CHAPTER 7

PORT DEMAND FORECAST FOR MONGLA PORT

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7.1 Methodology of Port Demand Forecast

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Demand forecast for Mongla Port has been carried out according to Fig. 7.1.1. The basic procedure can be summarized as follows;

First, the total cargo demand for the two Bangladesh seaports is projected through both the macro analysis and the micro analysis, which includes the projections by commodity, by assuming three different economic growth scenarios.

Secondly, the future share of Mongla Port on a commodity basis is examined taking into account the effects of development of a land transport system including openings of Rupsa Bridge and Paksey Bridge. A part of the total Bangladesh port cargo in 2015 is allocated to Mongla Port.

The Nepalese cargo is projected based on the assumption that the present cargo volume through seaports is around a half million tons as mentioned in Chapter 5, Section 5.1.4. The total Nepalese seaborne cargo is projected through commodity basis analysis. Then cargo allocation among the three ports, Mongla, Chittagong, and Calcutta, is examined taking into account infrastructure of each port and other factors such as business practice.

The future cargo throughput at Mongla Port in 2015 is forecasted by combining the cargo to/from Bangladesh and Nepal. The cargo handling method, namely, handling at the jetty or handling in the river by inland water ships, is assumed by the commodity.

Finally, by constructing the future OD table of port cargo handled at the jetty, the future land traffic related to Mongla Port including that of passing through Rupsa Bridge is projected.

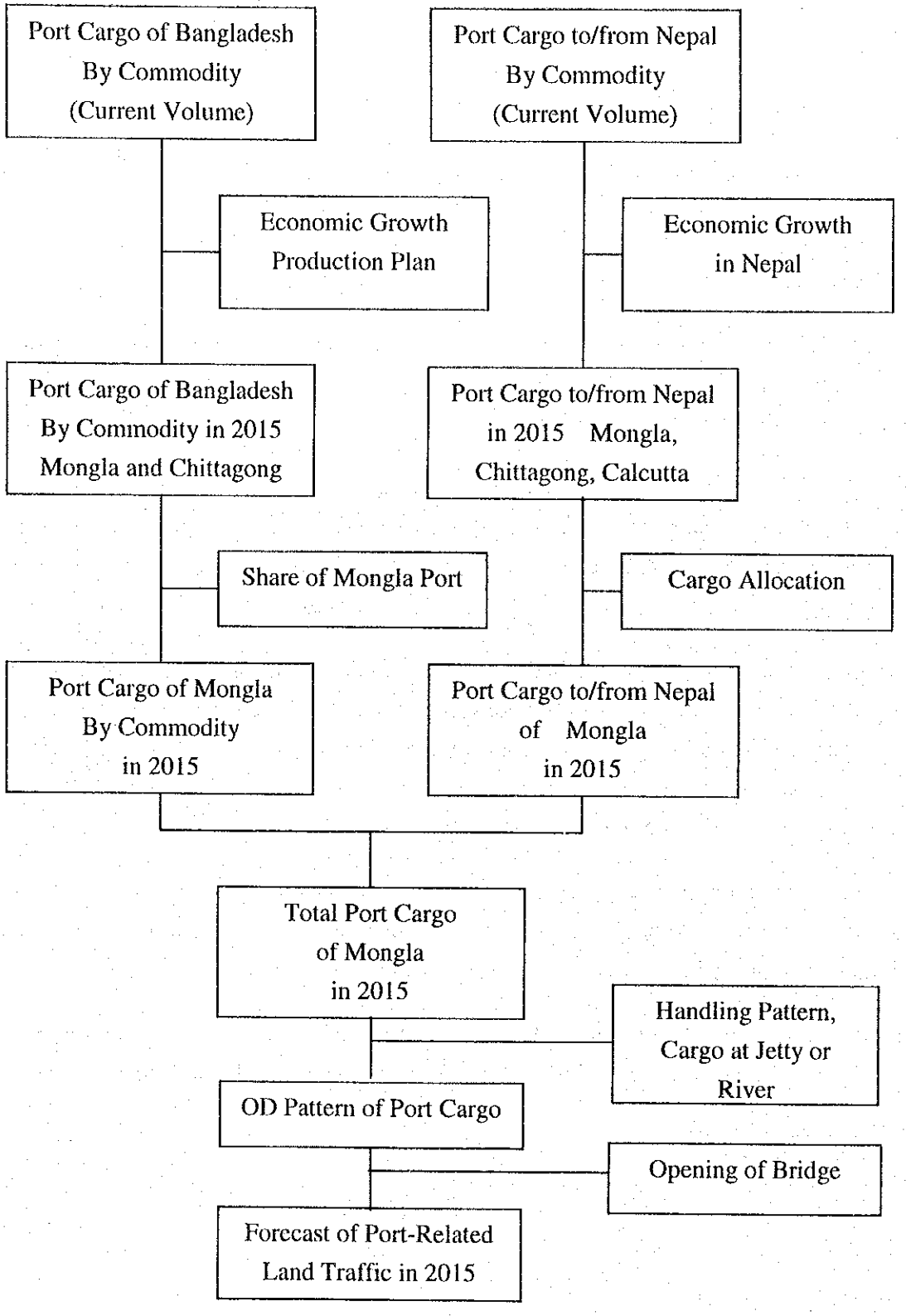


Fig 7.1.1 Flow Chart on Demand Forecast for Mongla Port

7.1.2 Prerequisite of Demand Forecast

The following economic scenarios shown in Table 7.1.1 are presumed for carrying out the forecast of port cargo demand. According to these economic scenarios, three different figures of port cargo demand for the two Bangladesh seaports as of 2015 are presented in this report. An average economic growth rate of 5.0% for Bangladesh and 4.0% for Nepal is assumed as the most probable scenario for the port demand forecast.

Table 7.1.1 Economic Growth Scenarios for Bangladesh and Nepal

		Economic Growth Rate
Bangladesh	Scenario 1	4.4%
	Scenario 2	5.0%
	Scenario 3	5.5%
Nepal	Scenario 1	4.0%
	Scenario 2	7.1%

Note: Figures indicate an average annual growth rate

The functional allotment between the two seaports is examined through analysis of the present pattern of cargo distribution as well as the future development of inland transport system such as bridge constructions at Rupsa and Paksey, which affects the time consumed for inland transport between the major cities and the two seaports. Of course a lot of development will occur up to 2015, however, in order to simplify the analysis, only the opening of the two bridges is assumed for examination of cargo allocation.

The functional allotment among Mongla Port, Chittagong Port, and Calcutta Port for the Nepalese cargo is also examined. However, it is assumed that Calcutta Port will still have a much greater advantage than Mongla and Chittagong Ports.

Finally, an OD table of port cargo at Mongla Port's jetty is constructed using the most probable forecast data. The traffic volume of inland transport to/from Mongla Port and the port area such as truck traffic and the port related business traffic is also projected.

7.2 Future Cargo Demand for Bangladesh Ports

7.2.1 Macro Demand Forecast

The macro demand forecast for the Bangladesh seaports is carried out for three different scenarios. The correlation analyses between port cargo volume by import and export and the Bangladesh GDP in constant price are conducted for growth rates of the GDP of 4.4%, 5.0%, and 5.5%.

The results of the calculation are summarized in Table 7.2.1.

Table 7.2.1 Cargo Demand for Bangladesh Seaports

(Figures in thousand metric tons)

Year	Annual GDP Growth Rate	Import (growth rate)	Export (growth rate)	Total (growth rate)
'97/'98		11,900	2,055	13,954
2015	4.4%	23,285 (4.0%)	4,448 (4.6%)	27,733 (4.1%)
	5.0%	25,737 (4.6%)	4,939 (5.3%)	30,676 (4.7%)
	5.5%	27,970 (5.2%)	5,386 (5.8%)	33,357 (5.3%)

Note: Import --- R (correlation coefficient) = 0.759
Export --- R = 0.842

Whereas the growth of GDP has been very steady these years, the cargo throughput of the two Bangladesh seaports have rather fluctuated, showing no growth between '90 and '94 (Fig. E-7.2.1 in Appendix E). This seems to have resulted in relatively low R values of correlation formulas.

While the more detailed commodity-based forecast follows this macro analysis, the overall perspective can be grasped from the analysis, that is, the growth rate of port cargo will be less than that of the GDP, and the growth rate of the export will exceed that of the import. All these tendencies shall be taken into account for the further detailed analysis.

7.2.2 Micro Demand Forecast

The micro demand forecast is carried out by commodity basis as shown in Figs. E-7.2.2 and E-7.2.3 in Appendix E. The methodology and result of each analysis is as follows.

1) General Goods Import

Volume of imported general cargo is forecasted using the correlation analysis with the GDP. The results are as follows.

Table 7.2.2 Forecast of General Goods Import

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		4,099
2015	4.4%	12,831
	5.0%	14,711
	5.5%	16,424

Note: R (Correlation Coefficient) = 0.993

2) POL Import

Volume of imported POL is forecast using the correlation analysis with the GDP.

Table 7.2.3 Forecast of POL Import

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		2,794
2015	4.4%	5,984
	5.0%	6,661
	5.5%	7,277

Note: R = 0.915

3) Cement Import

Though cement consumption in Bangladesh will greatly increase in the future due to rising construction works, cement is acquired either from import of manufactured cement or domestic cement production. The recent trend shows that domestic cement production is greatly expanding, while import of manufactured cement has remained at almost the same level for some time. Accordingly, the import of manufactured cement is forecasted to remain at the same level of the average of the latest three years' import volume

Table 7.2.4 Forecast of Cement Import

(Figures in thousand metric tons)

Year	Cargo Volume
'97/'98	2,001
2015	2,200

4) Foodgrain Import

The volume of foodgrain import is simply equal to the domestic demand minus the domestic production. These records have fluctuated a lot and it would be impossible to correlate

foodgrain with any indices. Therefore, the average of these three years' import volume is taken as the future volume.

Table 7.2.5 Forecast of Foodgrain Import

(Figures in thousand metric tons)

Year	Cargo Volume
'97/'98	1,164
2015	1,450

5) Fertilizer Import

Fertilizer has played a key role in agriculture development. The volume of fertilizer import again depends on the demand in the nation and the domestic production. Though the volume of import had gradually decreased from '89 to '94, a rapid increase can be found from '94 to the current year. Therefore, the volume of import is projected to increase at the rate of the GDP growth starting from the average of the latest three years' import volume.

Table 7.2.6 Forecast of Fertilizer Import

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		737
2015	4.4%	1,333
	5.0%	1,478
	5.5%	1,610

6) Clinker Import

As mentioned earlier the domestic production of cement is expected to greatly increase. As the raw materials for manufacturing cement the volume of clinker import is projected to increase corresponding to the growth of the national economy. In this sense the volume is calculated using the correlation with the GDP.

Table 7.2.7 Forecast of Clinker Import

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		604
2015	4.4%	2,811
	5.0%	3,271
	5.5%	3,689

Note; R = 0.871

7) Edible Oil Import

Though the volume of imported edible oil has not showed significant growth, the volume will surely increase with the population growth and improvement of living standards of the Bangladesh people. In this sense it is projected that the volume will increase with the population growth (annual growth rate of 1.3%)

Table 7.2.8 Forecast of Edible Oil Import

(Figures in thousand metric tons)

Year	Cargo Volume
'97/'98	366
2015	484

8) Sugar and Salt Import

Sugar and salt imports actually decreased until '95/'96 but from then it has increased to the current year. It is assumed that the volume will increase with the population growth rate based on the average of the latest three years' import volume.

Table 7.2.9 Forecast of Sugar and Salt Import

(Figures in thousand metric tons)

Year	Cargo Volume
'97/'98	105
2015	130

9) Miscellaneous Import

The volume of miscellaneous goods is expected to increase with the growth of the GDP. The growth rate of the GDP is taken for growth from the average of the latest three years' import volume.

Table 7.2.10 Forecast of Miscellaneous Goods Import

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		30
2015	4.4%	64
	5.0%	71
	5.5%	77

10) Jute and Jute Goods Export

Jute and jute goods have been one of the most important export items of Bangladesh, however, it may be impossible for this industry to greatly develop in the future due to development of chemical textile and competition with other countries. As a matter of fact export figures in these ten years have remained almost in the same range of 650 to 770 thousand tons a year. The future demand is projected using the average growth of agriculture sector in Bangladesh, that is 1.62%, 1.84%, and 2.02% per annum, each of which corresponds to the GDP growth rate of 4.4%, 5%, and 5.5% respectively.

Table 7.2.11 Forecast of Jute and Jute Goods Export

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		763
2015	4.4%	947
	5.0%	985
	5.5%	1,017

11) Garments Export

Garments industry is currently one of the leading export industries in Bangladesh. The export of this export-oriented industry is expected to increase with the GDP growth.

Table 7.2.12 Forecast of Garments Export

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		343
2015	4.4%	1,592
	5.0%	1,844
	5.5%	2,073

Notes; R = 0.995

12) General Goods Export

The volume of the exported general goods has fluctuated in these ten years unlike that of its import counterpart. The future volume is forecasted using the average GDP growth rate based on the average of the latest three years' export volume.

Table 7.2 13 Forecast of General Goods Export

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		339
2015	4.4%	614
	5.0%	681
	5.5%	742

13) Fertilizer Export

Fertilizer is manufactured at several plants in Chittagong and its export volume depends on the production scale of these plants. The export volume in these ten years has greatly fluctuated, however, the government has a policy to promote exports, so the future volume is projected to increase corresponding to the growth rates of the GDP.

Table 7.2 14 Forecast of Fertilizer Export

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		331
2015	4.4%	784
	5.0%	869
	5.5%	946

14) Naphtha Export

Naphtha is one of the byproducts of oil refinery and is produced at only Chittagong in Bangladesh. Due to the production plans of the oil refinery factories, the export volume in these ten years has shown a decreasing trend. The volume of naphtha export is projected to remain in its present range.

Table 7.2 15 Forecast of Naphtha Export

(Figures in thousand metric tons)

Year	Cargo Volume
'97/'98	110
2015	100

15) Shrimp Export

Shrimp processing is a growing industry in Bangladesh, though the export volume still remains very small compared with that of Thailand etc. It is presumed that the industry will rapidly develop, and the export volume will be closely related with the GDP growth.

Table 7.2.16 Forecast of Shrimp Export

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		17
2015	4.4%	66
	5.0%	75
	5.5%	84

Notes: R = 0.968

16) Miscellaneous Export

The volume of miscellaneous export has steadily grown these years. The future volume is projected using correlation analysis with the GDP.

Table 7.2.17 Forecast of Miscellaneous Export

(Figures in thousand metric tons)

Year	GDP Growth Rate	Cargo Volume
'97/'98		151
2015	4.4%	705
	5.0%	815
	5.5%	915

Notes: R = 0.850

17) Conclusion of Demand Forecast in Bangladesh Seaports

In conclusion, the combined total cargo volume of forecast by the micro analysis is summarized as follows;

Table 7.2.18 Total Cargo Throughput by Micro Analysis

(Figures in thousand metric tons)

Year	GDP Growth Rate	Forecast Cargo Volume		
		Import	Export	Total
'97/'98		11,900	2,055	13,954
2015	4.4%	27,287	4,808	32,095
	5.0%	30,456	5,369	35,825
	5.5%	33,342	5,878	39,220

Though they are slightly greater than those by the macro analysis, the results of the detailed micro analysis corresponding to the GDP growth rate of 5.0%, which would be the most realistic, are to be used for the further analysis.

18) Commodity-based Future Cargo Throughput

The commodity-based forecast by the micro analysis, which is used for the further study, is summarized below.

Table 7.2.19 Import Cargo Throughput of Bangladesh Seaports in 2015

(Figures in thousand metric tons)

Year	General Cargo	POL	Cement	Food-grain	Fertilizer	Clinker	Edible Oil	Sugar & Salt	Others	Total
97/98	4,099	2,794	2,001	1,164	737	604	366	105	30	11,900
2015	14,711	6,661	2,200	1,450	1,478	3,271	484	130	71	30,456

Table 7.2.20 Export Cargo Throughput of Bangladesh Seaports in 2015

Year	Jute and Jute goods	Garments	General Cargo	Fertilizer	Naphtha	Shrimp	Others	Total
97/98	763	343	339	331	110	17	151	2,055
2015	985	1,844	681	869	100	75	815	5,369

7.2.3 Functional Allotment between the Two Ports

One of the most important factors for examining allocation of port cargo among ports is "time distance" between a port and a place of cargo's origin/destination. By the opening of the two major bridges up to 2015, the Rupsa Bridge and Puksey Bridge, Mongla Port will be getting closer to the most places of origins/destinations of its cargo in terms of time consumed for land cargo transportation. The time distance table of road transportation is formulated by assessing the effects of bridge developments, which is shown in Table 7.2.21.

Table 7.2.21 Time Distance between Sea Ports and Major Cities

Origin/ Destination	Mongla Port			Chittagong Port	
	Present Condition		With bridges	Present Condition	
	Distance	Time(hours)	Time(hours)	Distance	Time(hours)
Khulna	42 km	2 - 3	1 – 2	555 km	30 – 40
Kustia	205 km	8 – 9	7 – 8	467 km	24 – 36
Rajshahi	345 km	12 - 14	10 – 13	509 km	14 – 16
Bogra	465 km	15 – 17	13 – 16	450 km	12 – 16
Dinajpur	592 km	20 – 21	18 – 19	588 km	24 – 30
Barisal	297 km	12 – 14	11 – 13	531 km	20 – 30
Dhaka	342 km	16 – 20	15 – 19	264 km	8 – 10
Mymensingh	448 km	18 – 22	17 – 21	379 km	13 – 15

Note:--- Distance is defined as one along the major roads ordinarily used.
--- Only opening of two bridges is taken account in constructing the table, so the condition for Chittagong Port will not be much changed.
--- Time is defined as that consumed by ordinary freight trucks.

Presuming that the opening of the bridge will shorten the time distance by approximately an hour, Mongla Port will have better condition in terms of time required for reaching places in the northwestern region such as Rajshahi, and Bogra. However, the condition of road transportation between Mongla Port and Dhaka will not greatly change, leaving Chittagong Port much more competitive in terms of transport time. The hinterland of Mongla Port has a possibility to expand to the northwestern region to some degree, though it is also true that port hinterlands may be affected by other factors such as business practice and scale of the port itself.

In the case that railway is extended to Mongla Port, the same situation will take place, that is, the time consumed by transport to the northwestern region such as Rajhshahi will be drastically reduced though that to Dhaka will not be greatly affected.

Inland water transport system will be affected to some extent by the opening of the bridges, and some of cargo now transported by the inland water system will shift to land transport.

However, the total cargo demand will increase so greatly that the inland water system will still have to play a significant role even in the future.

The future shares of Mongla Port on a commodity basis are given in the Tables 7.2.21 and 7.2.23, though it would be difficult to exactly determine the figures of shares although it is safe to say that the shares of Mongla Port will definitely expand in the future (Fig. E-7.2.3 in Appendix E). The bulk cargo handled at Mongla Port is already widely distributed in the nation mainly by means of inland water transport, therefore, the shares of these commodities would remain in the same range. On the other hand the Mongla Port's shares of break bulk cargo such as general cargo will increase to some extent due to development of the land transport system.

Table 7.2.22 Mongla Port's Shares of Import Cargo

(Figures in %)

Year	General Cargo	POL	Cement	Food-grain	Fertilizer	Clinker	Edible Oil	Sugar & Salt	Others
Average in 3 Years	3	0	50	25	50	45	0	0	70
2015	5	0	50	25	50	50	0	0	75

Table 7.2.23 Mongla Port's Shares of Export Cargo

(Figures in %)

Year	Jute, Jute Goods	Garments	General Cargo	Fertilizer	Naphtha	Shrimp	Others
Average in 3 Years	65	0	1	0	0	100	2
2015	67	5	2	0	0	100	3

7.2.4 Cargo Throughput of Mongla Port in 2015

Multiplying the total cargo throughput of Bangladesh seaports by the shares of Mongla Port, the future cargo throughput of Mongla Port is calculated. Other than the cargo mentioned earlier, LPG cargo is added, because a company is planning to construct a LPG depot adjacent to a cement factory in Mongla Port and has already acquired the land for this. The overall results are presented in Table 7.2.24.

Table 7.2.24 Cargo Throughput of Mongla Port in 2015

(Figures in thousand metric tons)

Year	General Cargo	POL	Cement	Food-grain	Fertilizer	Clinker	Edible Oil	Sugar Salt	LPG	Others	Import Total
97/98	65	0	955	285	412	604	0	0	0	19	2,339
2015	856	0	1,100	363	739	1,635	0	0	79	53	4,825

Year	Jute, Jute Goods	Garments	General Cargo	Fertilizer	Naphtha	Shrimp	Others	Export Total	Grand Total
97/98	504	0	4	0	0	17	2	528	2,867
2015	660	92	134	0	0	75	24	985	5,811

7.2.5 Container Cargo at Mongla Port

For estimating container cargo at Mongla Port in 2015, a radical but simple presumption is made, that is, all the cargo which can be containerized is to be transported in containers in 2015. Containerization has developed so rapidly that almost all the break bulk commodities are currently containerized in the advanced sea routes in the world. Though currently this is not the case with Bangladesh seaports, it is expected to be so in 2015, more than 15 years from now.

According to this theory, the volume of containerized cargo is projected as follows; first commodities are selected which can be containerized, secondly containerization ratio is assumed for each commodity (actually the ratio is 100% for all the commodities except jute and jute goods which has a ratio of 60% due to the expected cargo handling pattern). The results are presented in Table 7.2.25. .

Table 7.2.25 Containerization Ratio (Containerized Cargo Volume / Total Cargo Volume) at Mongla Port

Year	Import		Export				
	General Cargo	Others	Jute, Jute Goods	Garments	General Cargo	Shrimp	Others
Average in 3 Years	35%	40%	18%	n.a.	0%	100%	0%
2015	100%	100%	60%	100%	100%	100%	100%

Notes: Bulk cargo such as cement clinker, food grain, fertilizer will not be containerized in the future.

Assuming the containerized ratios for each containerized commodity, the volume of container cargo at Mongla Port in 2015 is calculated as shown in Table 7.2.26 and Fig. E-7.2.5 in Appendix E.

Table 7.2.26 Container Cargo Throughput at Mongla Port in 2015

(Figures in metric tons)

Year	Import			Export						Grand Total
	General Cargo	Others	Total	Jute, Jute Goods	Garments	General Cargo	Shrimp	Others	Total	
97/98	24	4	28	99	0	0	17	0	116	144
2015	856	53	909	396	92	134	75	24	721	1,631

To facilitate the further examination, the volume of containerized cargo is converted into TEUs. Using the current unit weight of 11.8 tons and 12.8 tons per a stuffed 20 foot container box for import and export respectively, the number of stuffed TEU is calculated to be 77 thousand for import, and 56 thousand for export.

Currently a number of empty container boxes can be found at Mongla Port because of the imbalance between import and export container volumes. Since the future volume of import and export container cargo is more balanced than the present one, not so many empty container boxes are required in the future. The ratio of the number of empty containers to that of stuffed containers is expected to be around 0.5 in total, though the current ratio is almost 1.0.

The ratio of the number of 40 foot container boxes to that of 20 foot boxes is assumed to be 0.6, similar to the current ratio, 0.639 (the number of 40 foot boxes/that of 20 foot boxes).

Finally, bearing in mind that the number of TEU including empty boxes should be almost the same for import and export due to round trips of container boxes, the future container throughput in a container box basis is as shown in Table 7.2.27 and Fig. E-7.2.6 in Appendix E.

Table 7.2.27 Container Throughput in TEU Basis

(Figures in thousand boxes)

Year	Import			Export			Total		
	20foot	40foot	TEU	20foot	40foot	TEU	20foot	40foot	TEU
'97/'98	4	3	10	4	3	10	8	6	20
2015	46	28	101	46	28	101	92	55	201

7.2.6 Cargo Handling Methods by Commodity

Considering the current cargo handling, the future cargo handling methods and facilities by commodity are summarized in the Table 7.2.28. Though cargo handling at mooring buoys and anchorage areas is encouraged even in the future, a certain amount of bulk cargo is assumed to be handled at the jetty as it is currently done.

Table 7.2.28 Cargo Handling Methods by Commodity

(Figures in thousand metric tons)

	Commodity	Tons	Handling Methods	Handling Places
Import	General Goods	856	Container	100% at the Jetty
	Cement	1,100	Conventional	100% at Mooring or Anchorage
	Food-grain	363	Conventional	90% at Mooring or Anchorage 10% at the Jetty
	Fertilizer	739	Conventional	90% at Mooring or Anchorage 10% at the Jetty
	Clinker	1,635	Conventional	Private Facilities Mooring or Anchorage
	LPG	79	PLG Tanker	Private Facilities
	Others	53	Container	100% at the Jetty
Export	Jute, Jute Goods	660	Container or Conventional	70% (incl. Container)at the Jetty 30% at mooring or Anchorage
	Garments	92	Container	100% at the Jetty
	General Goods	134	Container	100% at the Jetty
	Shrimp	75	Container	100% at the Jetty
	Others	24	Container	100% at the Jetty

7.3 Demand Forecast for Nepalese Cargo

7.3.1 Nepalese Seaport Cargo Demand

Based on the current handled volume at the three ports and under the assumption that the Nepalese economic growth rate would be 4.0% per annum, which is the ADB's estimate and slightly lower than that of Bangladesh, and 7.1% per annum, which is the Nepalese government's target figure, three different demand forecasts for the Nepalese port cargo are examined. The methodologies of the three different forecasts are presented below.

--- methodology of projection
1) macro analysis 1 — total volume of export/ import is projected with the economic growth rate of 4.0%
2) macro analysis 2 — same as the above with the economic growth rate of 7.1%
3) micro analysis — each commodity is projected individually with the economic growth rate of 4.0%

The forecasts are shown in Figs. E-7.3.1 and E-7.3.2 in Appendix E, and the results are presented in Table 7.3.1.

Table 7.3.1 Forecast of Nepalese Cargo

(Figures in thousand metric tons)

Type of Forecast	Import					Total Export	Grand Total
	General Goods	Fertilizer	Edible Oil	Others	Total		
Macro 1	n.a.	n.a.	n.a.	n.a.	830	388	1,219
Macro 2	n.a.	n.a.	n.a.	n.a.	1,422	809	2,231
Micro	1,179	179	219	30	1,606	388	1,994

Note: The details are shown in Fig. E7.3.2 in Appending E.

The result of the micro forecast with the growth rate of 4.0% is considered to be the most probable, therefore, the total volume of approximately 2 million tons in the micro analysis is used for the further examination.

7.3.2 Cargo Allocation among the Ports

Though it is a tough job to allocate the future Nepalese cargo to the three ports because the rationale for allocation cannot be easily found, three different scenarios for functional

allotment among the ports are examined. Before explaining the scenarios, some conditions are clarified.

--- Calcutta Port has currently has a great advantage of transporting the Nepalese cargo with well developed port and land infrastructure as well as special treatment of the Nepalese cargo. And these advantages would persist in the future.

--- All the Nepalese cargo through the Bangladesh ports must eventually cross the Indian territory, since Bangladesh does not have a direct border connection with Nepal, which may cause much extra cost, transport time, etc.

--- General cargo, most of which is transported in the form of container, would be prone to be handled at integrated large ports with a lot of container routes and enough infrastructure. It might be very difficult for Mongla Port to compete with Calcutta Port especially in container handling to/from Nepal.

The three scenarios are set up for examination of the Nepalese cargo handled at Mongla Port. Each case has the following basic assumptions;

--- Case 1 to sustain the present share of Mongla Port for the Nepalese cargo, namely, only one third of fertilizer

--- Case 2 to increase the share of bulk cargo handling and to handle a small portion of the general cargo, namely, a half of fertilizer, 20% of general cargo etc.

--- Case 3 to increase the share of bulk cargo and to handle a certain amount of the general cargo, namely, a half of fertilizer, 30-40% of general cargo etc.

The results of the analysis are shown in Table 7.3.2

Table 7.3.2 Nepalese Cargo Handled at Mongla Port in 2015

(Figures in thousand metric tons)

Type of Allocation	Import					Total Export	Grand Total
	General Goods	Fertilizer	Edible Oil	Others	Total		
Case 1	0	60	0	0	60	0	60
Case 2	200	90	0	10	300	100	400
Case 3	400	90	0	10	500	150	650

Case 1 underestimates the activities of Mongla Port taking into account the improvement of land traffic infrastructure such as Rupsa Bridge.

Case 3 is an aggressive allocation for Mongla Port, however it would be difficult to attract a third of the general cargo, most of which is containerized, given the actual circumstances.

In conclusion, Case 2 is thought to be the most probable alternative, where Mongla Port handles 400 thousand tons out of 2 million tons, or 20% of the total cargo volume.

Port cargo is handled at Mongla Port in the following manner. As summarized in Table 7.3.3, general cargo which includes all export cargo is expected to be 100% containerized up to 2015 and be handled at the jetty. "Others" of import is miscellaneous goods and will be handled at the jetty as 100% container cargo. Most fertilizer will be unloaded from mother vessels to river ships at either anchorage or mooring buoys and be transported to Khulna or Nawapara, where the cargo is transshipped to trucks or railway.

Table 7.3.3 Nepalese Cargo at Mongla Port in 2015

(Figures in thousand metric tons and thousand TEUs in ( ))

	Import			Export	Total
	General Goods	Fertilizer	Others	General Goods	
Container/ Non-Container	Container	Non-Container	Container	Container	
Place of Handling	100% Jetty	90% Water 10% Jetty	100% Jetty	100% Jetty	
'97/'98	0	41	0	9	41
2015	200 (20)	90	10 (1)	100 (20)	400

Notes: TEU is converted according to the procedures mentioned earlier for the Bangladesh cargo.

7.4 Distribution of Port Cargo to/from Hinterland

7.4.1 Port Cargo Distribution by Modes

As currently more than 94% of the cargo is handled at mooring buoys and anchorage, and only a small quantity of cargo, mainly containers, is handled at the jetty, mode sharing is very distinctive and clear, that is, all the cargo handled at the river is transshipped by inland water ships and all the cargo handled at the jetty is transshipped by trucks. As mentioned earlier the system of transport to/from Mongla Port is very reasonable for a riverine country like Bangladesh. As a matter of fact river transport is cost efficient with relatively less impact on environment, and is especially suitable for bulk cargo, which is in general not sensitive to transport time.

It would be, therefore, a good assumption that this distribution system would persist to the future, which means that Mongla Port would still largely depend on water transport for cargo movement to/from the hinterland.

Mode sharing of each commodity is shown in Table 7.4.1. As a general rule most bulk cargo will be handled at the river and all the container cargo will be handled at the jetty. However, some bulk cargo on conventional vessels would also be handled at the jetty. The volume of this type of cargo is presumed to be around 10% of that of the total cargo handled at the jetty because it is found that currently the volume of this type of cargo accounts for just more than 10% of the total volume handled at the jetty with decreasing trend.

Table 7.4.1 Mode Sharing of Commodity at Mongla Port in 2015

(Figures in thousand metric tons)

Handling Facilities	Commodity		Volume or TEU	
			Bangladesh Cargo	Nepal Cargo
Jetty	Import	General Goods	856	200
		Food grain	36	0
		Fertilizer	74	9
		Others	53	10
	Export	Jute, Jute Goods	462	0
		Garments	92	0
		General Goods	134	100
		Shrimp	75	0
		Others	24	0
	Total		1,806	319
Mooring Buoys, Anchorage, or Private Facilities	Import	Cement	1,100	0
		Food grain	327	0
		Fertilizer	665	81
		Clinker	1,635	0
		LPG	79	0
	Export	Jute, Jute Goods	198	0
	Total		4,004	81

7.4.2 OD Pattern of Port Cargo

The future OD table of the cargo handled at the jetty is constructed based on the following assumptions;

--- The hinterland of Mongla Port would be expanded in the future, though the degree of its expansion is difficult to quantitatively assess.
--- The share of the cargo to/from Dhaka is assumed to be doubled in 2015 due to the opening of bridges such as Rupsa Bridge.
--- The north-western region of the country would partly become the hinterland of Mongla Port, because cities such as Rajsahahi could be reached faster from Mongla than from Chittagong
--- The north-western region would have a share of approximately 10% of the total Mongla Port cargo.

Based on these assumptions and the current pattern of cargo distribution the future OD pattern of Mongla Port's land cargo is constructed as follows

Table 7.4.2 Future Distribution Pattern of Mongla Port' Cargo

Origin and Destination Areas	Import	Export
Khulna City	35%	60%
South-Western Region*	25%	10%
Dhaka	15%	10%
North-Western Region	10%	10%
Nepal	15%	10%

Note: South-Western region is defined as Khulna Division excluding Khulna City, Barisal Division, and southern Dhaka Division.

7.5 Port Development Plan

7.5.1 Berth Requirement in 2015

1) Summary of Cargo Demand

In order to calculate the future berth requirement, the forecast cargo is categorized as follows.

Table 7.5.1 Summary of Port Cargo at Mongla Port

(Figures in thousand metric tons)

Category		Cargo Volume in 2015
Jetty	Container	1,940 (242 thousand TEUs)
	Conventional	185
River		4,086

The future berth requirement is calculated assuming the capacity of the existing berthing facilities as well as this cargo volume.

2) Container Berth Requirement

Assuming that the same ship's gear will be used in the future, in other words gantry cranes will not be introduced, (though every possible effort for efficiency improvement will be made by the MPA), the capacity of the existing container berth (J9) is calculated as follows;

--- number of handling boxes per hour	15 boxes/hr
--- business hours a day	20 hrs/day
--- working days a year	350 days /year
--- berth occupancy rate	0.7
--- coefficient for contingency	0.9

The calculation yields (15x20x350x0.7x0.9) 66,150 boxes a year for a capacity of a berth. Since the number of container boxes to be handled in 2015 is approximately 180 thousand, the required number of container berths is 2.7 or 3 berths.

3) Conventional Berth Requirement

The capacity of a conventional berth generally depends on not only the dimensions of the berth itself but also the kinds of cargo handled at the berth. In other words it is much more difficult to assume a general capacity for a conventional berth. In some examples, however, it is often assumed for planning purposes that a conventional berth for vessels of 10,000-20,000 DWT with a depth of around 10m has the capacity of 100 to 200 thousand tons a year.

Being a berth much shallower than 10m, the existing conventional berth at Mongla Port (J5-J8) has the expected capacity of 100 thousand or less.

The number of required conventional berths is calculated as 2 or 3 berths in order to handle the forecast cargo volume of 185 thousand tons. Theoretically, at least one of the present four berths will be not in use in the future and could be changed to another use, namely, container handling.

4) Requirement for Mooring and Anchorage Berths

Cargo volume handled at mooring buoys and anchorage area is expected to moderately increase. As mentioned in Chapter 5, it has been learned from the MPA's personnel that it would be rather easy to increase the number of buoys and anchorage points without much additional cost. It is concluded that it would be easy to deal with the future increased cargo demand at the facilities on the river. Under these circumstances no further analysis will be made for buoy and anchorage berths.

7.5.2 Development Plan of Container Berths

As stated above, three container berths will be required until 2015. Two additional berths should be planned in the following manner.

--- One berth is acquired by redeveloping one of the existing conventional berths. Redevelopment of the J8 berth, which includes demolishing transit shed and pavement of container yard, will be the most appropriate alternative because it can be continually used with the existing container berth, J9.

--- The other new berth has to be developed at either side of the present jetty.

Whether a new berth is constructed at the extension of J5 or that of J9 totally depends on the cost of construction and efficiency of container handling. If the existing concrete piles which were installed some 30 years ago can be still used in the future, the extension of the J5 would be a better alternative, however, the container handling will be less efficient than the case of extension of the J9 because of operation matters. Therefore, the location of a new container berth should be studied in detail when actually planning construction.

7.5.3 Alternative Schemes for Dredging

The most appropriate targeted level of water depth should be reviewed from the viewpoints of necessary dredging cost and capacity expansion of the port. The yearly maintenance dredging volume or its cost is a more crucial factor for considering water depth than capital dredging because cost of maintenance dredging accumulates to a huge sum of money.

The study on "Mongla Port Area Development Project" by the ADB in 1996 analyzed several schemes for dredging. The main schemes are as follows;

--- scheme 1 -6.1m of the natural draft at the jetty front with the minimum maintenance dredging
--- scheme 2 -6.8 draft at the jetty front
--- scheme 3 -7.7 draft at the jetty front
--- scheme 4 -8.0 draft at the jetty front

The study assumes that the required volumes of maintenance dredging and their corresponding costs are as follows;

--- scheme 1 40 thousand m^3/year at US$ 108 thousand
--- scheme 2 400 thousand m^3/year at US$ 1.2 million
--- scheme 3 2.8-4.3 million m^3/year at US$ 9.8-6.2 million
--- scheme 4 3.8-5.3 million m^3/year at US$ 12.0-8.4 million

The study concludes that scheme 2 is the best alternative, since it yields the maximum internal rate of return.

In addition to that the study on " Port Upgrading Project" by the ADB in 1998 concludes that the most suitable option is to maintain the Port with the permissible vessels' draft of 7.0m with the maintenance dredging cost of US$ 3.3 million.

As a matter of fact, it is not realistic, for example, to carry out the yearly dredging work with more than several million cubic meters with the cost of several million US$, because the MPA only makes a net profit of six or seven million US$, even taking into account the additional revenue accrued from the increased draft of the Port.

Finally, it is concluded that the most suitable target for vessels' draft of Mongla Port is to be around 7.0 m, which does not contradict the coming dredging plan of the MPA, namely target depth of 7.5m, because it involves some allowance for siltation during the first year.

Though a careful study shall be needed including the detailed hydrological analysis in the future to determine the most suitable target water depth of the Port, it may be reasonable to assume the water depth equivalent to the vessels' drafts of around 7.0 m, which was recommended by the studies of the ADB, and which is also conformed to the capital dredging scheme the MPA will carry out including siltation allowance in '98 and '99. This will also be justified from the financial viewpoint, because the expenditure is estimated to be within the current range of the net profits.

7.6 Port-Related Land Traffic Forecast

7.6.1 Basic Presumption

Port related land traffic is defined here to be land traffic to/from the expanded public jetty, the cement factories and the planned LPG distribution depot, and the planned EPZ. Land traffic generated by port activities includes not only container trailers and cargo trucks transporting port cargo but also port related business traffic which supports port activities.

Forecast is made by assuming the average tonnage loaded on a truck, a load factor, and a general coefficient between the number of trucks and that of business trips. Other important issues to be assumed are presented below;

- --- Container boxes are transported only by container trailers, which are currently not used in Bangladesh.
- --- Conventional general cargo is transported by trucks, whose average load is assumed to be in the same range as present.
- --- The existing cement factories are expanded as planned and a new LPG distribution depot is under operation, but other industries are not considered.

--- The EPZ is fully in operation.
--- The case including railway extension to Mongla Port is examined after forecasting the case without it.

7.6.2 Land Traffic from the Jetty

The volume of port cargo handled at the jetty was projected in the earlier chapter as follows.

Table 7.6.1 Jetty Cargo at Mongla Port

(Figures in thousand metric tons)

Handling Facilities	Commodity		Volume or TEU	
			Bangladesh Cargo	Nepal Cargo
Jetty	Import	General Goods	856 (container)	200 (container)
		Food grain	36(conventional)	0
		Fertilizer	74(conventional)	9 (conventional)
		Others	53 (container)	10 (container)
	Export	Jute, Jute Goods	462 (66 thousand of conventional)	0
		Garments	92 (container)	0
		General Goods	134 (container)	100(container)
		Shrimp	75 (container)	0
		Others	24 (container)	0

Container boxes are transported by container trailers which are of two types, a 20 foot container trailer and a 40 foot container trailer. Simply a trailer carries a container box, however there should be a distinction between the two types. Conventional general cargo is transported by trucks of the ordinary type, each of which carries 7.01 tons for export and 9.20 tons for import as described in the previous chapter. The number of trailers and trucks can be calculated by this procedure and usually a half of this number should be added as for that of port-related business vehicles such as a visitors' vehicle and a commuter bus. All these numbers again should be doubled because of load factors, assuming round trip's use of vehicles cannot be realized.

The future land traffic to/from the jetty is summarized below.

Containers are to be carried by container trailers. The number of trailers is calculated as follows;

20 foot container --- 110,000 units/ year (incl. Nepalese containers) means 300 trailers/day

40 foot container --- 66,000 units/year (incl. Nepalese containers) means 180 trailers/day

Conventional cargo (185 thousand tons) is also handled at the jetty. Assuming that the average tonnage of trucks will be the same as the current one, 7.30 tons/truck, the land traffic generated by this is calculated as 70 trucks/day as presented in Table 7.6.2.

Table 7.6.2 Land Traffic from Jetty

(Figures in trucks/day)

	'97/'98			2015				
	Trucks	Passenger Vehicles	Total	20 foot Trailers	40 foot Trailers	Trucks	Passenger Vehicles	Total
Jetty	120	60	180	600	360	140	550	1,650

7.6.3 Land Traffic from Cement Factories

The current loaded truck traffic from the two cement factories was assumed to be 50 trips/day in the previous chapter. The total production scale would be expanded into 1 million tons/year from the current scale of 390 thousand tons/year. Assuming the present distribution pattern persists, the future loaded truck traffic would be 130 trips/day, this generates 65 trips/day of the related vehicle traffic

The newly planned LPG factory has the scheme to distribute 24,000 bottles of LPG gas a day in the future. Because 50 bottles can be carried by a truck, the loaded truck traffic of 480 trips/day is generated by the LPG distribution depot. As a result, the total land traffic generated from the cement and LPG industry is summarized as presented in Table 7.6.3.

Table 7.6.3 Land Traffic Generated from Port-Related Industry

(Figures in trips/day)

Industry	1997/1998			2015		
	Trucks	Passenger Vehicles	Total	Trucks	Passenger Vehicles	Total
Cement Factories	100	50	150	260	130	390
LPG Depot	0	0	0	960	480	1,440

7.6.4 Land Traffic from the EPZ

It might be a difficult task to forecast traffic demand generated from the planned EPZ, since naturally the kind of industry in the EPZ cannot be specified at the moment. The traffic demand from the EPZ is roughly estimated by taking into account the actual example of the Chittagong EPZ. The Chittagong EPZ reportedly has an approximate traffic volume of 200 trucks and 1,300 passenger vehicle a day at the EPZ entrance. Because the future land scale of the Mongla EPZ is almost equivalent to that of the current EPZ at Chittagong, it is assumed that the Mongla EPZ will have almost the same traffic demand. Therefore, the traffic demand generated from the Mongla EPZ is projected as in Table 7.6.4.

Table 7.6.4 Traffic from the Mongla EPZ

(Figures in trips/day)

Mongla EPZ	1997/1998			2015		
	Trucks	Passenger Vehicles	Total	Trucks	Passenger Vehicles	Total
EPZ	0	0	0	200*	1,300	1,500

Note: Theoretically, most of this movement is between the EPZ and the jetty.

Finally, all the traffic generated from the port zone is summarized as in Table 7.6.5.

Table 7.6.5 Total Land Traffic Generated from the Port Area

(Figures in trips/day)

	97/98			2015				
	Trucks	Passenger Vehicles	Total	20 foot Trailers	40 foot Trailers	Trucks	Passenger Vehicles	Total
Jetty	120	60	180	600	360	140	550	1,650
Cement LPG	100	50	150	0	0	1,220	610	1,830
EPZ	0	0	0	0	0	(200)*	1,300	1,300
Total	220	110	330	600	360	1,360	2,460	4,780

Note: The figure of (200)* is not included in the total number because of the above stated reason.

7.7 Analysis of Tariff and Financial Status of Mongla Port

7.7.1 General

The tariff structure of ports for the future should be carefully studied, because ports are competing with one another with their service and charges which are shown in tariffs. This is especially the case with Mongla Port, because Mongla Port shall be competing domestically

and internationally, especially with Chittagong Port and Calcutta Port.
Since Mongla Port is far behind Chittagong Port and Calcutta Port in terms of handling volume of general cargo and so forth, and furthermore the physical port infrastructure including road system is not as good as those of the two ports, the tariff of the Mongla Port should not be higher than those of the two counterparts. Mongla Port will have to make every effort to attract more port cargo partly by advocating a reasonable tariff system.

Reciprocally the development scale of Mongla Port including its maintenance cost is to be restricted by the tariff setting which can be competitive in the region. Accordingly, when a new development is initiated, it should be kept in mind that the present tariff of Mongla Port, which seems to be slightly lower than that of Calcutta Port and almost as same as that of Chittagong Port, is to be maintained in the future.

7.7.2 Procedure of Analysis

It is proposed that a new container berth be constructed and another container berth be redeveloped in order to deal with the greatly increasing container demand. This project, including handling equipment etc., involves a certain amount of funds, which should be raised by the MPA.

As mentioned earlier, on the other hand, the tariff of the Mongla Port should not be raised in the future to go beyond those of the adjacent ports so as to attract port cargo. Therefore, it is not thought to be a good idea that the tariff is drastically raised so as to cover the funds necessary to implement new projects.

In this section the proposed project is evaluated from the financial view point, which does not mean the detailed financial analysis but the financial evaluation of the incremental costs and revenues concerning the projects, on the assumption that the tariff will remain in the same range. If the container terminal project is evaluated financially healthy at the current tariff level, it reciprocally means the tariff will not need to be raised in the future, at least for the project.

The analysis proceeds as follows.

--- First, the necessary cost for the projects is to be estimated in a very rough manner.
--- Secondly, the revenue from the project is to be estimated.
--- Finally, the financial internal rate of return for the project is to be calculated.

7.7.3 Cost Estimation of the Project

The project cost is roughly estimated to reach US$ 45 million in the current price. Without the data on the natural conditions etc. the unit prices of construction work, equipment and so on were evaluated referring to the results of the WB study as well as the examples of other developing countries.

The items covered in the process are as follows.

- --- civil works for construction of a new berth; wharf structure, etc.
- --- civil works for redeveloping a container berth; demolition of a transit shed, pavement, etc.
- --- container facilities; container storage yard, CFS, etc.
- --- handling equipment; straddle carriers, trailers, forklifts, etc.
- --- additional annual maintenance dredging in front of the new berths
- --- annual operation expenditure
- --- annual maintenance cost for facilities and equipment

It is presumed for the calculation that measures for efficiency improvement on the existing container terminal will be taken through 2000, redevelopment work of J8 will be carried out in 2005, and a new berth will be constructed from 2008 through 2010, corresponding to the demand forecast.

7.7.4 Revenue from the Project and Internal Rate of Return

Holding the tariff at the same level as at present, it is estimated that the revenue for the MPA raised from handling a container box, which is the compound average of a 20 foot and a 40 foot box, is to be approximately $US 60, including port dues, berth occupancy charge, etc. The total revenue from the incremental portion of container handling, which is related to containers handled at the additional two berths, will reach around $US 8 million in 2015 beginning from 2006, when the newly redeveloped J8 is in operation.

Putting together every year's cost and revenue above mentioned, the financial internal rate of return for the proposed project is calculated as 6.8%. This value is considered to be high enough because generally in Bangladesh a large portion of the implementation cost is prone to be introduced from foreign countries with a very low interest rate, for example 1.0% for OECF.

It can be concluded, therefore, the container project will be feasible at least in financial terms, though the detailed study would be required for the actual project implementation.

7.7.5 Future Tariff of Mongla Port

As far as the container project is concerned, it is not necessary to raise the tariff in the future, based on the above financial study.

It is concluded that Mongla Port is able to handle the forecast cargo in 2015 of more than 6 million tons without financial difficulties, in other words, it does not need to raise its tariff and can attract enough port cargo competing with the adjacent seaports.

7.8 Future Studies for Water Transport Facilities

7.8.1 Multi-Modal Terminal at Khulna Port

The future cargo demand for Khulna Port is expected to greatly increase, especially between Mongla Port. According to the current OD statistics of Mongla Port, inland water cargo of more than a half million tons is transported between Khulna Port and Mongla Port. The aforementioned demand forecast for Mongla Port shows that inland water cargo to/from Mongla Port would increase from 2.7 million tons to approximately 4 million tons in total, even taking into account the shift of cargo handling system from "at the river" to "at the jetty" to some extent. Khulna Port should be prepared for the foreseeable demand increase not only of ordinary river traffic but also the one generated by Mongla Port.

Being situated at a potentially advantageous location adjacent to the railway station, the cargo terminal of the current BIWTA is not directly accessible to the Khulna station, and only has a limited space. If a multi-modal terminal, where cargo of different transport modes is handled together in a systematic way, is developed as an expansion of the existing terminal, the capacity of Khulna Port will be greatly increased and port cargo will be transported efficiently and economically. As a result, it will be much easier to attract the Nepalese bulk cargo such as fertilizer through saving cost and time of transportation.

In order to realize a new multi-modal terminal at Khulna Port, first of all a study on a new multi-modal terminal is needed to be carried out. The content of the study is as follows;

1) demand forecast for Khulna Port
2) demand forecast for land traffic (truck and railway)
3) functional allotment the other ports such as Nawapara
4) layout plan of a new terminal
5) handling system of a new terminal
6) required handling equipment
7) cost estimate

8) examination of project feasibility

7.8.2 Formulation of Master Plan on Inland Water Transport

Nearly 10 years have passed since the current master plan for inland water transport system in Bangladesh was formulated in 1989. Though a new planning study, which is rather an institutional issues oriented one, is now being formulated by the DANIDA, no master plans including a physical plan of actual facilities have not been prepared yet. Since the circumstances around the nation have greatly changed, an updated master plan is definetly needed for the future increasing demand.

The following is the outline of a required study for a new master plan.

1) evaluation of the current inland water transport system
2) evaluation of the existing facilities
3) demand forecast for inland water transport
4) requirement of future river port facilities
5) case studies for the major 11 river ports
6) introduction of a new development strategy
7) examination of a new administration system
8) evaluation from the financial viewpoint
9) identification of new projects
10) establishment of a new policy

CHAPTER 8

TRAFFIC DEMAND FORECAST

CHAPTER 8 TRAFFIC DEMAND FORECAST

8.1 Methodology

Traffic demand forecasts in this Study were made through the following process:

(1) Making present origin and destination (OD) tables
Construction of OD tables by organizing traffic survey data introduced in Chapter 4 by vehicle type.

(2) Future traffic demand
Existing literature is reviewed concerning estimates for future total transport demand (the 'Control Total').

(3) Modal share analysis for different transport modes
Existing literature is reviewed in the analysis of the modal share in the future for each mode of transport (road, rail, and inland waterway).

(4) Future traffic volume by zone
Total transport demand as well as socioeconomic indicators for the various zones are reviewed in the investigation of future traffic volume by zone.

(5) Traffic patterns analysis at the Rupsa Ferry Ghat
Latent demand for the Rupsa Ferry is indicated by much shuttle service to the Rupsa Ferry ghat. It is predicted that flow pattern will greatly change in the future with the construction of a bridge nearby. Estimates are made for potential user demand arising from the bridge construction.

(6) Vehicular traffic volumes arising from Mongla Port freight handling
Distribution procedures are established for future vehicular traffic volumes arising from handling of freight at Mongla Port.

(7) Future OD table forecasting
Based on the above results, future OD tables are estimated for each vehicle type.

(8) Traffic assignment
Forecasted future OD traffic volumes are assigned upon the future road network as established.

(9) Forecasting of bridge traffic volumes
Based on the assignment results, bridge traffic volumes are forecasted.

8.2 Zoning

Zones are delimited for traffic forecasting based on the smallest administrative areas for which socioeconomic indicators were available as well as the accuracy of OD survey from the manner of survey execution and the survey locations.

In the center of Khulna and Mongla areas as the study areas, zoning is done. Khulna city area was split into four zones, and Khulna and Bagerhat zilas were divided in accordance with the thana boundaries, whereas other districts were combined into zilas appropriate to the direction of the future trunk road. Zoning results are shown in Fig. 8.2.1.

8.3 Present (1998) OD tables

8.3.1 Estimation of Present (1998) OD Table

The existing transport demand within the related area should be clarified for grasping the present traffic condition and forecasting the future traffic demand of the traffic volume crossing the Rupsa River. The Present 1998 OD tables by vehicles type were made based on the result of roadside interview survey (Refer to Fig. 8.3.1). As results of the survey, the study team have got the information of the inter-city traffic pattern, the crossing river traffic pattern (by Rupsa Ferry) and the traffic pattern at the Rupsa Ghat, and created the Present OD tables.

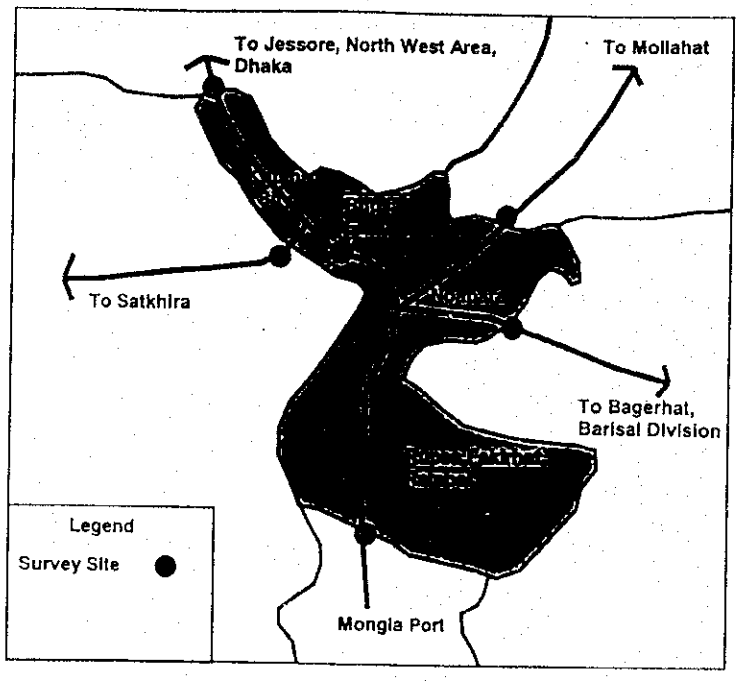


Fig. 8.3.1 Location of Survey Sites

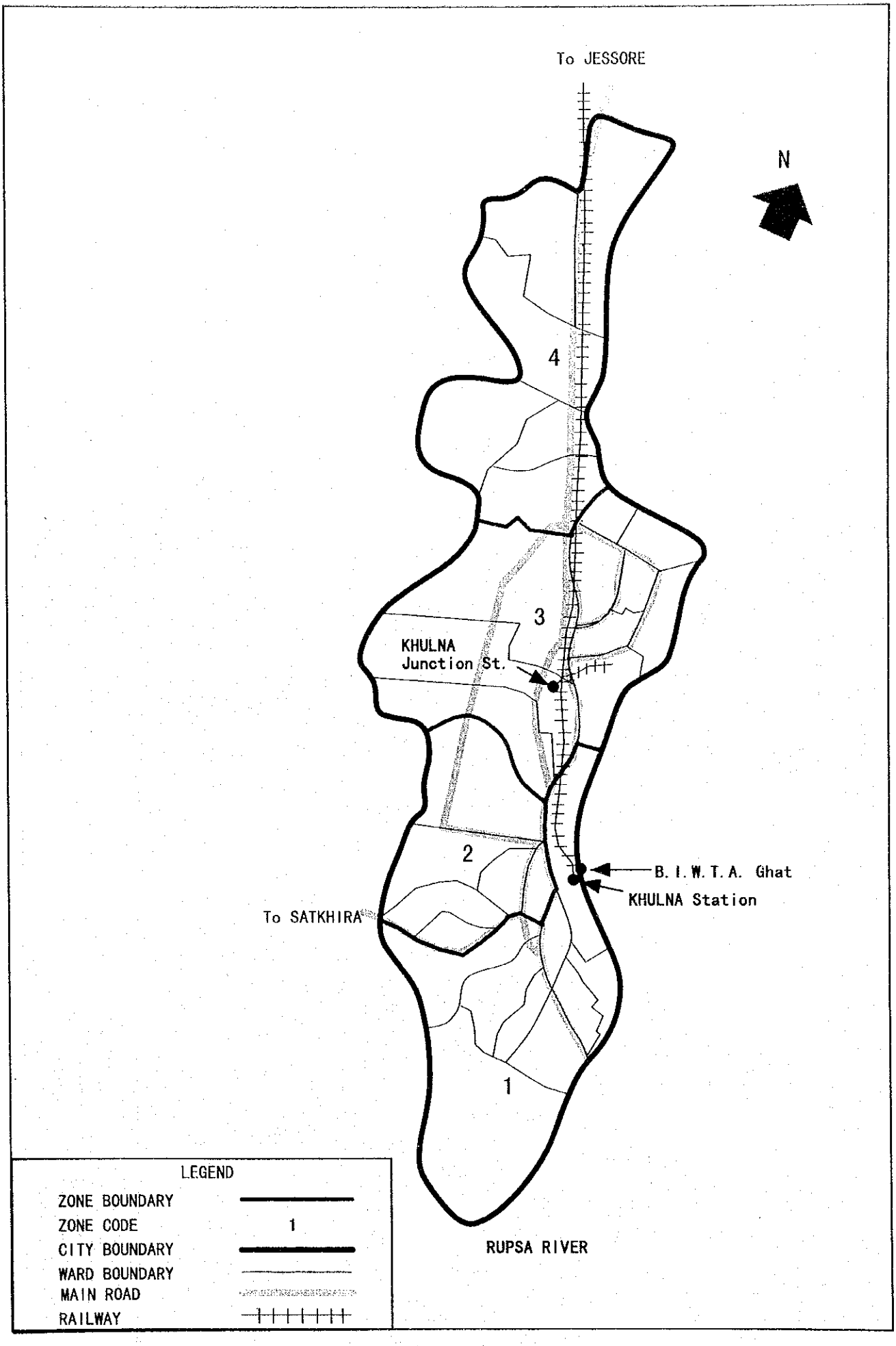
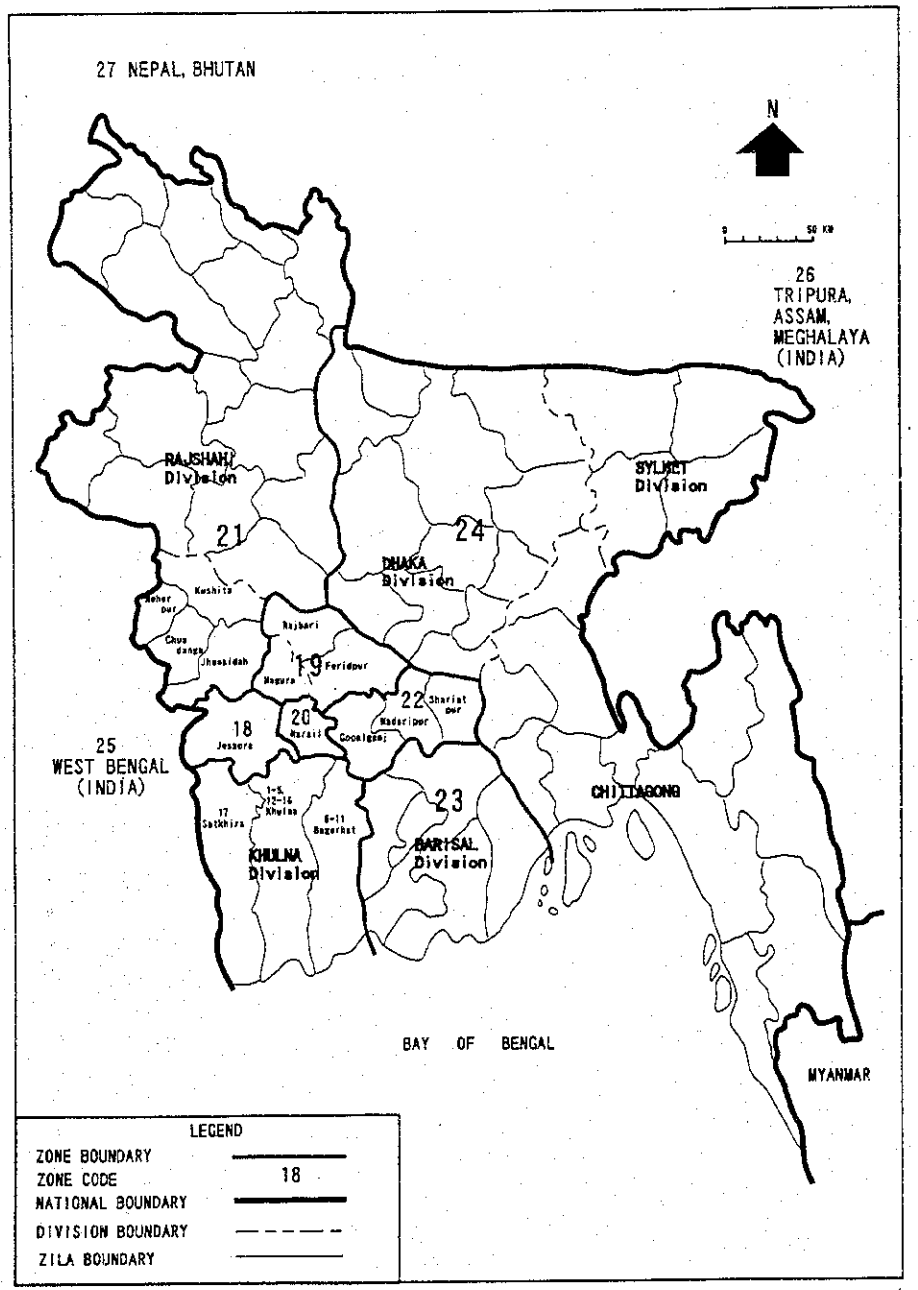


Fig. 8.2.1(1) Zoning



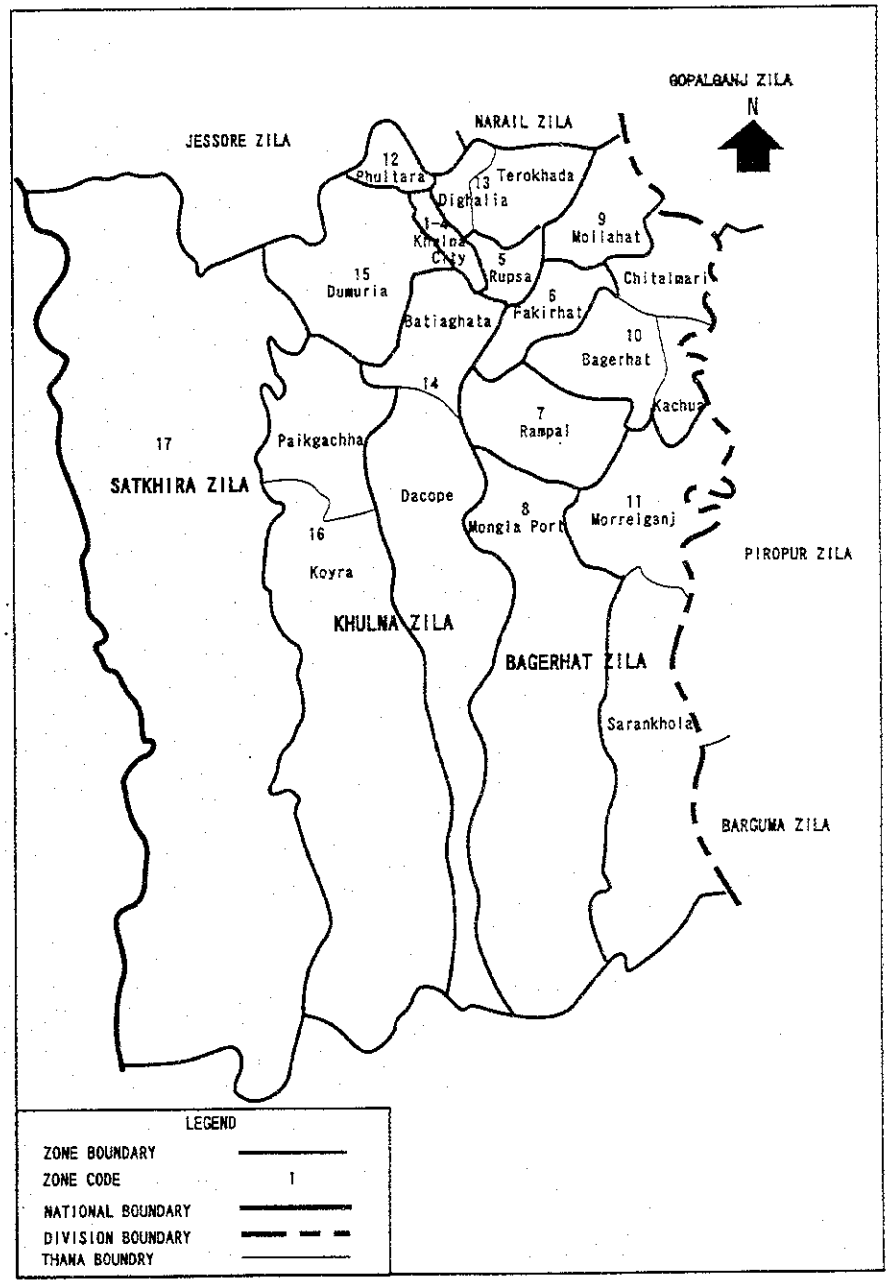


Fig. 8.2.1(2) Zoning

The general flow of the 1998 year OD tables (1998 OD) estimation is shown in Fig. 8.3.2. The overall tasks can be divided into 3 steps.

a. OD matrices of traffic crossing the Rupsa river
   The OD matrices of traffic crossing the Rupsa river are created from the results of roadside interview survey at Rupsa Ghat.
b. Adjustment of the inter-city traffic
   The OD matrices of inter-city traffic are adjusted by the results of roadside interview survey at inter-city roads.
c. Adjustment of the traffic related the Rupsa Ghat
   The OD matrices of traffic related the Rupsa Ghat are adjusted by the results of roadside interview survey at Rupsa Ghat.

The results of reality check on the 6 inter-city road and Rupsa Ferry is reasonable, because difference in traffic volume between results of traffic count survey and of assignment by all types of vehicles are less than or equal 5%. The difference by vehicle types are within 30%, most of them are less than 10%. (refer Table F-8.3.1 in Appendix F).

1998 year OD tables and desired lines are shown by 7 aggregated zones in Table F-8.3.2 – and F-8.3.3 and Figs. F-8.3.1 – 8.3.6 in Appendix F, Table 8.3.1 shows the codes of the aggregated zones. Large traffic flows are observed between Khulnra city - Jessore and Khulna city - Satkhira, directions.

Table 8.3.1 Aggregated Zone Code

Aggregated Zone	Analysis Zone Code
Khulna City	1, 2, 3, 4
Rupsa, Fakirhat, Rampal	5, 6, 7
Jessore, Northwest Area,	12, 13, 18, 19, 20, 21, 24,25,26,27
Satkhira etc.	14, 15, 16, 17
Mongla port	8
Bagerhat, Barisal Division etc.	10, 11, 23
Mollahat etc.	9, 22

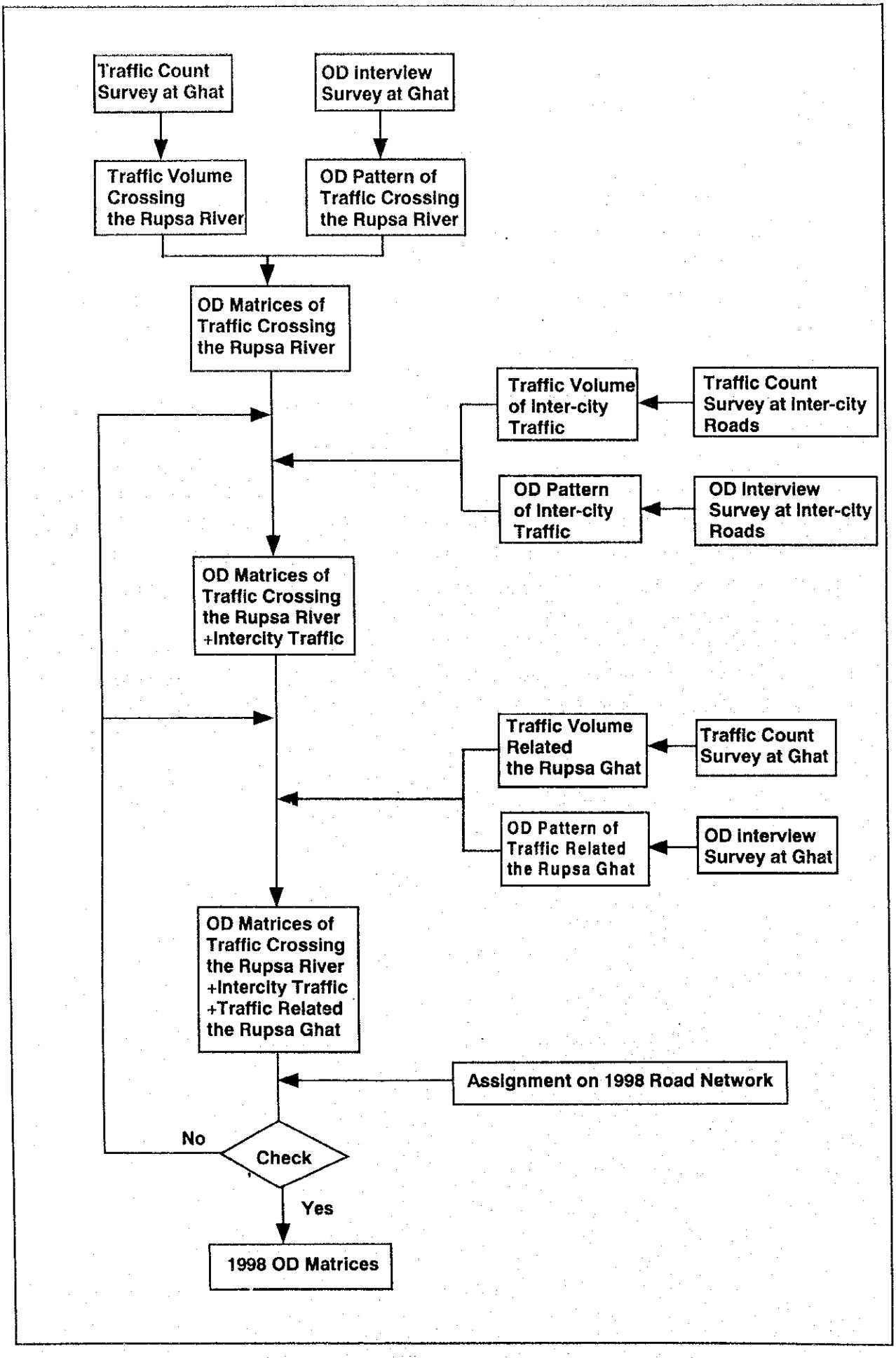


Fig. 8.3.2 General Flow of 1998 OD Matrices Estimation

8.3.2 Present Conditions

(1) OD pattern at Rupsa ferry

OD distribution pattern of the traffic crossing the Rupsa river by Rupsa ferry is shown in Fig. 8.3.3. Large traffic flows are observed between Khulna city and eastside area of the Rupsa river. It seems that the main traffic is related to Khulna city and not long distance trip as between eastside of the Rupsa River area and North West Area etc.

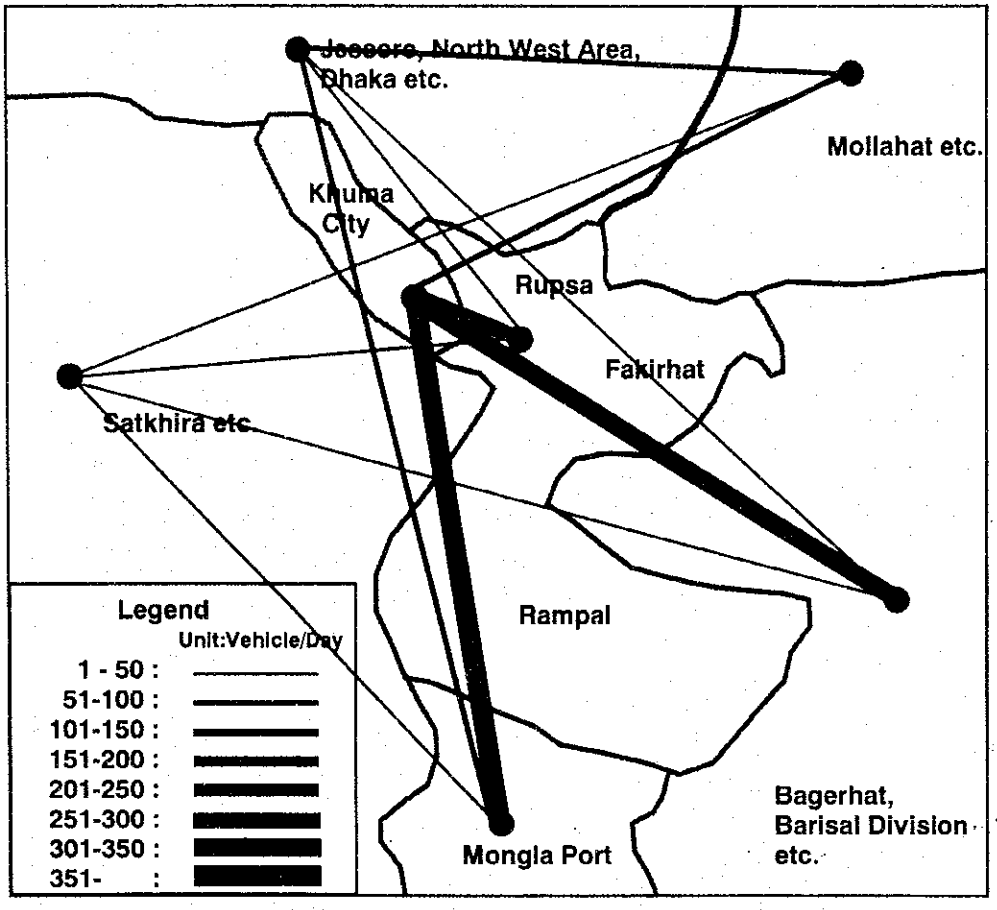


Fig. 8.3.3 OD Pattern of Traffic Crossing the Rupsa River by Rupsa Ferry (All Type Vehicles) in 1998

(2) Traffic movement at Rupsa Ghat

There is phenomenon that many auto rickshaws and buses are waiting at Rupsa Ghat for getting passengers. It seems that a main reason is shortage of the ferry capacity. In the present condition of the ferry, there are terrible traffic congestion for getting on the ferry. Then many passenger choice the way to get off the auto rickshaw/bus at ghat, to get on the ferry and again to get on auto rickshaw/bus at other side of the ghat. The results of assignment express the phenomenon as shown Fig. 8.3.4 and Fig. 8.3.5.

Accordingly, these turn trips at Khulna side ghat are auto rickshaw 1888 trips and bus 119 trips, at Rupsa side ghat are auto rickshaw 802 trips and bus 560 trips. The trips at Khulna side ghat are mainly short distance trips as intra-city trips by auto rickshaw. On the other hand, the trips at Rupsa side ghat composed of less short trips and more longer trips.

(3) Truck Traffic Volume Related Benapole

Benapole is an international gate between Bangladesh and India. International commodities are unloaded off and loaded on the Bangladesh trucks there and are delivered to destination. These truck traffic flow is shown in Table 8.3.2. More than 66% of the traffic flow is to Khulna Division. Traffic between Benapole and Jessore Zila accounts for 43.6%.

Table 8.3.2 Truck Traffic Flow from/to Benapole

Area	Vehicle/day	
Khulna Zila	134	15.1%
Satkhira Zila	11	1.2%
Jessore Zila	387	43.6%
MaglaZila	27	3.0%
North area of Khulna Division	24	2.7%
Dhaka Division	186	20.9%
Rajshahi Division	89	10.0%
Sylhet Division	11	1.2%
Chittagong Division	19	2.1%
Total	888	100.0%

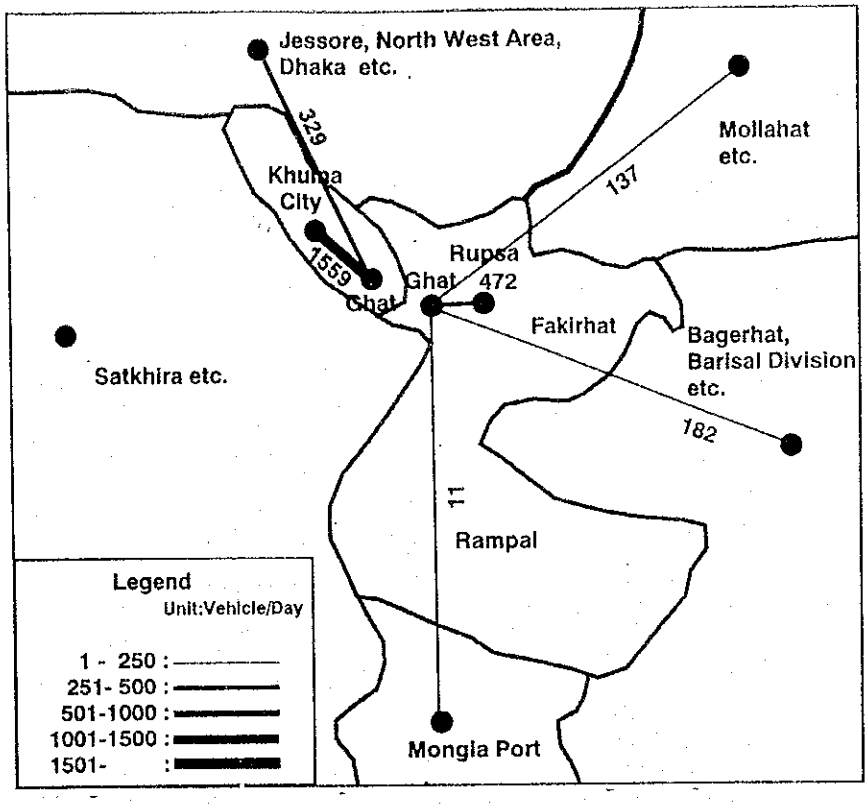


Fig. 8.3.4 Auto Rickshaw Traffic Flow in 1998
(origin or destination at Rupsa Ghat and not crossing the Rupsa River)

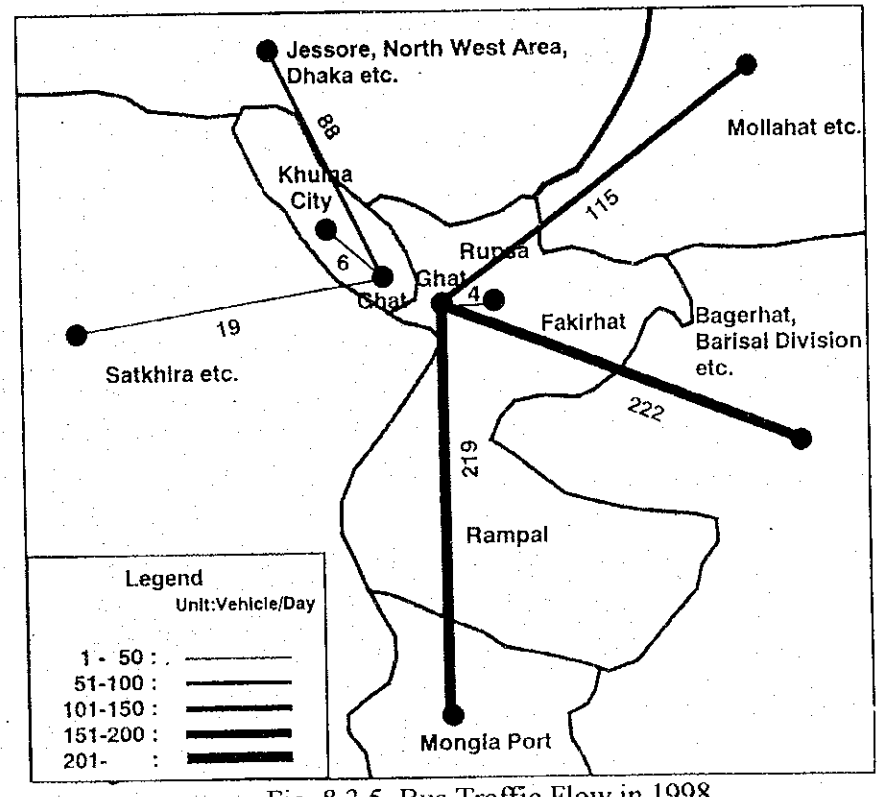


Fig. 8.3.5 Bus Traffic Flow in 1998
(origin or destination at Rupsa Ghat and not crossing the Rupsa River)

8.4 Future OD Tables

8.4.1 Control Total

In general, traffic demand increases with GDP and population growth, as domestic and international trade in agriculture and industry prosper. Bangladesh is enjoying a growth rate in passenger and freight transport exceeding the rate of GDP growth.

Forecasts on national transport demand as published in the "Bangladesh Integrated Transport System Study" (BITSS) by the Planning Committee of the Government of Bangladesh are arranged in the following Table 8.4.1

Table 8.4.1 Future National Transport Demand

Year	Passenger (billion passenger-Km)	Freight (billion ton-Km)
1974/75	17	2.6
1984/85	35	4.8
1988/89	57	6.3
1992/93	66	9.0
1996/97	72	10.2
1997/98	77	10.9
1999/2000	89	13
2004/2005	116	17
2009/2010	150	23
2014/2015	196	30

Note : 1) Values for passenger-Km and ton-Km in 1997/98 are estimated by the Study Team.
Source : BITSS

These forecasts are based on the following premises: an annual growth in GDP of 4-5%, and an annual rate of increase of passenger and freight transport demand of 6.0-7.5% given a transport elasticity value of 1.5. In fact, growth in demand from 1992/93 to 1996/97 stayed beneath 3%; nonetheless, the completion of the Jamuna Multipurpose Bridge (JMB) and the Dhaka Eastern Bypass is expected to bring a marked increase in transport demand. A more realistic demand growth rate would probably be 3.0-7.5%. Accordingly, rates of increase in passenger and freight transport demand are taken at 5.5% and 6.5% respectively.

This study applies the forecast results for total traffic demand (control total) derived within the national transport plan constructed by BITSS as priority planning figures. Accordingly, this study applies future increases between 1998 and 2015 of 2.54 times for passenger demand, and 2.75 for freight demand.

8.4.2 Modal Share Analysis for Different Transport Modes

As indicated above, the passenger and freight transport demand has been increasing in Bangladesh, but this increase is not evenly shared over the various modes of transport. Table 8.4.2 reveals that until recently the greatest increase had been in road transport but in the 1996/97 rail and inland waterway transport had slightly better growth.

In 1974/75 passenger transport by road occupied the largest fraction of national passenger transport at 54%, but by 1996/7 this had grown to 73%. In the same period freight transport by road has grown from 35% to 63%. It appears that rail and water sectors have been continuously losing its passenger share since 1974/75. From 30% and 16% respectively the rail and water sector's share in 1974/75 dropped down to 13% and 14% in 1996/97. Although water sector's share of freight traffic has marginally dropped from 37% in 1974/75 to 30% in 1996/97, the share of rail transport has declined more sharply from 28% in 1974/75 to 7% in 1996/97. Thus the faster expansion of the national road network as well as the increase in the vehicle ownership led to such an overwhelmingly major share for the road transport of the country.

Based on the trend of transport demand mentioned above, the future modal share has been forecasted in the BITSS as shown in Table 8.4.2. and Fig. F-8.4.1 in Appendix F.

As regards passenger transport demand, the share of road transport indicates an upward trend from 73% in 1996/97 to 82% in 2014/15, while the rail and waterway shares show some decreasing trend during the same period. In the case of freight transport, the share of road transport shows some increasing trend from 63% to 72% while the share of waterway transport may decline to 11% from 30%. The share of rail transport is forecasted a marginal increase, due to alignment of rail on the Jamuna Multipurpose Bridge (JMB) and establishment of rail link between Joydebpur and the bridge site.

Increase in road transport of passengers and freight will be guaranteed by the shared use of the JMB, the building of the Dhaka Eastern Bypass and the construction of road bridges at Paksey and Rupsa.

Table 8.4.2 Transport Demand and Modal Shares

Year	Passenger					Freight				
		Modal Distribution					Modal Distribution			
	Passenger-Km (billion)	Road (%)	Rail (%)	Watert (%)	Total (%)	Ton-Km (billion)	Road (%)	Rail (%)	Watert (%)	Tota' (%)
1974/75	17	54	30	16	100	2.6	35	28	37	100
1984/85	35	65	20	16	100	4.8	48	17	35	100
1988/89	57	68	17	15	100	6.3	59	11	30	100
1992/93	66	75	12	13	100	9.0	61	7	32	100
1996/97	72	73	13	14	100	10.2	63	7	30	100
1997/98	77(1.00)	-	-	-	100	11(1.00)	-	-	-	100
1999/2000	89(1.15)	76	10	13	100	13(1.19)	65	10	25	100
2004/2005	116(1.50)	79	10	11	100	17(1.56)	68	11	21	100
2009/2010	150(1.94)	80	10	10	100	23(2.11)	70	11	19	100
2014/2015	196(2.54)	82	10	8	100	30(2.75)	72	11	17	100

Note : 1) Data relate to Mechanized transport only and data relating to raod transport referes to Bus, Truck, Car and other four wheelers.

2) Values for passenger-Km and ton-Km in 1997/98 are estimated by the Study Tewam.

Source : BITSS

Based on the BITSS forecasts, road transport of freight and passengers between 1998 and 2015 is expected to increase by factors of 2.81 and 3.14, respectively, mirrored by a proportional increase in passenger and freight vehicles. In this light, the factor of 2.71 for increase in passenger vehicles (motorcycles, autorickshaws, cars and buses) can be considered to be reasonable.

8.4.3 Future Traffic Volumes by Zone

Forecasting of future traffic volumes in the various zones is carried out using future passenger and freight total demand (control total) figures as well as socioeconomic indicators by zone.

Indicators used in this Study include zonal population for forecasting passenger traffic volumes by zone, and freight traffic demand done forecast by BITSS on the Zila.

8.4.4 Traffic Patterns Analysis at the Rupsa Ferry Ghat

As indicated, the Rupsa Ferry is normally congested; in particular, the autorickshaws and busses which bear the burden of so much of public transport avoid boarding the ferry for reasons of efficiency. Instead, passengers are let off at the ghat, cross by ferry, and then board autorickshaws or busses once again to take them to their destinations. This situation is expected to be much ameliorated by the construction of the bridge across the Rupsa River.

The latent traffic demand for Rupsa River crossing that will arise upon the construction of the bridge can be forecasted on the basis of Origin-Destination studies of the existing situation.

Table 8.4.3 Latent Traffic Demand for Rupsa River Crossing

	Khulna from Rupsa		Rupsa from Khulna	
	1998	2015	1998	2015
Aoutorickshaw	455	1,373	352	1,062
Bus	296	847	260	745

Source: Study Team

8.4.5 Vehicular Traffic Volumes Arising from Mongla Port Freight Handling

2,125,000 ton cargo handled at me jetty 8 Mongla Port in 2015 are applied in the forecasting of vehicular traffic volumes arising from the harbour freight handling. Moreover, the vehicular traffic volumes in the case of the railway extension from Khulna to Mongla Port are examined here. In this case, it is forecasted that a part of long-distance freight transport demand (for example, freight transport demand to Nepal) would be mainly diverted to rail transport.

8.4.6 Future OD Table Forecasting

Based on the information presented above, the procedure for the construction of OD tables describing future traffic conditions is as follows:

1. Future OD projections are mainly constructed following the Present Pattern procedure.
2. OD traffic volume estimates prepared by the Present Pattern Methods should be adjusted for future traffic flow patterns forecast for the Rupsa Ferry ghat area.
3. Further, existing OD tables on vehicular traffic arising from the handling of freight at Mongla Port can be adjusted by the projected increase in freight handled at this port. Furthermore, in the case with railway extension, adjustment to the OD tables will be necessary.

   An OD table constructed by this method is presented in Table F-8.4.1 in Appendix F.

8.5 Projection of Future Traffic Volume

Traffic assignment simulation is carried out using the software STRADA (System for Traffic Demand Analysis), supplied by JICA.

8.5.1 Conditions for Traffic Assignment

Elements used in the traffic assignment simulation are briefly discussed below:

(1) Road network

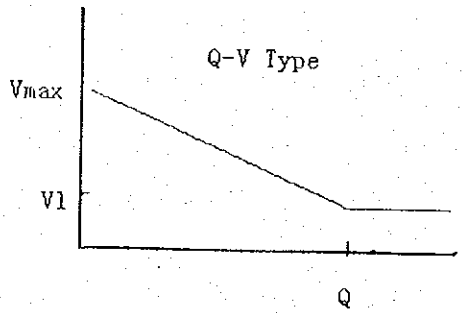
The road network used consists of the national highways, feeder roads (including urban roads), along with roads whose future construction is certain. Two candidate routes for the Khulna Bypass, Alignment A and B, as well as their access links are also added to the network. Additionally, RHD information on plans for a wide area trunk road was incorporated. The resultant future road network is as shown in Fig. 8.5.1.

(2) Link specifications

The length and lane number for each link is specified using RHD road inventory data, and data from the road repair program as well as road construction plans for the City of Khulna, available with the KDA. Moreover, for each link the traffic variables of capacity (Q) and speed (V) are arranged in a Q-V table, as shown in Table 8.5.1.

Table 8.5.1 Q-V Table

No.	Capacity (pcu)	Max. Velosity (Km/h)	No. of Lanes	Remarks
1	22,200	60	2	National Low Type, Regional High Type, Intercity Road
2	16,400	60	2	Regional Low Type, Intercity Road
3	12,900	60	2	Other Intercity Road
4	7,800	40	2	Urban Road



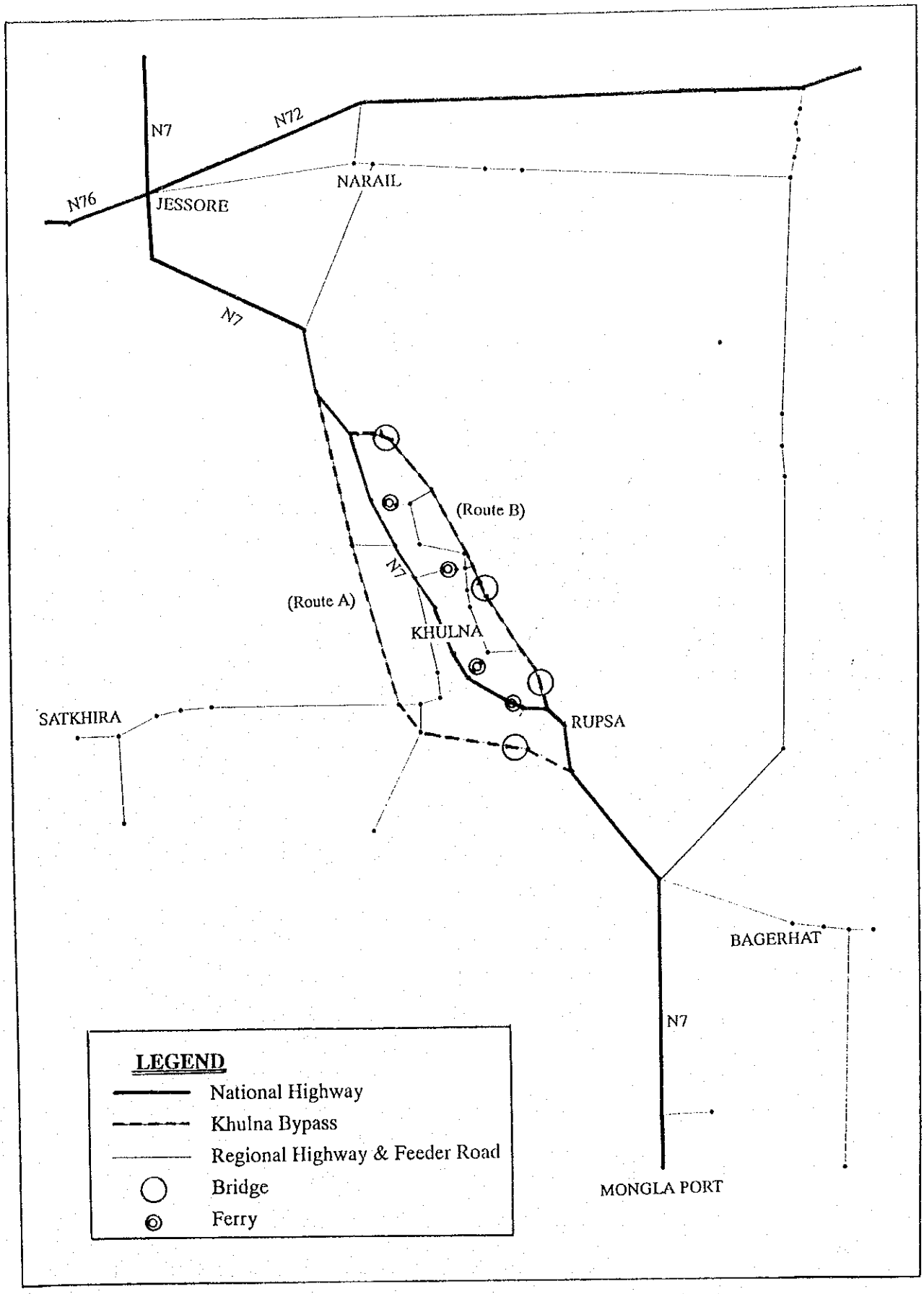


Fig. 8.5.1 Road Network

(3) Traffic assignment method

Traffic assignment is conducted using the Equilibrium Assignment Method (EAM) available in the JICA STRADA program.
The equilibrium assignment is based on the total system optimization and loads the OD trips to the network so as to minimize the total travel time in the network.

(4) Traffic assignment cases

Traffic assignments are executed using forecast future OD tables and the road network as described. The resulting six cases are shown in the Table 8.5.2.

Table 8.5.2 Traffic Assignment Cases

Network (Bypass route)	Future OD	
	without Railway Extension	with Railway Extension
Route A(without Rupsa Ferry)	CASE 1	CASE 2
Route B(with Rupsa Ferry)		
With KDA Bypass	CASE 3	CASE 4
Without KDA Bypass	CASE 5	CASE 6

8.5.2 Results of Traffic Assignment

Results of traffic assignment are shown in Fig. F-8.5.2 in Appendix F. Table 8.5.3 shows evaluation indices (e.g., total vehicle Km and vehicle hours) from the assignment results.

Table 8.5.3 Total Vehicle Km's and Vehicle Hours

	Total Vehicle Kms (x 1000 pcu-Km/day)	Total Vehicle Hours (x 1000 pcu-hour/day)
CASE 1	3,278.7	87.6
CASE 2	3,032.1	79.5
CASE 3	3,549.6	100.3
CASE 4	3,345.3	92.6
CASE 5	3,506.9	125.8
CASE 6	3,263.5	117.7

From above table, the total vehicle Km's and vehicle hours in the case of traffic assignment on the network including Khulna Bypass route A are less than that in other cases. That is, the

efficiency of the road network that includes candidate Alignment A is better than that includes Alignment B.

8.5.3 Forecasting of Bridge Traffic Volumes

Based on the assignment results by case, traffic volumes crossing the bridge over the Rupsa river are analyzed, and the results are shown in Table 8.5.4.

Table 8.5.4 Traffic Volumes Crossing Bridge over Rupsa River

	Present (Ferry) (vehicles/pcu)	CASE 1 (vehicles/pcu)	CASE 2 (vehicles/pcu)	CASE 3 (vehicles/pcu)	CASE 4 (vehicles/pcu)	CASE 5 (vehicles/pcu)	CASE 6 (vehicles/pcu)
Motorcycle	381/114	1117/335	1120/336	967/290	1003/301	977/293	977/293
Autorickshaw	30/30	2536/2536	2536/2536	2279/2279	2350/2350	2292/2292	2294/2294
Car	232/232	1120/1120	1120/1120	1012/1012	1041/1041	1012/1012	1013/1013
Bus	211/528	3465/8663	3512/8779	2902/7255	3037/7592	2944/7360	2978/7445
Truck	409/818	2915/5829	2556/5112	2637/5274	2337/4673	2636/5271	2273/4546
Total	1263/1722	11153/18483	10844/17883	9797/16110	9768/15957	9861/16228	9535/15591
Average Trip Length (Km)	-	53.5	53.3	68.5	69.5	68.9	68.6

Traffic demand on the Bridge is forecasted 11,150 vehicles/day in Case-1 (Route A and without Railway Extension) and 9,800 vehicles/day in Case-3 (Route B and without Railway Extension), while average trip length is 53.5 km in Case-1 and 68.5 km in Case-3, that is 28% increase. It is obvious that Route B forces vehicles to make detour and meets traffic demand in lesser degree.