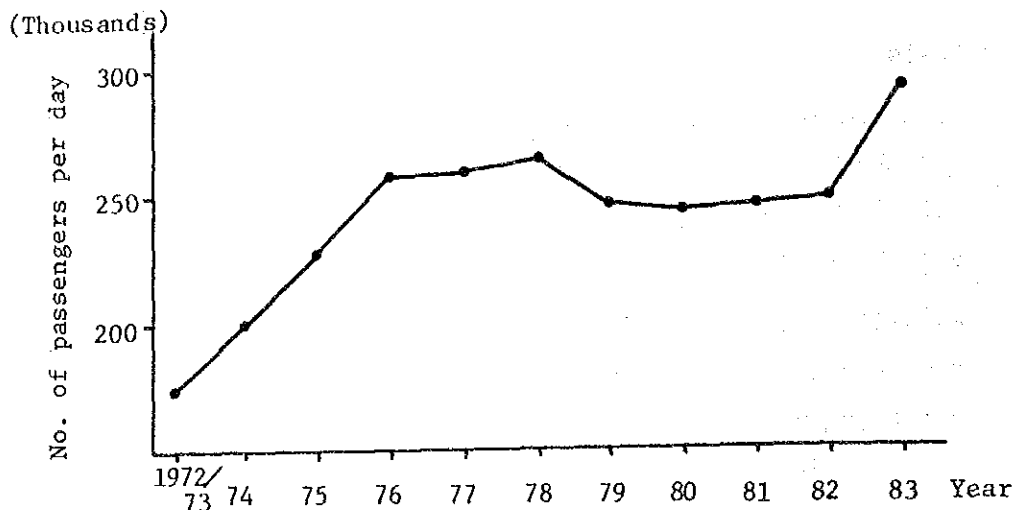
Fig. 2-3-2　No. of Passengers Carried per Day by Railway
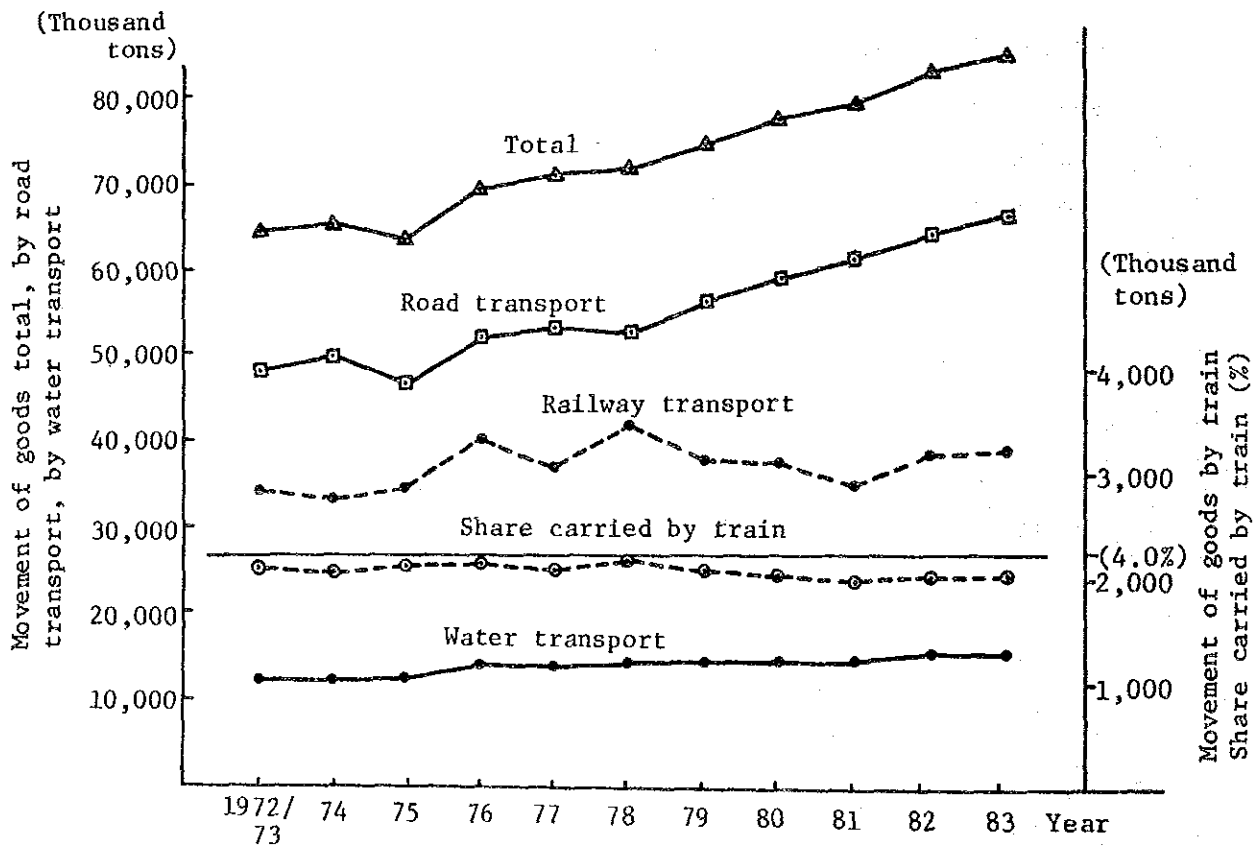
Fig. 2-3-3　Movement of Goods, by Means of Transport
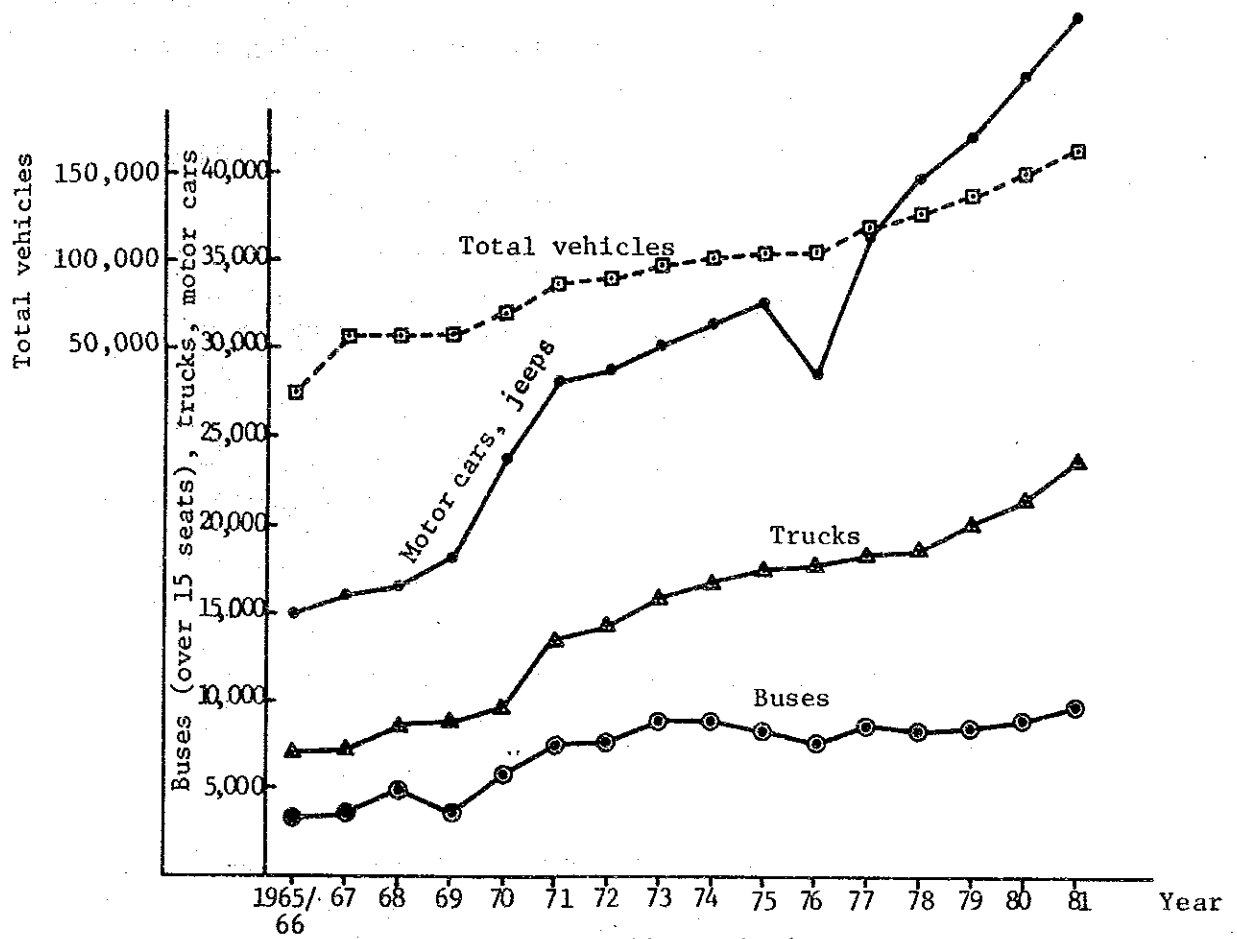
Source: 1982 Statistical Yearbook of Bangladesh

Fig. 2-3-4 Number of Motor Vehicles Registered by Type of Vehicle

2-3-2 Premises of Traffic Demand Forecast

(1) Objective and precision of survey

The traffic demand studied here will ultimately be used as basic data to determine the scale of facilities for the new rolling stock manufacturing plant.

The precision of the demand forecast in this survey depends on its objectives and how the forecast results are used.

(2) Subject of forecast

In this survey, the subject of the forecast is the nationwide flow of passengers and goods in Bangladesh.

(3) Forecast years

The forecast years are 1992 (when this project will start) and 2020 (about 30 years from now).

(4) Zoning

The territory is zoned into 20 districts.

(5) Basic assumptions of demand forecast

1) Passenger traffic

- The number of railway passengers is estimated by the trip generation rates method. The railway influences the area within 10 km of its route, and trip generation is correlated with the city population under this influence.

- The trip end model method is used for modal split.

- The interzonal trip distribution is estimated by the model equation based on gravity model method.

- The traffic assignment to routes is estimated by the minimum path between each pair of zones, with the entire traffic volume being assigned to only one of the zones in the pair.

- The sectional traffic of the calculated route is studied based on the actual values of sectional traffic between Bahadurabad – Tistamukh Ghat and Jagannathganj – Sirajganj along the Jamuna River. The model equation developed based on these results is

considered adequate.

2) Good traffic

- Goods flow is estimated, classifying it first into agricultural and industrial products.

- The flow of both products should correlate with their respective outputs.

- Regarding the interzonal flow of agricultural products, the goods generation should correlate with the traffic calculated from the output in each zone. The goods concentration should correlate with the city population.

- Industrial goods generation and concentration should correlate with the traffic scale calculated from the industrial output of each zone.

(6) Node and link data

The Bangladesh Railway has neither a new line construction plan nor a route expansion plan at present. Its future network is assumed to be the same as the present one.

1) Node

A node is established in each district, selecting a representative station therein. Hence, all other stations are concentrated at this node. Nodes are not established in districts that have no railway route. Consequently, 14 nodes (nozes) are established, as shown in Fig. 2-3-5.
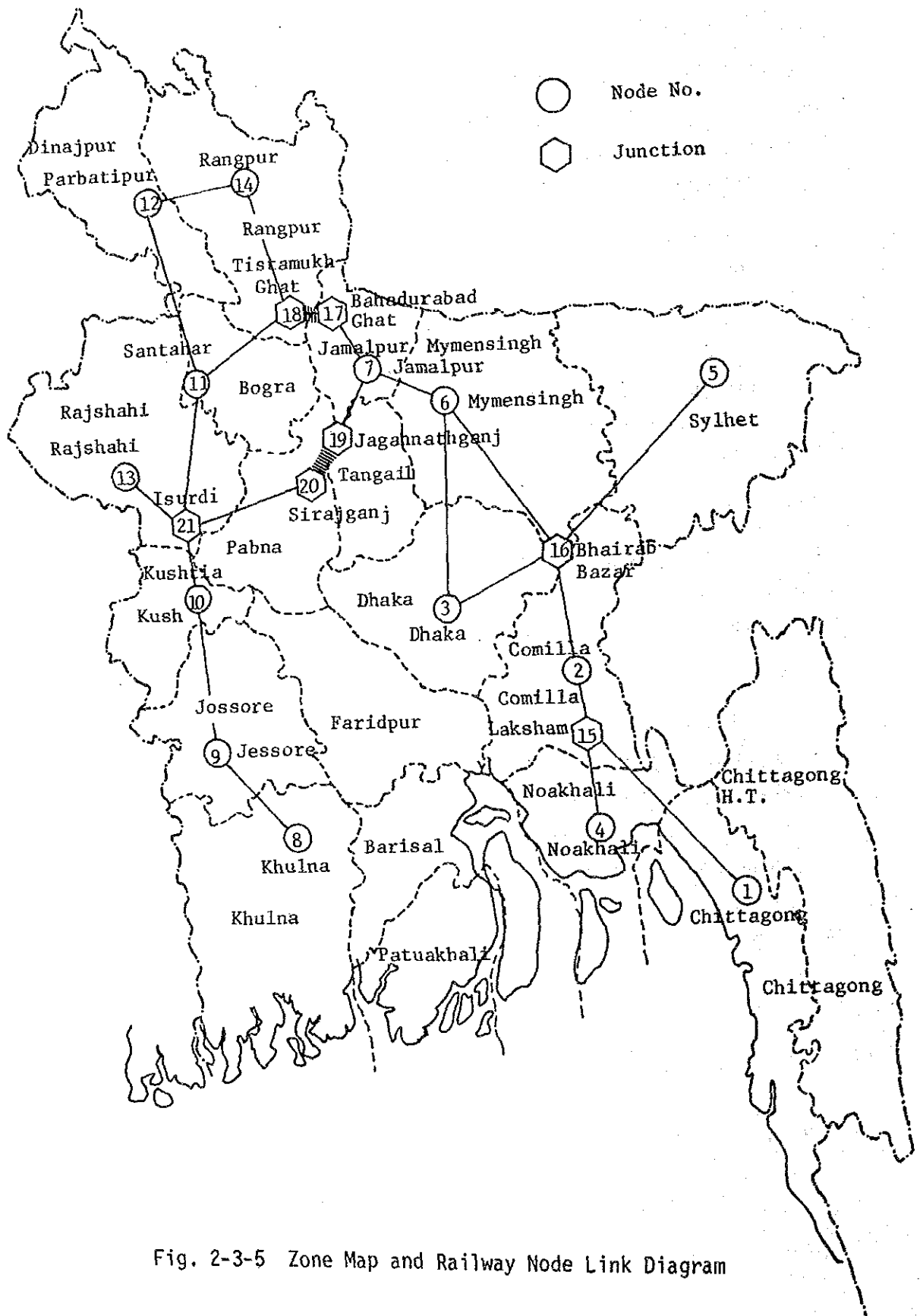
Fig. 2-3-5 Zone Map and Railway Node Link Diagram

2) Link data

The required time between stops (according to Bangladesh Railway
Timetable No. 25) is used as standard data for linking the nodes.

2-3-3 Forecast of Future Traffic Demand

(1) Passenger traffic demand

1) Estimation of present flow

a) Estimation of trip generation

Trip generation is estimated by the trip generation rates method.
The control total for trip generation in each zone is 247,000
persons (derived by dividing total railway passengers in 1981/82
(published in the "Information Book 1983") by 365 days). Then,
this number is distributed according to the population scale of
urban centres in each district to calculate the respective trip
generation and trip concentration of each zone.

Fig. 2-3-6 shows the estimated trip generation flow.

b) Estimation of distributed traffic flow.

The interzonal flow is estimated by the gravity model method.
The reasons why the gravity model was adopted are as follows;

(1) The survey team could not obtain the actual statistical
data which are able to find the interzonal traffic flow
volume for railway passengers and freight goods.

(2) Therefore the above flow volume have to be assumed by some
other ways. There are several methods to obtain the present
interzonal O-D table as described following.
There are several methods to analyze as described follow-
ing.
First, the traffic flow volume is assumed on the basis of
the traffic investigations using actual railway passengers
and the good flows on the railways.
As a second method, the volume is assumed by using the
model formula.
The latter method was adopted in this survey due to the

following reasons.

The present O-D tables assumed by the model formula are presumptive figures so that the formula must be as simple as possible.

- In this point, the gravity model is easy to be calculated with a few parameters involved.

- The theory of the gravity model will be applied everywhere unlike other models that are applied at the limited districts.

The general equation of the gravity model method is as follows:

$$T_{ij} = K \frac{G_i{}^{\alpha} \cdot A_j{}^{\beta}}{D_{ij}{}^{\gamma}} \qquad \text{----------------- (formula 2-1)}$$

T_{ij} Traffic flow between zones i and j

G_i Traffic generated in zone i

A_j Traffic concentrated in zone j

D_{ij} Time and distance between zones i and j

K, α, β, γ Constants

The constants are fixed as follows in this survey:

$$\begin{cases} K & = 1.0 \\ \alpha & = \beta = 0.5 \\ \gamma & = 1.5 \end{cases}$$

The trial calculation is applied to this formula with fixed constants. And the final value obtained by the above trial calculation is verified with the present sectional flow at the Jamuna River as the traffic screen line.

Table 2-3-1 shows the present flow of passengers between the Jamura River sections of Bahadurabad (BHBD) - Tistamukh Ghat (TMG) and Jagannathganj (JUJ) - Sirajganj (SJYG).

Table 2-3-1 Number of Passengers between Riverside Stations
of the Jamuna River (Average passengers between
Jun. 84 and Nov. 84)

(Persons)

Bahadurabad-Tistamukh Ghat (BHBD) - (TMG)			Jagannathganj-Sirajganj (JUJ) - (SJYG)		
Upstream	Downstream	Total	Upstream	Downstream	Total
2,405	2,424	4,829	745	747	1,492

Source: BR

c) Interzonal flow

Fig. 2-3-7 shows the interzonal flow estimation-according to
the above data.

2) Estimation of future flow

a) Estimation of trip generation and concentration

· Future trip generation and concentration are calculated
including the addition of population growth at urban centre
in each district to present railway passengers in each
respectively district.

· The increase of passengers is calculated by the forecast
equation which determines from the actual values of trip
generation rates of railway passengers on the basis of the
present population scale in urban center. The study team
used the following forecast equation 2-2.

```
                                    ┌─────────────────┐
                                    │Transition of    │
                                    │national population│
                                    └─────────────────┘
                                                              ┌──────────────────┐
┌───────────────────┐                                         │Major method for  │
│Railway network,   │              ┌───────────────┐          │estimating future │
│Roadway network,   │              │Population      │          │population         │
│Water transport    │              │transition per  │          └──────────────────┘
│network            │              │district        │
└───────────────────┘              └───────────────┘
          │                                                ┌─────────────────────┐
┌───────────────────┐                                      │Establishment of     │
│Selection of city  │                                      │national population in│
│associated with railway                                   │1992 and 2020        │
│(under station influ-│─────────────────►                   └─────────────────────┘
│ence) in each district│                                              │
└───────────────────┘                                      ┌─────────────────────┐
                      ┌─────────────────────┐              │Population per       │
                      │City population under │              │district in 1992 and │
                      │station influence per │              │2020                 │
                      │district (1982)       │              └─────────────────────┘
                      └─────────────────────┘
┌───────────────────┐                   ┌──────────────────┐   ┌──────────────┐┌──────────────┐
│Nationwide railway │                   │Estimation of urban│   │Passengers at ││Population of  │
│passengers in      │                   │proportion of      │   │representative ││cities with    │
│1981/82            │                   │population per     │   │main stations ││representative  │
└───────────────────┘                   │district          │   └──────────────┘│main stations  │
          │                             └──────────────────┘                     └──────────────┘
                                                                                      │
          ┌──────────────────┐          ┌──────────────────┐   ┌────────────────────────────┐
          │Railway passengers │          │Establishment of  │   │Correlation equation        │
          │per district in   │          │future urban propor-│   │between city population     │
          │1982              │          │tion of population │   │and passengers              │
          └──────────────────┘          └──────────────────┘   │Y=50.59e^{-9.76×10^{-4}X}   │
                                                                └────────────────────────────┘
                                         ┌──────────────────┐
                                         │City population under
                                         │station influence per
                                         │district in 1992 and
                                         │2020              │
                                         └──────────────────┘

                                         ┌──────────────────┐
                                         │Increased city    │
                                         │population per district
                                         │in 1992 and 2020  │
                                         │(compared to 1982)│
                                         └──────────────────┘

                                         ┌──────────────────┐
                                         │Railway passenger │
                                         │increase due to   │
                                         │population growth │
                                         └──────────────────┘

                      ┌──────────────────────┐
                      │Estimation of railway │
                      │passengers per district│
                      │in 1992 and 2020      │
                      │(Estimation of trip   │
                      │generation and        │
                      │concentration per zone)│
                      └──────────────────────┘
```

$$Y = 50.59e^{-9.76 \times 10^{-4}X}$$

Fig. 2-3-6 Flow Chart for Estimating Passenger Traffic Demand
(Estimated Flow of Trip Generation)

Legend

(Persons/day)

▬▬▬▬	30,000
▬▬▬	24,000
▬▬	18,000
▬	12,000
—	6,000

Dinajpur

Rangpur

Jamalpur

Bogra

Mymensingh

Sylhet

Rajshahi

Kushtia

Dhaka

Jessore

Comilla

Khulna

Noakhali

Chittagong
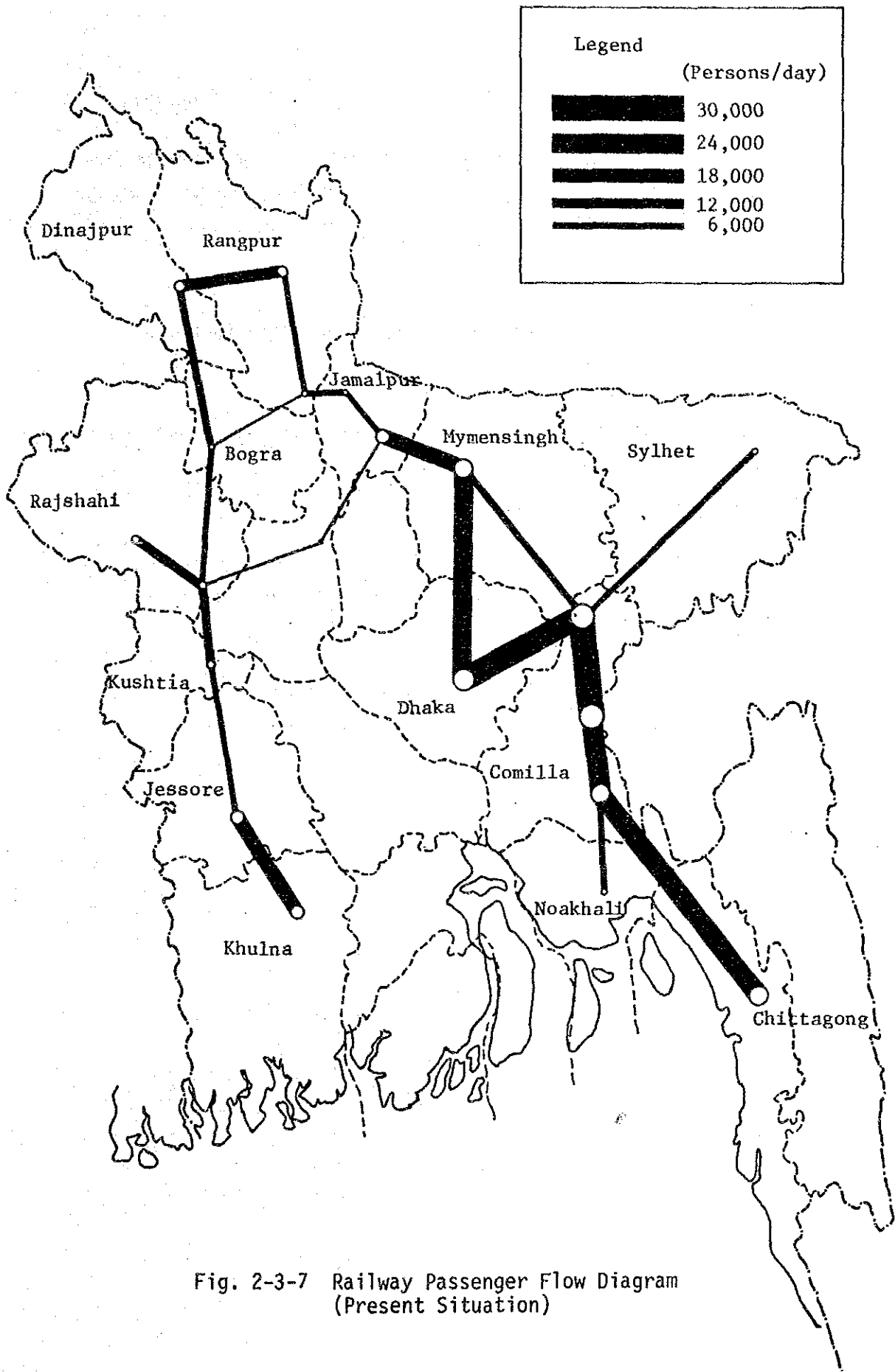
Fig. 2-3-7   Railway Passenger Flow Diagram
(Present Situation)

$$Y = 50.59\,e^{-9.76\times10^{-4}\cdot X} \quad \text{_____(equation 2-2)}$$

  Y Trip generation railway increased passengers

             (passengers/1000 persons)

  X Increase in urban centre population

$$Z = Y\cdot X$$

  Z Increase in railway passengers (persons)

The railway trip generation per district in 1991/92 and 2019/20 is shown in Appendix 2-4.

b) Estimation of distributed traffic:

In principle, the future interzonal flow can be estimated by the above-mentioned forecast formula (equation 2-1).

c) Interzonal flow:

The interzonal flow in 1991/92 and 2019/20 is shown in Table 2-3-2, and Fig. 2-3-8 and 2-3-9.

Table 2-3-2 Future Interzonal Flow

(Persons/day)

No.	Section Node i	Section Node j	Present flow (1981/82)	1991/92 (Forecast)	2019/20 (Forecast)
1	1	15	26137	44219	59127
2	2	15	28572	58814	77267
3	2	16	33936	62483	80707
4	3	6	23769	42092	52197
5	3	16	29243	44908	54487
6	4	15	5933	28597	35710
7	5	16	4700	12589	16963
8	6	7	16875	43062	63165
9	6	16	6785	21472	31097
10	7	17	4836	9883	14048
11	7	19	1494	3151	4405
12	8	9	18329	47455	73537
13	9	10	7083	18907	29333
14	10	21	10173	30346	47696
15	11	12	6552	18372	29949
16	11	18	1229	2338	3679
17	11	21	6380	19252	31523
18	12	14	12775	37622	57365
19	13	21	8639	25589	40032
20	14	18	3607	7545	10369
21	17	18	4836	9883	14048
22	19	20	1494	3151	4405
23	20	21	1494	3151	4405
Total passenger volume at the 23 main sections	*		265,371	594,881	835,514
	**		259,041	581,847	817,061
Index	**		1.00	2.25	3.15

Note * Including ferry boat passengers
     ** Excluding ferry boat passengers
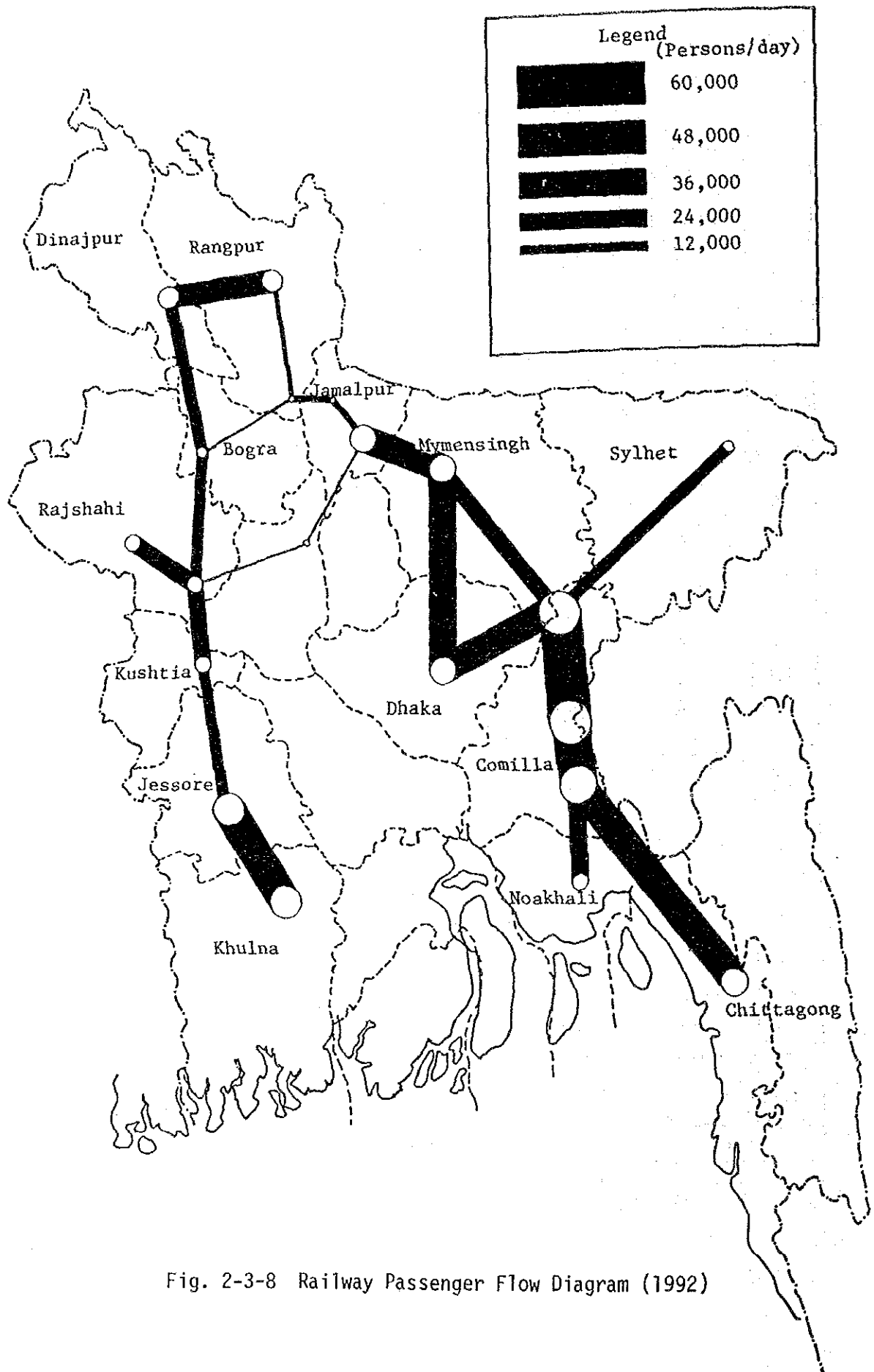
Fig. 2-3-8 Railway Passenger Flow Diagram (1992)

Legend
(Persons/day)

80,000
64,000
48,000
32,000
16,000

Dinajpur
Rangpur
Jamalpur
Bogra
Mymensingh
Sylhet
Rajshahi
Kushtia
Dhaka
Jessore
Comilla
Noakhali
Khulna
Chittagong
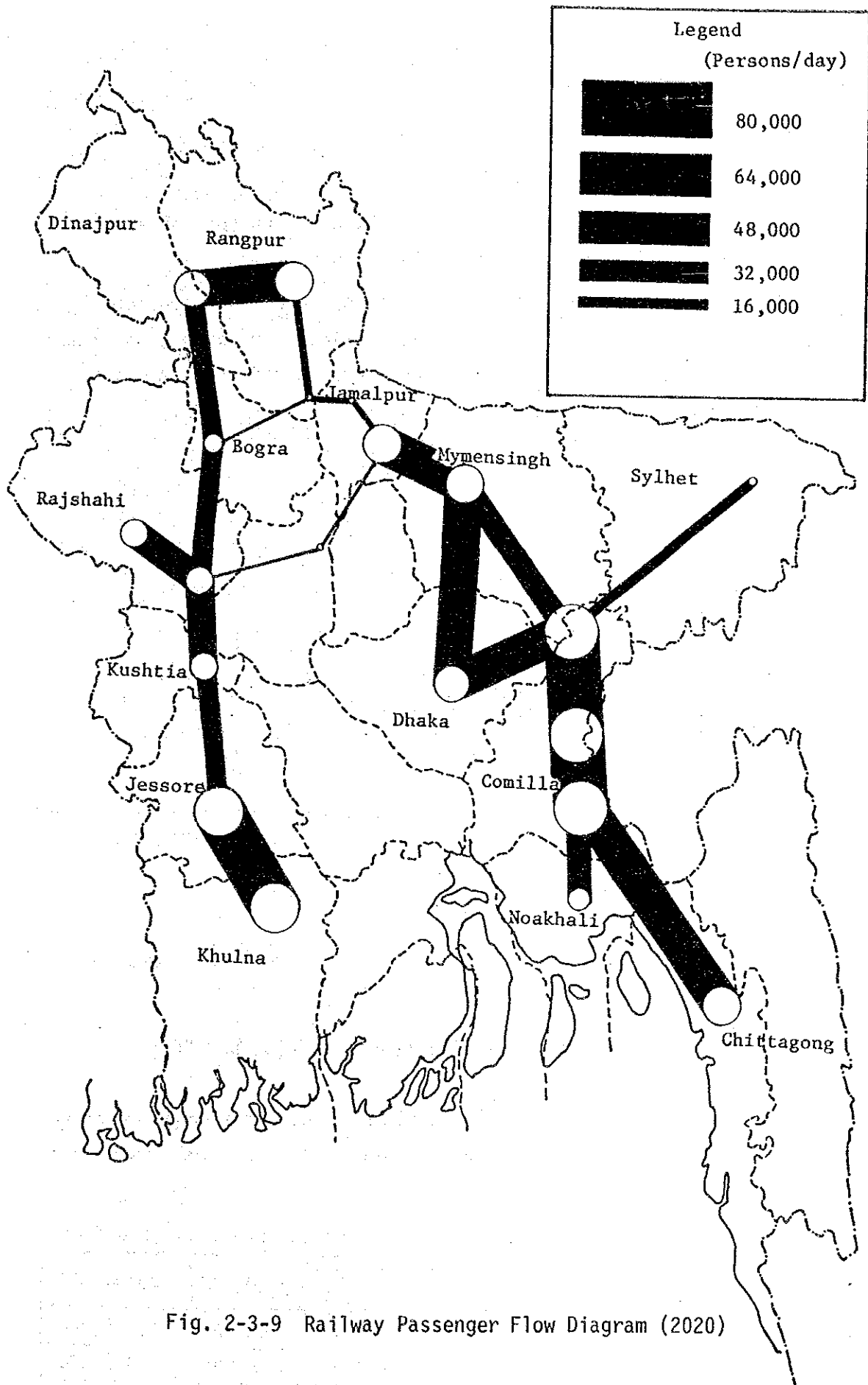
Fig. 2-3-9 Railway Passenger Flow Diagram (2020)

(2) Goods Traffic Demand

1) Estimation of total goods flow

Generally, the goods flow correlates highly with the GNP growth rate which in turn is directly proportional to GDP.

As shown in Fig. 2-3-10, the trend of GDP growth and the total goods flow carried by all transport modes (railways, roadways, water transport, and airways) are extremely well correlated in Bangladesh.
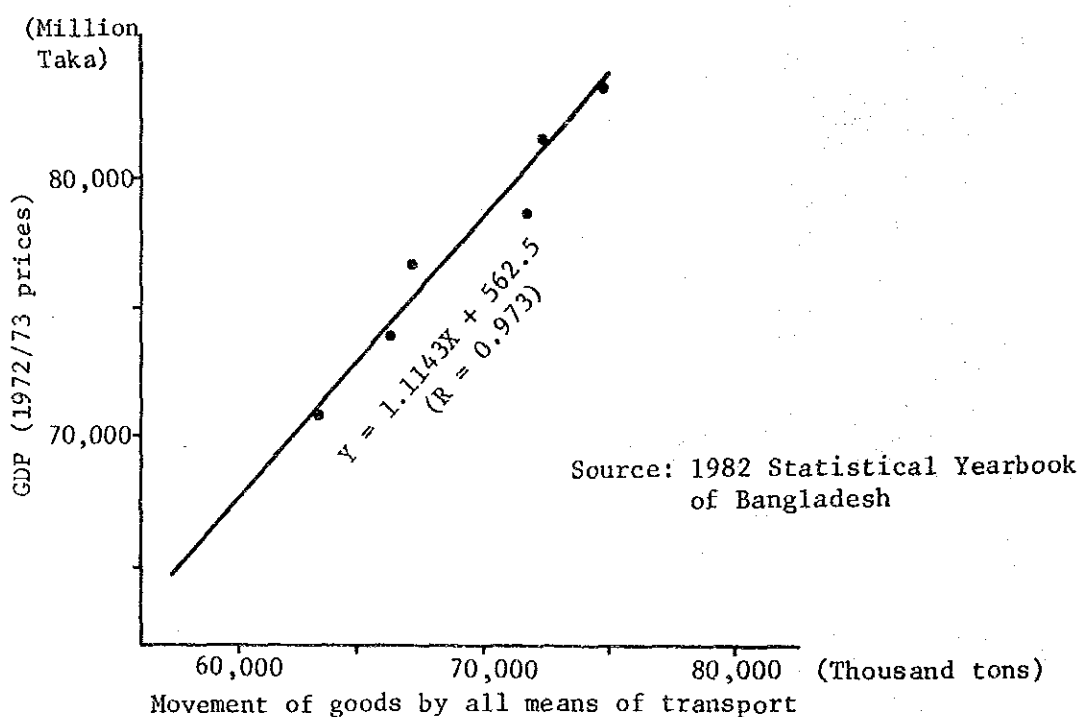
Fig. 2-3-10 Correlation between Goods Flow and GDP

In this survey, the study team estimated the total goods in target years as follows, pursuant to the estimated future GDP scale (See Table 2-2-8).

Figure 2-3-11 shows the estimated flow of railway goods traffic.

	Unit	1981/82 (actual)	1991/92	2019/2020
GDP	Million Taka	264,994	392,000	1,176,000
Total goods flow	Thousand Tons	81,980	119,700	357,800
Growth rate	1981/82 = 100	100	1.46	4.36

National economic frame work

Results and transition of past economic growth rate

Establishment of future economic growth rate (GNP growth rate = 4%/year)

Trends of GNP (actual values at 1972/73 prices)

Trends of total goods flow

Trends of railway goods flow

Economic scale in 1992 and 2020 (1972/73 prices)

Equation correlating GDP (X) and total goods flow (Y)

$$Y = 1.1143X + 562.5$$
$$(R = 0.973)$$

Trends of railway goods share
$$Y = 16.726^{-0.0175X}$$

Total goods flow in 1992 and 2020

Future railway share

Total railway goods in 1992 and 2020 (Control total)

National output of agriculture and industries in 1981/82

Railway goods for agriculture and industries (actual values in 1981/82)

Output of agriculture and industries in 1992 and 2020

Railway goods generation tonnage per output

Railway goods tonnage for agriculture and industries in 1992 and 2020 (primary estimated values)

Output of agriculture and industries by district in 1981/82

Total railway goods for agriculture and industries in 1992 and 2020

Railway goods for agriculture and industries by district in 1992 and 2020

Fig. 2-3-11 Flow Chart for Estimating Goods Traffic Demand

2) Railway share of total transport modes and total railway goods

As shown in Fig. 2-3-3, the railway share of the total goods carried by all transport modes tended to decrease slightly.

The shares among the various transports seem to be greatly influenced by the degree of improvement and the buildup of facilities (based on future investment in them). In this survey, the share is established as follows, according to the trend in past share distribution shown in Fig. 2-3-3.

(%)

	1981/82	1991/92 (Forecast)	2019/2020 (Forecast)
Railway share of total goods flow	3.88	3.55	2.06

where: $Y = 16.726e^{-0.0175X}$ Y   Railway share

X   Year

Using this data, the study team estimated the total railway goods as shown below.

	1981/82	1991/92	2019/2020
Total goods flow (Thousand tons)	81,980	119,700	357,800
Railway goods share (%)	3.88	3.35	2.06
Total railway goods (Thousand tons)	3,180	4,010	7,370

3) Railway goods generation rates against output

The study team established the railway goods generation rates versus agricultural and industrial output as follows (based on the actual values in 1981/82).

	Output (1981/82 prices) (Million Taka)	Railway traffic tonnage (Thousands Tons)	Railway goods generation per output (Generation rates) (1,000 ton/Million Taka)
Agriculture	121,689	1,812	0.015
Industries	41,571	1,367	0.033

4) Railway goods per industry

The study team projected the future railway goods per industry as shown below, using as a control total the future total railway goods calculated from the total goods flow.

	Goods gene-ration rates (1000 tons/ Million Taka)	1991/92			2019/2020		
		Output (Million Taka)	Railway goods		Output (Million Taka)	Railway goods	
			Primary esti-mated value (1,000 tons)	Final value (1,000 tons)		Primary esti-mated value (1,000 tons)	Final value (1,000 tons)
Agriculture	0.015	170,900	2,560	1,960	434,000	6,510	2,420
Industries	0.033	80,800	2,670	2,050	403,000	13,300	4,950
Total	-		5,230	4,010		19,810	7,370

Note: ☐ Control total

5) Estimation of present goods flow

a) Estimation of goods generation and concentration per zone

• Exported and imported goods
In Bangladesh, goods are exported and imported through Chittagong and Khulna Ports. The goods handled by these two ports annually are as shown below (actual values in 1981/82).

(Thousand tons/year)

	Chittagong	Khulna	Total
Export	525	748	1,273
Import	5,066	920	5,986
Total	5,531	1,668	7,259

Source: 1983 Statistical Pocket Book of Bangladesh

Of these goods, the railway goods (classified into agriculture and industries) are estimated as shown below from the data for Chittagong Port.

	Chittagong			Khulna		
	Export	Import	Total	Export	Import	Total
Agriculture	59	233	292*	84	42	126
Industries	—	338	338*	—	62	62
Total	59	571	630*	84	104	188

*Actual value by Year Book in 1982

Regarding the railway goods estimated in paragraph 4) above imported goods are considered to be generated goods, while exported goods are considered to be concentrated ones.

- Goods generated and concentrated per zone
  Appendixes 2-5 and 2-6 show the goods generated and concentrated per zone, distributed in each district according to its respective output scale (by subtracting the exported and imported goods mentioned above from the estimated railway goods in the forecast years).

b) Estimation of interzonal goods flow

- Model equation for estimating distributed traffic
  As a rule, the model equation used to estimate the passenger traffic distribution was also used to estimate the interzonal goods flow. However, the model equation was also corrected and modified (as it was for passenger traffic) by the present flow between Bahadurabad and Tistamukh. Correction was made by setting the Jamuna River as the screen line (due to the data of the present goods flow shown in "Information Book 1983").

  The constants used in this survey were as follows:

  $$T_{ij} = K \frac{G_i^{\alpha} \cdot A_j^{\beta}}{D_{ij}^{\gamma}}$$

  $K = 1.0$

  $\alpha = \beta = 0.5$

  $\gamma = 1.5$

- Present goods flow:
  The interzonal goods flow calculated from the above data is shown in Fig. 2-3-12.
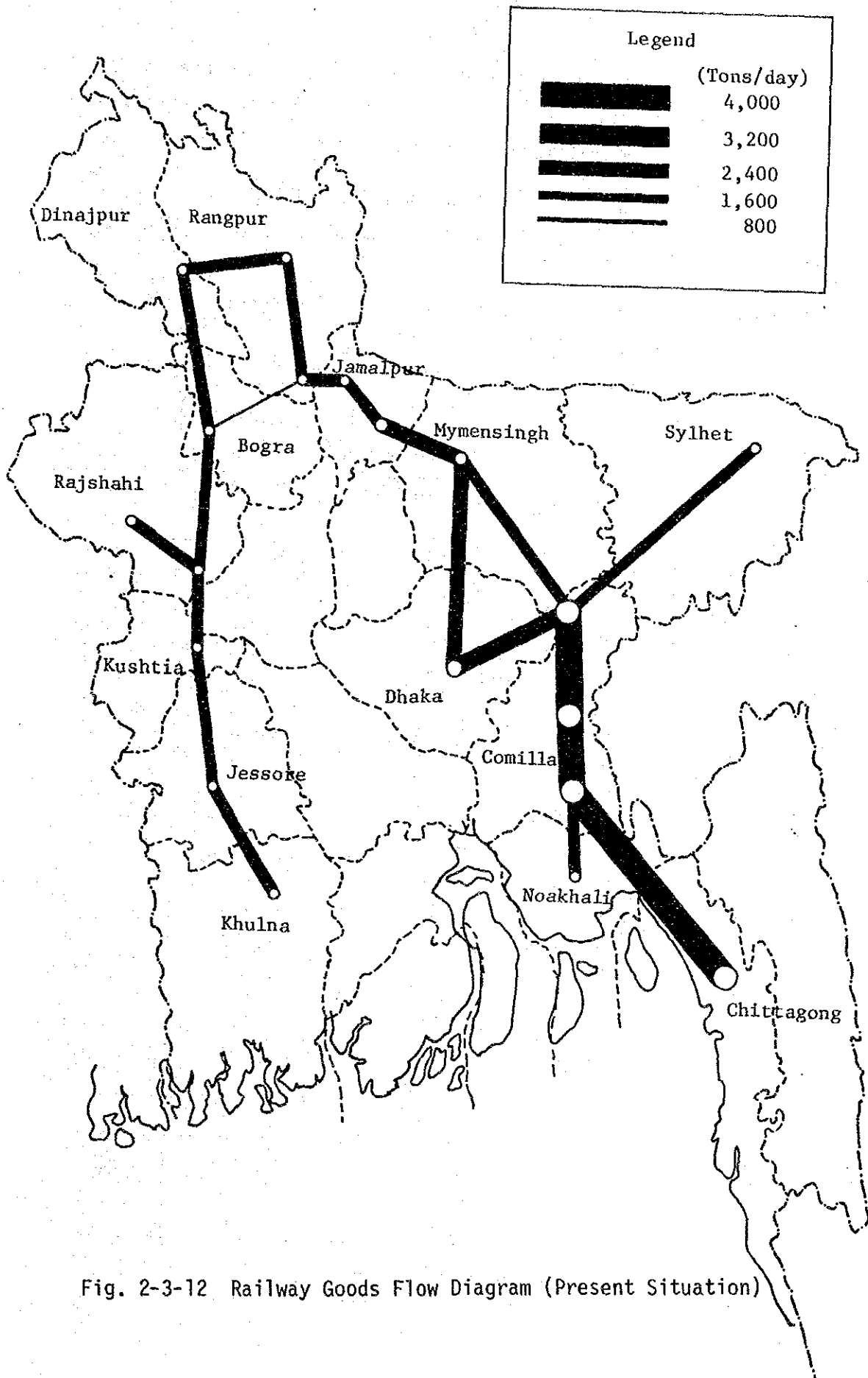
Fig. 2-3-12 Railway Goods Flow Diagram (Present Situation)

6) Estimation of future goods flow

The future goods flow based on the above-mentioned present interzonal flow is shown in Figs. 2-3-13 and 2-3-14. And the goods flow at the main 23 sections are also shown in Table 2-3-3.

Table 2-3-3 Interzonal Goods Flow

(Tons/day)

No.	Section		Present flow (1981/82)	1991/92 (Forecast)	2019/20 (Forecast)
	Node i	Node j			
1	1	15	3,644	4,596	7,396
2	2	15	3,888	4,880	7,828
3	2	16	3,806	4,816	8,298
4	3	6	2,246	2,818	5,438
5	3	16	2,564	3,240	5,150
6	4	15	1,332	1,652	2,916
7	5	16	1,206	1,556	3,078
8	6	7	2,292	2,886	5,624
9	6	16	1,412	1,776	3,442
10	7	17	1,530	1,942	3,648
11	7	19	0	0	0
12	8	9	1,811	2,230	3,710
13	9	10	1,504	1,952	5,212
14	10	21	1,536	1,842	2,978
15	11	12	1,632	2,006	3,724
16	11	18	130	180	358
17	11	21	1,312	1,512	1,894
18	12	14	1,268	1,572	3,088
19	13	21	1,312	1,554	2,108
20	14	18	1,400	1,762	3,290
21	17	18	1,530	1,942	3,648
22	19	20	0	0	0
23	20	21	0	0	0
Total goods volume at the 23 main sections	*		37,355	46,714	82,828
	**		37,202	44,772	79,180
Index			1.00	1.20	2.13

Note * Including ferry boat goods
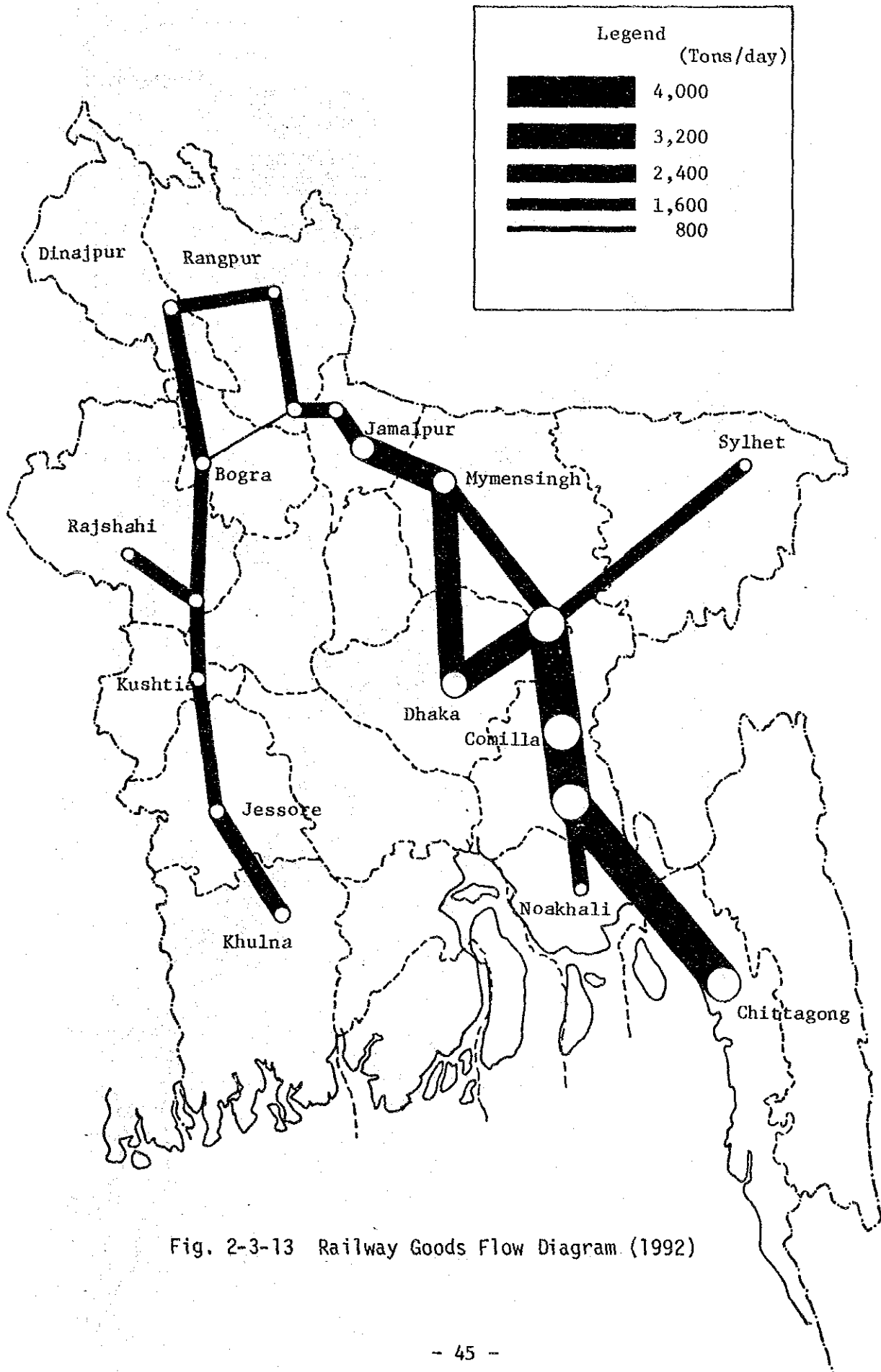   ** Excluding ferry boat goods
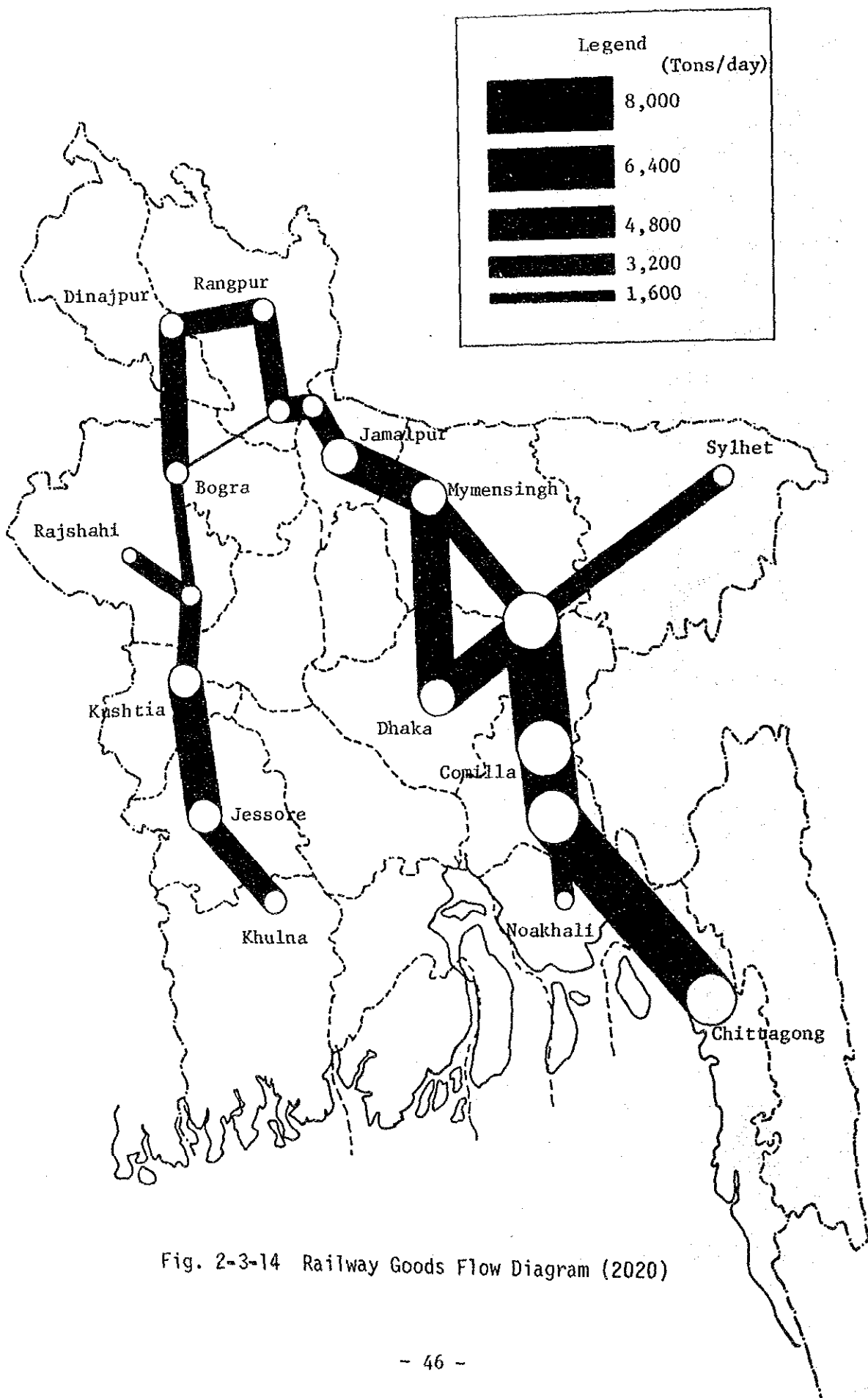
Fig. 2-3-13 Railway Goods Flow Diagram (1992)

Fig. 2-3-14 Railway Goods Flow Diagram (2020)

CHAPTER 3 RAILWAY TRANSPORTATION PLAN

3-1 General

According to the results of the aforementioned transportation demand forecast, by the time the rolling stock manufacturing plant begins operation (1992), passenger and goods transportation is expected to increase 2.25 times and 1.20 times respectively compared with 1982 as shown in Table 2-3-2 and Table 2-3-3.

Also, as shown in the same tables, transportation demand is expected to take place by 2020, the last year of this project, with passenger transportation increasing to 3.15 times and goods transportation to 2.13 times.

In addition to improving the track, facilities, signalling and safety facilities, station facilities, it is also necessary to take appropriate measures to reinforce the rolling stock fleet. These measures include increasing the number of locomotives, passenger carriages and goods wagons, improving the rolling stock performance by introducing new units and abandoning obsolete ones; and improving rolling stock utilization efficiency by reinforcing the inspection, maintenance, and repair system. The goal is to achieve safe, reliable, fast, and comfortable transportation that will be required to cope with the substantial increase in demand mentioned above.

At present, some improvements are being made in the tracks, signalling facilities and communication facilities of trunk lines. The transportation plan to cope with anticipated demand is drawn up as described below assuming the satisfactory progress of the improvement of the ground facilities through these measures.
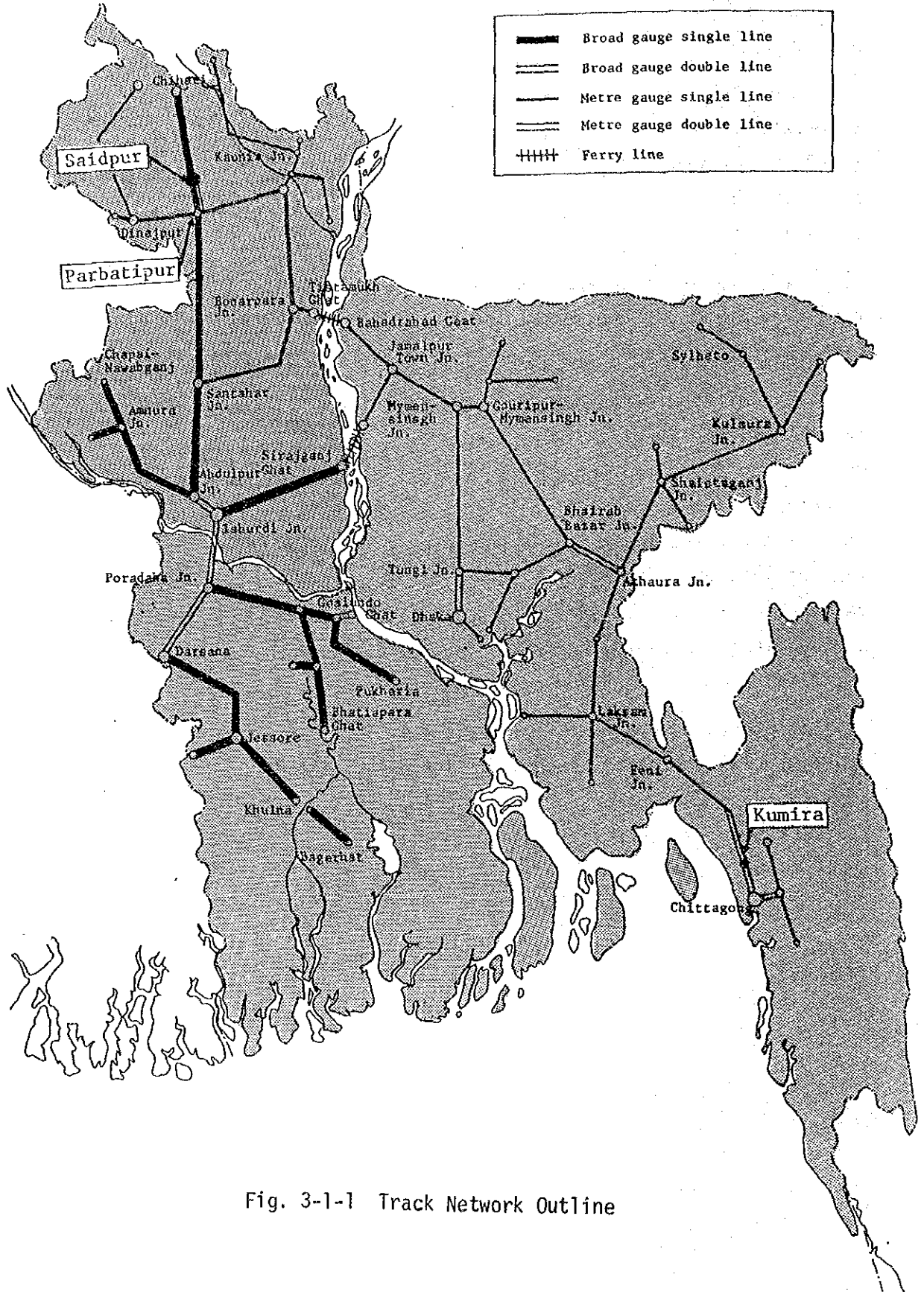
Fig. 3-1-1   Track Network Outline

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3-2 Train Operating Conditions

In this section, the transportation of passengers and goods is discussed in connection with the following items.

(1) Traction load and train length

. Current state

The current particulars regarding the train traction load and the number of hauled rolling stock units are stipulated in the Working Time Table No. 25 established by the Bangladesh Railway.

These parameters are restricted principally by the effective length of tracks in stations. On main lines each train is composed of 60 rolling stock in terms of 4-wheelers (68 in the Chittagong-Akhaura section), while in the slope sections of branch lines, it is on the order of 40 to 45 limited by the locomotives' tractive capacity.

In reality however, the passenger trains consist of 18 carriages at most, with an average of 8.9 carriages both in the MG and BG sections. Therefore, there is considerable room for expanding the transportation capacity by increasing the train length.

. Future plans

It will be quite difficult to substantially improve the railway facilities between now and 1992 in view of the short time available. Such being the case, temporary measures to be considered to cope with the increasing demand will aim at using tractive capacity of locomotives and the effective length in stations to their full capacity. This will increase the length of trains, as well as make efficient use of the reserve capacity of operation of additional trains mentioned later in this report.

Table 3-2-1 Average Train Length (1982/83)

Average number of rolling stock	Passenger		Mixed		Goods	
	BG	MG	BG	MG	BG	MG
	8.9	8.9	10.3	8.2	(44.3)	(51.2)

Notes: ( ) means unit number of wagons

The transportation plan for the year 2020 calls for increasing the effective length of stations by improving track layout therein and improving locomotive performance which, combined with the operation of additional trains, will bring about a substantial increase in the railway transportation capacity.

(2) Operation speed

. Current status

The maximum speed of trains in each line section is stipulated by the aforementioned Time Table, with 72.45 km/h on the MG trunk line sections and 96.6 km/h on the BG trunk line sections. Furthermore, the maximum speed of each kind of train varies within the limits of the aforesaid maximum operation speeds. That of super express trains, express trains, and mail trains on main lines is 72.45 km/h in MG sections and 80.45 km/h in BG sections, while that of ordinary passenger trains is 56.35 km/h in MG sections and 64.40 km/h in BG sections. That of through-operation goods trains is 32.20 km/h in BG sections and 32.20 km/h in MG sections.

. The operating speeds in Table 3-2-2 denote the maximum operating speeds possible when rolling stock and tracks are maintained in perfect condition (ensuring designed performance). Therefore, if the brake axle ratio is less than 100%, due to a faulty brake system or damaged air hose, the maximum operating speed should be reduced in proportion to the decrease in brake power.

Table 3-2-2   Present State and Future Plans for
Train Operation Speed

| Year | Gauge | Passenger trains | | | | Mixed trains | Goods trains |
		Super express	Express	Mail train	Ordinary		through
1982	MG	km/h 72.45	km/h 72.45	km/h 72.45	km/h 56.35	km/h 32.20	km/h 32.20
	BG	–	80.45	–	64.40	64.40	32.20
1992	MG	72.45	72.45	72.45	56.35	32.20	32.20
	BG	–	80.45	–	64.40	64.40	32.20
2020	MG	90	90	90	70	40	40
	BG	–	120	–	80	65	40

. Future plans

Track improvements will probably remain unfinished until after 1992 making it impracticable to substantially increase the operation speed throughout the whole railway network.

In the relevant transportation plan, therefore, the maximum speed of trains is left unchanged and it is assumed that there would be more margin of running time due to the further reduction of speed-restricting sections from those at present.

For the year 2020, the relevant railway transportation plan is drawn up by assuming maximum operation speeds of 90 km/h in the MG sections and 120 km/h in the BG sections. It is estimated that it will be possible to increase the maximum speeds by approximately 20%, as a consequence of the completion of the track improvement work.

(3) Number of trains

As of 1982, the daily average number of trains is 106 in BG sections and 301 in MG sections, totaling 407 trains. In view of the actual state of tracks, it is presumed that there is considerable reserve capacity for additional trains. In this connection, Table 3-2-3 compares the track capacity and the number of trains in sections of bottlenecks on trunk lines. Various corrective measures such as construction of intermediate stations or track duplication in long sections between adjacent stations are required in order to substantially increase the track capacity. Either of measures should be taken depending on the state of the track in question.

Table 3-2-3 Track Capacity and the Number of Trains

	Chittagong-Dhaka	Mymensing-Jamalpur Town	Ishurdi-Santahar	MG double track section	BG double track section
Track capacity	trains 55	trains 42	trains 26	trains 120	trains 120
Current number of train	38	28	20	60	22
Reserve capacity for additional trains	17	14	6	60	98

Note: The track capacity of the Ishurdi-Santahar section is calculated in terms of the Atrai-Raninagse section. However, it must be borne in mind that the track capacity of the latter section can be increased further by constructing a bypass track at the Shahagolo Station.

(4) State of tracks

The tracks are flat with few curves, because the national territory of Bangladesh consists of a flat alluvial fan. Such being the case, the operation speed is very rarely limited by such geometric factors as curves or slopes. In most cases, the designated hauling capacity is restricted by the effective length of the station, as mentioned before. It must be borne in mind however, that at some places like the vicinity of Sylhet, it is restricted by gradient.

The track structure is the same as originally constructed, with damage inflicted during the independence war. Tracks are presently being reinforced. For example, welded long rails are being laid in the Chittagong-Dhaka section; and the 178 km section between Akhaura and Sylhet is being rehabilitated.

In reality however, it is presumed to be impossible to finish the said track reinforcement work by 1992 and to subsequently increase train speed by that time. Such being the case, the 1992 railway transportation plan is drawn up based on the current train operation speeds. In contrast, the 2020 railway transportation plan is drawn up by assuming a 20% increase in train operation speeds because the tracks will be reinforced and the rolling stock will be improved by that time.

(5) Number of stations

The number of stations existing at the present time and the average distances between them are shown in Table 3-2-4.

Table 3-2-4 Number of Stations

	BG section	MG section		Total		
	West zone	East zone	West zone	East zone	West zone	Total
Number of stations	stations 174	259	83	259	257	516
Average distance	km 5.6	5.3	6.6	5.3	5.9	5.6

New stations may be constructed and some existing ones abolished in the future. However, in this report, the railway transportation plan is drawn up on the premise of the existing number of stations.

(6) Ferryboat transportation

The railway network of the BR is divided into two zones by the Jamuna River. Ferryboats are operated by the BR to interconnect the two zones. The ferryboats cross the river at two places, with three daily round trips between Bahadurabod Ghat and Tistamukh Ghat and two daily round trips between Jagannathganj Ghat and Sirajganj Ghat. The former handles goods wagons as well.

Historical records and future forecast of the ferry transportation system are shown in Table 3-2-5.

Table 3-2-5　Ferryboat Transportation Record and Forecast

	Banhadurabad Ghat ~ Tistamukh Ghat				Jagannathganj Ghat ~ Sirajganj Ghat	
	Passenger		Freight		Passenger	
	round trips	passenger	round trips	tons	round trips	passenger
1982	3	Actual record: 4836 Capacity:　5058	2	1530	2	1494
1992	6	9883	2	1942	2	3151
2020	9	14048	4	3648	3	4405

Notes:　1.　The capacity of the passenger ferryboat
　　　　　　　is calculated in terms of the 843 pas-
　　　　　　　senger-capacity of the Sonargaon-type
　　　　　　　ferryboats presently used.

　　　　　2.　The number of goods ferryboat trips is
　　　　　　　not stipulated in the Working Time Table.