8.3 Container Throughput at Seaports in Bangladesh in 1995 and 2005.

8.3.1 Method of Forecast

The steps involved in carrying out the forecast for container cargo throughput at sea Ports are:

a) Estimating the volume of containerizable cargo for the planning paired by macro-economic forecasting and micro-economic forecasting.

b) Estimating the trend of the ratio of containerization over the planning period by applying a logistic curve.

c) Estimating the container cargo throughput for the planning period at seaports by multiplying a) by b).

d) Estimating the container throughout for TEUS and container boxes for the planning period at seaports.

e) Estimating the ratio of CL and LCL for the planning period at seaports.

Macro - economic forecasting is a method of estimating cargo volume as a whole based on the correlation between the cargo volume and major economic indices.

Micro - economic forecasting is a method of estimating the cargo volume of each main commodity group individually. The total sea trade cargo of Bangladesh is calculated by summing up these cargo volumes.

The term "the ratio of containerization" means the ratio defined by (volume of container cargo)/(volume of containerizable cargo), and it is well known in advanced container ports that the chronological change of this ratio nicely fits a logistic curve, if the parameters are chosen properly.

The number of TEUs for laden containers is estimated by dividing the total volume of container cargo throughput at seaports by the average net tonnage per TEU.

The average net tonnage per TEU is calculated using the past record of seaports in Bangladesh.

The steps involved in forecasting the number of TEUs for empty containers are as follows:

a) Estimating the ratio of the number of TEUs for empty containers to the number of TEUs for laden containers by using the past records of seaports in Bangladesh.

b) Estimating the empty container throughput at seaports in Bangladesh by multiplying the number of TEUs for laden containers by a).

The number of container boxes for cargo handling is estimated using the ratio of the number of 20 - foot container boxes to the total number of container boxes.

The ratio of the number of 20 - foot container boxes to the total number of container boxes is calculated by the past records of container throughput at Chittagong Port.

The ratio of CL and LCL is estimated by the ratio of CL and LCL in the result of O/D survey for containers in Bangladesh and the result of interviews at the Chittagong Port Authority.

8.3.2 Container Throughput at Seaports in 1995 and 2005

(1) Containerizable Cargo

1) Macro - Economic Forecast

The volume of containerization cargo for export and import in Bangladesh for the planning period is forecast using the correlation equation between the past record of the total amount of containerizable cargo, which was defined in Chapter 3 and the GDP (Refer to Tables 3.13 and 1.5).

The correlation equations for exports and imports are as follows:

Exports: $Y=1.3234x+169,066.03177$ ($r \doteqdot 0.88$)

Where x:GDP (Million TK),(Refer to Table 8.4).

Y:Volume of exported containerizable cargo (Million TK)

r:Correlation coefficient

Imports: $Y=6.5485x-1,566,405$ ($r \doteqdot 0.92$)

Where x:GDP (Million TK),

Y:Volume of imported containerizable cargo (Metric ton)

r:Correlation coefficient

The results of these calculations are shown in Table 8.5.

Table 8.5 Estimated Volume of Containerizable Cargo in Future by Macro-Economic Method

(Unit:Thousand M.tons)

Year	1987	1995	2000	2005
Export	713	928	1,083	1,270
Import	1,158	2,187	2,956	3,883

2) Micro - economic Forecast

The main commodity groups for export and import decided based on the commodities listed in past records are as follows:

Exports: Fish and Crustaceans, Meat, Bran, Tea, other foods, Jute products, Textile, Bone and bone meal and others.

Imports: Vegetable, Fruit and nuts, Milk and cream, other foods, Textiles, Rubber, Paper, Chemical, Machinery and others.

(a) Exports

a) Fish and Crustaceans

The export volume of fish and crustaceans is forecast by time series analysis.

The equation of the estimate for export volume of fish and crustaceans is as follows:

$$Y=1.214x-2,394.566 \quad (r \doteqdot 0.74)$$

Where x: year

Y: Export volume (thousand tons)

r: Correlation coefficient

The results of the estimates for 1995, 2000 and 2005 are shown in Table 8.6.

Table 8.6 Estimate of Exported Fish & Crustaceans in Future

(Unit: '000 tons)

Year	Actual	Estimate
1979	6.4	-
1980	7.3	-
1981	0	-
1982	13.1	-
1983	12.6	-
1984	14.6	-
1985	16.7	-
1986	13.4	-
1987	20.7	-
1995	-	27.9
2000	-	34.0
2005	-	40.1

Source of actual quantities: Statistical Yearbook of Bangladesh

According to Table 8.6, the volume of the production of fish and crustaceans in the rivers of Bangladesh is bigger than marine production, but the latter sector's growth rate is higher.

The volume of exports is less than ten percent of production.

Any growth in exports of fish and crustaceans in future will be as a result of growth in the marine sector.

b) Tea and Meat

The growth in exports of tea and meats in the planning period of this project is estimated based on the average growth rates of the export volume of tea and meat in the world.

The growth of tea exports in Bangladesh is decreasing slightly year by year.

For meat, the growth of exports is not stable. But the government of Bangladesh is strongly promoting food production.

Therefore, in this study, the average growth rate of exports of meat and tea are assumed to be the same as those for meat exports and tea imports internationally.

The average growth of world meat exports form 1975 to 1985 was about 4.92 percent per year and the average growth of world tea imports from 1981 to 1985 was about 3.46 percent per year.

Table 8.7 shows the export volume (expressed as the number of animals) of meat in the world from 1975 to 1985 and the export volume of meat in Bangladesh from 1984 to 2005.

The export volume of tea for the planning period is shown in Table 8.8.

Table 8.7 Estimate of Exported Volume of Meat in Future

Year	Export in the world ('000 no.)	Export in Bangladesh Actual ('000tons)	Estimate ('000tons)
1975	5,547	-	-
1976	6,264	-	-
1977	6,811	-	-
1978	7,170	-	-
1979	7,829	-	-
1980	8,094	-	-
1981	8,860	-	-
1982	8,583	-	-
1983	8,944	2.5	-
1984	8,793	1.6	-
1985	8,966	2.9	-
1986	-	2.3	-
1987	-	4.5	-
1995	-	-	6.6
2000	-	-	8.4
2005	-	-	10.7

Source of actual quantities:Statistical *Yearbook of Bangladesh* and *Report of Agriculture in the World.*

Table 8.8 Estimate of Exported Tea in Future

(Unit:'000 tons)

Year	Import in the world	Export in Bangladesh	
		Actua	Estimate
1981	884		-
1982	891	31.6	-
1983	914	31.1	-
1984	1,035	25.2	-
1985	1,013	24.6	-
1986	-	13.2	-
1987	-	23.0	-
1995	-	-	30.2
2000	-	-	35.8
2005	-	-	42.5

Source of actual quantities:Statistical Yearbook of Bangladesh

c) Bran

The export volume of Bran in Bangladesh reached a summit in 1984. After that, the export volume of bran leveled off or decreased slightly.

The volume of export bran in Bangladesh is assumed not to increase in planning period.

The export volume of bran in Bangladesh for the planning period is calculated by the average of the export volume in Bangladesh from 1979 to 1985. (Refer to Table 8.9)

The result of the calculation is shown in Table 8.9.

Table 8.9 Estimate of Exported Volume of Bran in Future

(Unit:'000 tons)

Year	Actual	Estimate
1979	10.6	-
1980	12.4	-
1981	0.0	-
1982	13.3	-
1983	32.7	-
1984	24.4	-
1985	1.0	-
1986	0.0	-
1987	0.0	-
1995	-	15.7
2000	-	15.7
2005	-	15.7

Source of actual quantities:Statistical Yearbook of Bangladesh.

d) Other foods

Other major food export in Bangladesh are wheat, rice, barley and corn.

Exports of rice products are especially expected to increase.

The export volumes of other foods in Bangladesh for the planning period are estimated using the growth rate of the international export volume of grain, which includes wheat, rice, barley and corn.

The average growth rate of the export volume of grain from 1975 to 1985 was about 3.55 percent per annum. (Refer to Table 8.10).

The volume of exports of other foods in Bangladesh for the planning period are shown in Table 8.11.

Table 8.10 Grain Exports in the World from 1975 to 1985

('000 tons)

Year	Wheat &	Rice	Barley	Corn	Total	G.rate
1975	73,824	7,724	12,604	52,085	146,237	(%)
1976	69,064	8,916	13,930	62,377	154,287	5.50
1977	74,486	10,853	13,112	57,764	156,215	1.25
1978	84,921	9,600	14,585	68,792	177,898	13.88
1979	81,563	11,644	14,106	76,096	183,409	3.10
1980	99,527	12,978	16,226	80,304	209,035	13.97
1981	105,202	13,093	20,277	79,442	218,014	4.30
1982	104,979	12,044	18,346	70,040	205,409	-5.78
1983	111,816	11,436	17,754	69,045	210,051	2.26
1984	116,489	12,680	23,008	68,961	221,138	5.28
1985	104,994	10,851	21,808	69,597	207,250	-6.28
Average growth rate:						3.55

Source:Report of Agriculture in the world

Table 8.11 Estimate of Exported Volume of Other Foods in Future

(Unit:'000 tons)

Year	Actual	Estimate
1979	0.1	-
1980	0.2	-
1981	0.0	-
1982	0.8	-
1983	55.7	-
1984	27.4	-
1985	1.7	-
1986	0.8	-
1987	0.7	-
1995	-	0.9
2000	-	1.1
2005	-	1.3

Source of actual quantities:Statistical Yearbook of Bangladesh.

e) Jute products

Jute is the most famous commodity produced in Bangladesh.

Jute products exports are not increasing because of competition from synthetic yarns, which have supplanted jute products and other natural yarns.

But, studies of the uses of jute products are now being promoted in light of the fact that synthetic yarns present problems in terms of producing poisonous gases when burned.

Thus an increase in the export volume of jute products is expected in the near future.

Furthermore, the government of Bangladesh is strongly promoting the export of jute goods.

The export volume of jute goods in Bangladesh for the planning period is estimated by the average annual growth rate of export volume of jute products in Bangladesh from 1979 to 1987. This average annual growth rate is about 0.54 percent.

Table 8.12 shows the result of the estimate of the export jute products for the planning period in Bangladesh.

Table 8.12 Estimate of Exported Jute & Jute Products in Future

(Unit:'000 tons)

Year	Actual	Estimate
1979	454	-
1980	520	-
1981		-
1982	539	-
1983	517	-
1984	458	-
1985	470	-
1986	454	-
1987	474	-
1995	-	494.9
2000	-	508.4
2005	-	522.3

Source of actual quantities:Statistical Yearbook of Bangladesh

f) Textiles

The export volume of textiles in Bangladesh until 1986 was very small because textiles are newly developing industry in Bangladesh.

The growth in exports of textiles in Bangladesh for the planning period is estimated by using the growth in exports of textiles in Turkey from 1980 to 1987 and in Hong Kong from 1970 to 1987.

Large scale textile exports began in Turkey around 1980. The average annual growth rate textile exports in Turkey from 1980 to 1987 was about 17.5 percent.

In Hong Kong, exports of textiles increased slowly and steadily. The average growth textiles exports in Hong Kong from 1970 to 1987 was about 5.7 percent per annum.

In this report, the annual growth of textile exports in Bangladesh from 1987 to 1995 and from 1996 to 2005 are estimated at 17.5 percent and 5.7 percent, respectively.

Table 8.13 shows the export volume of textiles in Bangladesh for the planning period.

Table 8.13 Estimate of Exported Textile in Future

(Unit: '000 tons)

Year	Exports in Bangladesh	Export in Turkey	Export in Hongkong
1970	-	-	65
1975	-	-	51
1979	0.7	-	0
1980	0.4	11	56
1981	0.0	0	0
1982	0.1	0	0
1983	0.1	21	80
1984	0.0	26	87
1985	0.0	35	83
1986	0.0	29	118
1987	18.6	34	166
1995	67.5	-	-
2000	88.9	-	-
2005	117.1	-	-

Source of actual quantities:Statistical Yearbook of Bangladesh and Handbook of Textile in Japane

g) Bone and Bone meal

The export volume of bone and bone meal has been roughly constant in recent years. Viz, the fluctuation of the export volume of bone and bone meal in Bangladesh is very small.

So, the export volume of bone and bone meal in Bangladesh for the planning period is estimated by using the average volume, which is about 2,500 tons per year, of exports of bone and bone meal in Bangladesh from 1979 to 1987.

Table 8.14 shows the export volume of bone and bone meal in Bangladesh for the planning period.

Table 8.14 Estimate of Exported Volume of Bone and Bone Meal in Future

(Unit:'000 tons)

Year	Actual	Estimate
1979	2.4	-
1980	2.7	-
1981	-	-
1982	2.3	-
1983	2.4	-
1984	2.9	-
1985	3.2	-
1986	2.8	-
1987	1.6	-
1995	-	2.5
2000	-	2.5
2005	-	2.5

Source of actual quantities:Statistical Yearbook of Bangladesh.

h) Others

Other exports are composed almost entirely of break bulk cargoes other than fish and crustaceans, meat, bran, tea, other foods, jute products, textile and bone and bone meal.

The export volume of others goods is estimated by the correlation with the GDP.

The correlation equation between the volume of other exports and the GDP is as follows:

$$Y=0.00138x-425.0611 \quad (r \doteqdot 0.81)$$

Where Y:The volume of other exports (Thousand tons)

x:GDP (Million TK)

r:Correlation coefficient

The result of the estimate of other exports is shown in Table 8.15.

Table 8.15 Estimate of Exported Volume of Others in Future

Year	Export		GDP
	Actual ('000tons)	Estimate ('000tons)	(M.TAKA)
1979	51.7	-	319,803
1980	43.1	-	338,401
1981	0.0	-	343,181
1982	80.2	-	355,434
1983	14.8	-	370,603
1984	79.1	-	385,343
1985	129.2	-	401,104
1986	194.5	-	415,966
1987	169.9	-	425,279
1995	-	367.1	573,130
2000	-	529.5	690,621
2005	-	725.2	832,197

Source of actual quantities:Statistical Yearbook of Bangladesh.

(b) Imports

a) Vegetables

Basically, the import volume of vegetables is calculated by the difference between consumption and production.

But, the government of Bangladesh is strongly promoting food self - sufficiency.

Thus, after the above calculation, the import volume of vegetables is estimated by multiplying the result of the above calculation by 0.25.

The consumption of vegetables after 1990 is estimated by correlation with the population.

The correlation equation between the consumption of vegetables and the population is as follows:

$$Yc=0.01797\ Xp+225.66377\ (r \doteqdot 0.79)$$

Where Xp:Population (Thousands)

Yc:Consumption (Thousand tons)

r:correlation coefficient

The production of vegetables after 1990 is calculated by time series analysis.

The equation of the time series analysis is as follows:

$$Yp=40.7619\ Xy-78{,}892.47\ (r \doteqdot 0.79)$$

Where Xy:year

Yp:Production of vegetables (Thousand tons)

r:Correlation coefficient

The volume of imported vegetables after 1990 is estimated by the following equation:

$$Y=0.25(Yc-Yp)$$

Where Yc:Consumption (Thousand tons)

Yp:Production (Thousand tons)

Y:Volume of import (Thousand tons)

The result of the calculation for the planning period is shown in Table 8.16.

Table 8.16 Estimate of Imported Vegetables in Future

Year	Production		Consumption		Import	
	Actual ('000 MT)	Estimate ('000 MT)	Actual ('000 MT)	Estimate ('000 MT)	Actual ('000 MT)	Estimate ('000 MT)
1979	1,688	-	1,692.6	-	4.6	-
1980	1,766	-	1,766.0	-	0.0	-
1981	1,894	-	1,894.0	-	0.0	-
1982	1,994	-	1,998.3	-	4.3	-
1983	2,036	-	2,041.4	-	5.4	-
1984	2,020	-	2,030.2	-	10.2	-
1985	1,986	-	2,000.8	-	14.8	-
1986	1,960	-	1,973.6	-	13.6	-
1987	-	-	-	-	79.6	-
1995	-	2,428	-	2,496	-	69
2000	-	2,631	-	2,736	-	105
2005	-	2,835	-	3,001	-	166

Source of actual quantities:Statistical Yearbook of Bangladesh

b) Fruit and Nuts

The import volume of fruit and nuts is estimated by the difference between consumption and production.

The consumption of fruit and nuts after 1990 in Bangladesh is estimated by correlation with the population.

The correlation equation is as follows:

$$Yc=0.00838\ Xp+730.49375\ (r\doteqdot 0.82)$$

Where Xp:population (Thousand)

Yc:Consumption of fruit and nuts (Thousand tons)

r:correlation coefficient

The production of fruit and nuts after 1990 in Bangladesh is estimated by time series analysis.

The equation is as follows:

$$Yp=18.5476\ Xy-35,250.90\ (r\doteqdot 0.79)$$

Where Xy:Year

Yp:Production of fruit and nuts (Thousand tons)

r:Correlation coefficient

The import volume of fruit and nuts is calculated by the following equation.

$$Y=Yc-Yp$$

Where Yc:Consumption of fruit and nuts (Thousand tons)

Yp:Production of fruit and nuts (Thousand tons)

Y:Import volume of fruit and nuts (Thousand tons)

Table 8.17 shows the result of the estimation of fruit and nuts for the planning period.

Table 8.17 Estimate of Imported Fruit and Nuts in Future

Year	Production		Consumption		Import	
	Actual	Estimate	Actual	Estimate	Actual	Estimate
	Quantities ('000 MT)	Quantities ('000 MT)	Quantities ('000 MT)	Quantities ('000 MT)	Quantities ('000 MT)	Quantities ('000 MT)
1979	1,431.00	-	1,431.04	-	0.04	-
1980	1,483.00	-	1,483.00	-	0.00	-
1981	1,505.00	-	1,505.00	-	0.00	-
1982	1,572.00	-	1,572.00	-	0.00	-
1983	1,488.00	-	1,492.45	-	4.45	-
1984	1,519.00	-	1,527.30	-	8.30	-
1985	1,544.00	-	1,549.15	-	5.15	-
1986	1,616.00	-	1,621.65	-	5.65	-
1987	-	-	-	-	15.78	-
1995	-	1,752	-	1,789	-	38
2000	-	1,844	-	1,901	-	57
2005	-	1,937	-	2,025	-	88

Source of actual quantities:Statistical Yearbook of Bangladesh

c) Milk and Cream

The import volume of milk and cream is estimated by the difference between consumption and production.

The consumption of milk and cream in Bangladesh after 1990 is estimated by multiplying per capita consumption by the population.

The per capita consumption of milk and cream in Bangladesh after 1990 is estimated using the past records of the consumption of milk and cream and the population.

The consumption of milk and cream in Bangladesh after 1990 is estimated by the following equation:

$$Yc=Pc \times X$$

Where Pc:Per capita consumption (0.008 tons/person)

X:Population (Thousand)

Yc:Consumption of milk and cream (Thousand tons)

The volume of production of milk and cream in Bangladesh after 1990 is estimated by time series analysis.

The equation is as follows:

$$Yp=8.6X-16,377.79 \quad (r \doteqdot 0.99)$$

Where X:year

Yp:Volume of production of milk and cream in Bangladesh (Thousand tons)

r:Correlation Coefficient

The import volume of milk and cream after 1990 is estimated by the following equation.

$$Y=Yc-Yp$$

Where Yc:Consumption of milk and cream (Thousand)

Yp:Volume of production of milk and cream (Thousand)

Y:Import volume of milk and cream after 1990. (Thousand tons)

The result of the estimation is shown in Table 8.18.

Table 8.18 Estimate of Imported Milk and Cream in Future

Year	Production		Consumption		Per capita consumption		Import	
	Actual ('000 MT)	Estimate ('000 MT)	Actual ('000 MT)	Estimate ('000 MT)	Actual ('000 MT)	Estimate ('000 MT)	Actual ('000 MT)	Estimate ('000 MT)
1979	1,142.0	-	1,142.0	-	0.013	-	0.0	-
1980	1,112.0	-	1,112.0	-	0.013	-	0.0	-
1981	1,126.0	-	1,126.0	-	0.012	-	0.0	-
1982	1,206.0	-	1,206.0	-	0.013	-	0.0	-
1983	716.0	-	752.5	-	0.008	-	36.5	-
1984	724.0	-	790.5	-	0.008	-	66.5	-
1985	734.0	-	794.2	-	0.008	-	60.2	-
1986	742.0	-	814.2	-	0.008	-	72.2	-
1987	750.0	-	810.2	-	0.008	-	60.2	-
1995	-	819	-	1,011	-	0	-	192
2000	-	862	-	1,118	-	0	-	255
2005	-	905	-	1,236	-	0	-	330

Source of actual quantities:Statistical Yearbook of Bangladesh

d) Others Foods

Basically, the import volume of other foods after 1990 is estimated by the calculation of the correlation equation between GDP and the import volume.

But, the government of Bangladesh is strongly promoting food self-sufficiency.

So, after the above calculation, the import volume of other foods is estimated by multiplying the result of the calculation by 0.50.

The import volume of other foods is estimated by the following equation:

$$Y=(0.00203x-739.0473)\times 0.50$$

Where X:GDP (Million TK)

y:Import volume of other foods (Thousand tons)

The result of the calculation is shown in Table 8.19.

Table 8.19 Estimate of Imported Other Foods in Future

Year	Import	
	Actual ('000 MT)	Estimate ('000 MT)
1982	4.0	-
1983	5.3	-
1984	9.7	-
1986	131.0	-
1987	117.6	-
1995	-	424
2000	-	663
2005	-	950

Source of actual quantities:Statistical Yearbook of Bangladesh

e) Textiles

The volume of import textiles in Bangladesh is roughly constant or falling slightly.

The textiles imported by Bangladesh are assumed to be cotton goods, nylon yarn and other textile goods.

So, in this report, the volume of import textiles is estimated by the average volume of textile imports (cotton goods, nylon yarn and other textile goods) from 1985 to 1987.

The average volume of imported textiles from 1985 to 1987 was about 41,000 tons per year.

Table 8.20 shows the imported textile goods from 1985 to 1987.

The volume of imported textiles in Bangladesh for the planning period is shown in Table 8.21.

Table 8.20 Imported Textile Manufacturing Goods

(unit:'000 tons)

Year	Cotton Goods	Nylon Yarn	Other Textiles	Total
1985	47.309	0.857	5.038	53.204
1986	34.230	1.089	4.234	39.553
1987	23.124	1.358	6.531	31.013
Average(1985-1987)				41.257

Source:Statistical Yearbook of Bangladesh

Table 8.21 Estimate of Imported Textile Goods in Future

('000 MT)

Year	Actual	Estimate
1979	58.4	-
1980	77.4	-
1981	68.3	-
1982	57.1	-
1983	79.8	-
1984	63.9	-
1985	53.2	-
1986	39.6	-
1987	31.0	-
1995	-	41
2000	-	41
2005	-	41

Source of actual quantities:Statistical Yearbook of Bangladesh

f) Rubber

Imports rubber tires and rubber materials are mainly composed of manufactured goods.

Thus, the import volumes of these cargoes for the planning period are estimated by the correlation with the GDP.

The correlation equation between the volume of rubber imports and the GDP is as follows:

$Y=0.0000525X-18.15706$ (r 0.95)

Where X:GDP for the planning period (Million TK)

y:Import volume of rubber for the planning period (Thousand tons)

r:Correlation coefficient

Table 8.22 shows the volume of rubber imports in Bangladesh for the planning period.

Table 8.22 Estimate of Future Rubber Imports

Year	Import		GDP
	Actual ('000 MT)	Estimate ('000 MT)	(M.TAKA)
1982	0.3	-	355,434
1983	1.2	-	370,603
1984	2.9	-	385,343
1985	2.6	-	401,104
1986	3.3	-	415,966
1987	4.4	-	425,279
1995	-	12	573,130
2000	-	18	690,621
2005	-	26	832,197

Source of actual quantities:Statistical Yearbook of Bangladesh

g) Paper

The volume of paper imports is estimated by the difference between consumption and production.

The production of paper for the planning period is estimated by time series analysis.

The equation is as follows:

$$Yp=5.94647X-11,718.52 \quad (r \doteqdot 0.9)$$

Where X:year

Yp=Production of paper in Bangladesh (Thousand tons)

r=Correlation coefficient

The consumption of paper for the planning period is estimated by the correlation with the GDP.

The correlation equation between the volume of consumption of paper and the GDP is as follows:

$$Yc=0.0004325X-86.82551 \quad (r \doteqdot 0.87)$$

Where X:GDP for planning period (Million TK)

Yc:Volume of consumption for planning period (Thousand tons)

r:Correlation coefficient

The volume of paper imports for the planning period is calculated by the following equation:

$$Y=Yc-Yp$$

Where Yc:Volume of consumption (Thousand tons)

Yp:Volume of production (Thousand tons)

Y:Import volume of paper for the planning period (Thousand tons)

The result of the calculation is shown in Table 8.23.

Table 8.23 Estimate of Imported Paper and Paper Products in Future

Year	Production		Consumption		Import	
	Actual ('000 MT)	Estimate ('000 MT)	Actual ('000 MT)	Estimate ('000 MT)	Actual ('000 MT)	Estimate ('000 MT)
1979	52.3	-	54.6	-	2.3	-
1980	52.7	-	54.4	-	1.7	-
1981	67.2	-	68.3	-	1.1	-
1982	53.6	-	53.6	-	0.0	-
1983	68.6	-	68.9	-	0.3	-
1984	93.4	-	97.0	-	3.6	-
1985	90.5	-	91.6	-	1.1	-
1986	89.4	-	89.4	-	0.0	-
1987	92.3	-	92.3	-	0.0	-
1995	-	145	-	161	-	16
2000	-	174	-	212	-	38
2005	-	204	-	273	-	69

Source of actual quantities:Statistical Yearbook of Bangladesh

h) Chemicals

The volumes of chemicals and chemical products imports are estimated by correlation with GDP.

The correlation equation between the total volume of imports of chemicals and chemical products and GDP is as follows.

$$Yt=0.001029X-341.1991 \quad (r \quad 0.93)$$

Where X:GDP (Million TK)

Y:Import volume of chemical and chemical products (Thousand tons)

r:Correlation coefficient

The result of the calculation is shown in Table 8.24.

Table 8.24 Estimate of Imported Chemical and Chemical Products in Future

Year	Import		GDP
	Actual ('000 MT)	Estimate ('000 MT)	(M.TAKA)
1982	17.9	-	355,434
1983	37.5	-	370,603
1984	59.9	-	385,343
1985	92.2	-	401,104
1986	75.5	-	415,966
1987	90.8	-	425,279
1995	-	248	573,130
2000	-	369	690,621
2005	-	515	832,197

Source of actual quantities:Statistical Yearbook of Bangladesh

i) Machinery and Others

There are no records of the volume of machinery imports in Bangladesh. So, in this study, the volume of imported machinery for the planning period is estimated based on the data of O/D surveys carried out in the first field survey of this study.

The steps followed in estimating the volume of imported machinery are as follows:

1. The ratio of the volume of imported machinery to the total amount of containerizable cargo is calculated using the result of the O/D survey.
2. The import volume of the other commodities for the planning period is estimated using the GDP.
3. The volume of imported machinery for the planning period is estimated by multiplying the volume of the total imported Containerisable cargo by the item 1.

In the result of the O/D survey, the ratio of the volume of imported machinery to the import volume of the total containerizable cargo is about 17.1 percent.

The import volume of other commodities for the planning period is estimated by correlation with the GDP.

The correlation equation is as follows:

$$Y=0.003332X-732.2454 \quad (r \doteqdot 0.75)$$

Where X:GDP (Million TK)

Y:Import volume of other commodities for the planning period (Thousand tons)

r:Correlation coefficient

The result of the calculation is shown in Table 8.25.

Table 8.25 Estimate of Other Imports (including machinery) in Future

Year	Import		GDP
	Actual ('000 MT)	Estimate ('000 MT)	(M.TAKA)
1979	326.7	-	319,803
1980	443.3	-	338,401
1981	326.6	-	343,181
1982	446.5	-	355,434
1983	602.1	-	370,603
1984	621.5	-	385,343
1985	377.6	-	401,104
1986	774.2	-	415,966
1987	670.6	-	425,279
1995	-	1,177	-
2000	-	1,569	-
2005	-	2,041	-

Source of actual quantities:Statistical Yearbook of Bangladesh

The volume of machinery imports for the planning period is calculated by the following equation:

$$Y=L \times X$$

Where X:Volume of the total imported cargo (Thousand tons)

L:The ratio of the import volume of the machinery to the import volume of the total containerizable cargo (0.171)

Y:Import volume of the machinery for the planning period (Thousand tons)

The volume of machinery imports in Bangladesh for the planning period is shown in Table 8.26.

Table 8.26 Estimate of Machineries

Year	Total import ('000 MT)	Machineries ('000 MT)
1995	2,217	334
2000	3,115	462
2005	4,226	620

(c) Result of the Micro-Economic Forecast

The results of the micro-economic forecast for export and imports are shown in Table 8.27 and Table 8.28.

Table 8.27 Estimated Containerizable Cargo Volume in Future for Exports by Micro-Economic Method

('000tons)

	1995	2000	2005
Fish & Crustaceans	28	34	40
Meat	7	8	11
Bran	16	16	16
Tea	30	36	43
Other food	1	1	1
Jute products	495	508	522
Textile	67	89	117
Bone & Bone meal	3	3	3
Others	367	529	725
Total	1,013	1,224	1,477

Table 8.28 Estimated Containerizable Cargo Volume in Future for Import by Micro-Economic Method

('000 MT)

	1995	2000	2005
Vegetable	17	26	42
Fruit & nuts	38	57	88
Milk & cream	192	255	330
Other foods	212	331	475
Textile	41	41	41
Rubber	12	18	26
Paper	16	38	69
Chemical	248	369	515
Machinery	334	462	620
Others	843	1,106	1,421
Total	1,954	2,705	3,626

3) Containerizable Cargo in 1995, 2000, 2005

According to Table 8.5, 8.27 and 8.28, the difference between the macro-economic and the micro-economic forecasts is not large. So, the volume of containerizable cargo adopted for 1995, 2000 and 2005 is the average results of the macro-economic and micro-economic forecasts.

Table 8.29 shows the containerizable cargo in 1995, 2000 and 2005.

Table 8.29 Estimated Volume of Containerizable Cargo in Future

(Unit:'000 tons)

Year	Import			Export		
	Macro Forecast	Micro Forecast	Average	Macro Forecast	Micro Forecast	Average
1995	2,186.7	1,953.8	2,070.2	927.5	1,013.5	970.5
2000	2,956.1	2,704.6	2,830.4	1,083.0	1,224.4	1,153.7
2005	3,883.2	3,626.0	3,754.6	1,270.4	1,477.5	1,373.9

(2) Ratio of Containerization

The ratio of container cargo volume to containerizable cargo volume is estimated using a logistic curve of which the constants are decided based on the statistics of the CPA and MPA and the socio-economic conditions in Bangladesh.

In this study, the ratio of containerization for import is estimated into three categories:

Maximum, minimum and medium.

The equation of the logistic curves for imports and exports are as follows:

(Exports)

$$Y=\frac{80}{1+0.75^{(x-10)}}$$

(Imports)

Maximum:

$$Y=\frac{85}{1+0.73^{(x-12)}}$$

Minimum:

$$Y=\frac{85}{1+0.88^{(x-14)}}$$

Medium:

$$Y=\frac{85}{1+0.83^{(x-13)}}$$

Where x:Number of years from 1978.

Y:Ratio of containerization.

Tables 8.30 and 8.31 show the ratio of containerization to containerizable cargo.

Table 8.30 Ratio of Containerization for Exports

(Unit: %)

Year	1987	1995	2000	2005
Ratio of containerization	37.27	70.58	77.54	79.40

Table 8.31 Ratio of Containerization for Imports

(Unit: %)

Year	Maximum	Minimum	Medium
1987			32.02
1995	70.40	50.55	57.64
2000	81.50	62.52	71.61
2005	84.25	71.44	79.17

(3) Calculation of Container Cargo Volume and Number of Loaded Containers in Bangladesh for Export and Import in 1995, 2000, 2005.

a) Container Cargo volume in 1995, 2000 and 2005

The container cargo volume in 1995, 2000 and 2005 is calculated by multiplying the ratio of containerization, which is estimated in (2), by the containerizable cargo, which is estimated in (1).

Tables 8.32 and 8.33 show the volume of container cargo for export and import, respectively.

Table 8.32 Number of Loaded Containers for Export in Future

Year	Contai-nerizable cargo ('000tons)	Ratio of contai-nerization (%)	Volume of container cargo ('000tons)	Number of laden containers ('000TEUs)
1995	970.5	70.6	685	61
2000	1,153.7	77.5	895	80
2005	1,373.9	79.4	1091	97

Table 8.33 Number of Loaded Containers for Import in Future

Year	Contai-nerizable cargo	Ratio of Containerization			Volume of container cargo			Number of laden containers		
	('000tons)	*Maximum* (Case-1) (%)	*Minimum* (Case-2) (%)	*Medium* (Case-3) (%)	*Maximum* (Case-1) ('000tons)	*Minimum* (Case-2) ('000tons)	*Medium* (Case-3) ('000tons)	*Maximum* (Case-1) ('000TEUs)	*Minimum* (Case-2) ('000TEUs)	*Medium* (Case-3) ('000TEUs)
1995	2,070.2	84.61	50.55	57.64	1,457.5	1,046.5	1,193.4	112	80	92
2000	2,830.4	84.98	62.52	71.61	2,306.7	1,769.4	2,026.9	177	136	156
2005	3,754.6	85	71.44	79.17	3,163.2	2,682.3	2,972.5	243	206	228

b) Number of Loaded Containers (TEU) in 1995, 2000, 2005

The container cargo volume per TEU is estimated using the average of container cargo per TEU at Chittagong and Mongla ports from 1984 to 1988. (Refer to Table 3.15)

Thus, the number of containers for the planning period of this project is estimated by dividing the container cargo volume estimated in a) by the container cargo volume per TEU.

Tables 8.32 and 8.33 show the number of loaded containers (TEU) for exports and imports in Bangladesh in 1995, 2000 and 2005.

8.4 Number of Containers coming to and from Dhaka Area

1) Ratio of Number of Loaded Containers coming to and from the Dhaka Area

The ratio of the number of loaded containers to and from the Dhaka area to the number of loaded container throughput at Chittagong and Mongolia ports is estimated by the result of the O/D survey and the interviews at the CPA.

The result of the O/D survey and the interviews at the CPA are shown in Table 8.34.

Table 8.34 Ratio of Number of Laden Container to and from Dhaka Area

Source of the ratio	Ratio	
	Export (%)	Import (%)
O/D Survey	65	93
Chittagong Port Authority	60	60
Adopted ratio in this study	65	76

For exports, the difference in the ratios is not so large.

So, for this study, the O/D survey ratio has been adopted.

For imports, there is a large difference between the result of the O/D survey and the interviews at the CPA.

So, the average of the ratio between the result of the O/D survey and the interviews at CPA is adopted in this study. (Refer to Table 8.34)

2) Container cargo volume coming to and from the Dhaka Area

The container cargo volumes coming to and from the Dhaka area for export and import are estimated by multiplying the container cargo volume, which was estimated in 8.3 by the ratio of the number of loaded containers to and from Dhaka area, which was estimated in 1) of 8.4.

In this study, the future volume of import container cargo is adopted as the Medium container cargo volume in Table 8.33.

Table 8.35 shows the container cargo volumes coming to and from the Dhaka area in 1995, 2000 and 2005.

Table 8.35 Container Cargo Volume to and from Dhaka Area

(Unit: 1000 tons)

Year	Import	EXPORT	Total
1995	907	445	1,352
2000	1,540	582	2,122
2005	2,259	709	2,968

Chapter 9 FUTURE CONTAINER TRAFFIC

9.1 Traffic Modal Split

9.1.1 Methodology and Preconditions

(1) Methodology

On the future routes for the container traffic between Dhaka and two seaports - Chittagong and Mongla ports, there will be three traffic modes; railway, roads and inland waterway. On the Dhaka-Mongla Route, only inland waterways will be able to transport containers until 2005, as described in Chapter 5. All the containers in this route, therefore, will be transported by inland waterway. But on the Dhaka-Chittagong Route, there will be three traffic modes. In this chapter, the Study Team estimates the traffic modal split of the future container traffic on the routes between Dhaka and two seaports.

There are two inland waterway routes, the Dhaka-Chittagong and Dhaka-Mongla routes. The costs and voyage times of these two routes are only slightly different, as shown in Fig. 9.2, Table 9.6 and 9.8. The Study Team, therefore, will treat these two waterways as one mode, averaging them vis-à-vis other two modes, namely railways and roads. After the estimation of the modal split between three traffic modes, the container traffic volume for inland waterways will be distributed to these two routes.

The basic concept in estimating the traffic modal split is that it will be determined based mainly on the costs. Accordingly, the marginal costs for the container traffic are calculated with the three traffic modes, respectively. Marginal costs mean the necessary additional costs from now to transport the containers in the target year, which consist of the operating costs and the future investments from now till the target year. Furthermore, the time factor is considered in the estimation of the traffic modal spilt and converted into the costs. Finally, the traffic modal split is estimated based on the concept that it will be basically determined in inverse proportion to marginal costs.

The number of the containers to be handled by each traffic mode will be determined through repeated calculation, as shown in Fig. 9.1.

In the estimation of the total of TEUs coming in and out of Dhaka via three modes on the two routes, the "in" and "out" totals balance, because the forwarders will make the number of containers balance.

The overall traffic routes and the additional future investments for each traffic mode are shown in Fig.9.2.

The scope of the comparison of the marginal costs between three traffic modes are shown in Fig. 9.2. From the viewpoint of the fair comparison between three traffic modes, the additional investment of the fair comparison between three traffic modes, the additional investment costs at the seaports are included in the marginal costs of the container transport for each traffic mode.

(2) Preconditions

At the calculation of marginal costs, the following conditions are premised:

1) The hypothetical year is basically 2005 at the calculation.

2) The traffic costs will be calculated as the financial costs, including the taxes and other transfer expenditures, such as customs duty, development surcharge tax, import permission fee and admission income tax.

3) All of the investment costs are estimated in the 1990 prices and if necessary, the deflators presented in Table 9.1 are used. At the same time, the fluctuations of the exchange rates are modified as for the foreign currency portion.

4) From the viewpoint of the fair and healthy competition between three traffic modes, the same interest rates are premised to all modes, 11.5% for the public-sector investments and 17.0% for the private sector investments.

5) The depreciation expenses are calculated by straight-line method and the residual value is premised as 10%. Accordingly, 90% of the original costs are depreciable.

6) Traffic times and handling capacities.

The traffic times and the handling capacities of three traffic modes are assumed as shown in Table 9.2.

The bases of these assumptions are as follows:

① One container train is composed of 1 locomotive and 30 wagons, each of which can transport 2 TEU containers.

② According to the present train schedule, one container train will travel in each direction every day. For this schedule, 2 locomotives and 30@4 wagons are necessary, as shown in Fig. 9.3.

③ The working days of the semi-trailer are assumed as 300 days, according to the BRTC.

④ The running speed of the semi-trailer combination is expected to be 40k/hr., which means a round trip will be made 1.64 days, as shown in Fig. 9.4 and Table 9.2.

7) If the free competition is ensured, Chittagong Port might get a great portion than Mongla Port in the container handling business. Since Chittagong is the largest container port in this country and there is already the actual container flow between Chittagong and Dhaka Area. However, taking account of the existing port facilities that are usable for container handling at Mongla Port, the same share 19.0% as the present one at Mongla Port is expected in the future in the container flow between Mongla and Dhaka Area to be established newly by this project. Notwithstanding that, the voyage times and the traffic costs between Dhaka and two seaports have little difference, so, that scarcely affects on the result of the modal split.

Table 9.1 Wholesale Price Indices of Industrial Products

Base : 1969-70 = 100

Year	Indices
1973 - 74	294
1974 - 75	459
1975 - 76	401
1976 - 77	392
1977 - 78	432
1978 - 79	449
1979 - 80	544
1980 - 81	603
1981 - 82	667
1982 - 83	741
1983 - 84	788
1984 - 85	854
1985 - 86	904
1986 - 87	915
1987 - 88	962
1988 - 89	1,034
1989 - 90 (November)	1,120
1990 - 91	1,136*

Source : Bangladesh Bank, "Economic Trends", June, 1990.

* Estimated through the method of least squares.

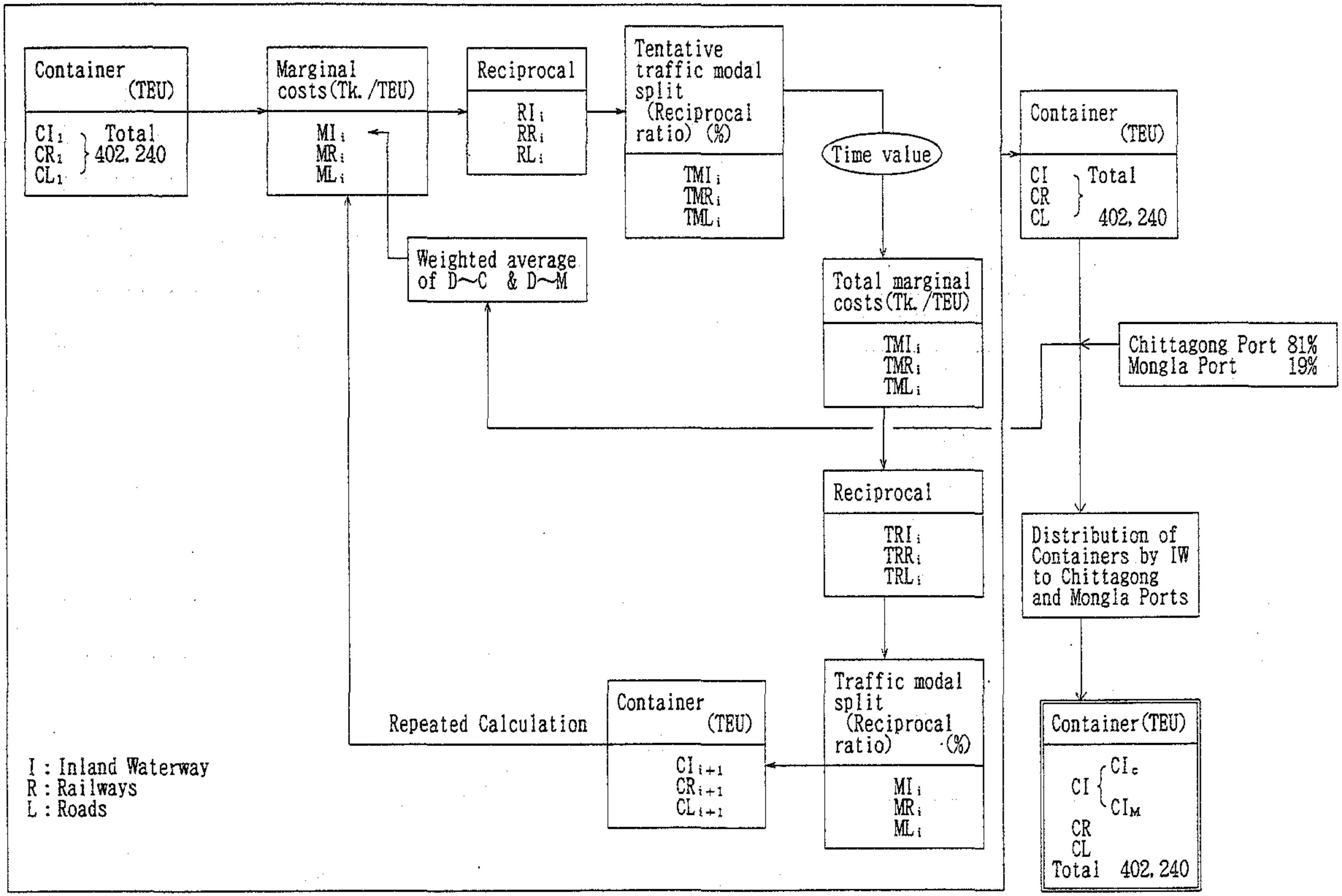


Fig. 9.1 Estimation of Traffic Modal Split for Long-term Plan (2005)

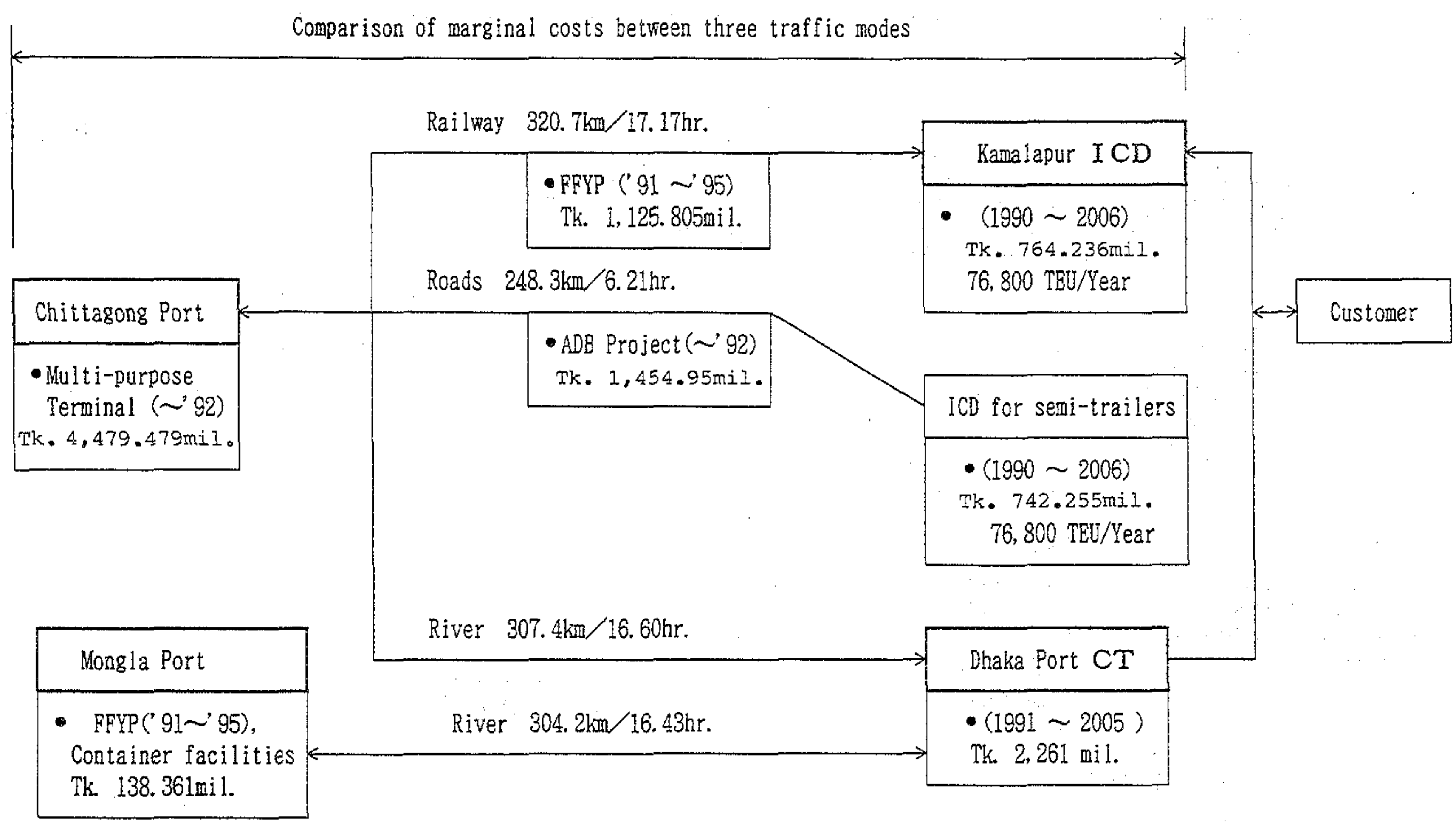


Fig. 9.2 Traffic Routes and Investments

Table 9.2 Traffic Times and Transport Capacity

Traffic modes	Traffic times		Working days in a year	Capacity	Transport capacity in a year
	Journey time one way	Round trip			
Container vessel by inland waterway	Dhaka-Chittagong 307.4 km/10knots=16.60hr. Dhaka-Mongla 304.2 km/10knots=16.43hr.	days 3	days 341	88 TEU/vessel	$\frac{341}{3}$ X88X2=20,005 TEU/vessel
Railways	Dhaka-Chittagong (16hr.30min+17hr.50min)/2=17.17		300	60 TEU/train	2 locomotives+30X4wagons 60X300X2=36,000 TEU
Semi-trailer Combination by roads	Dhaka-Chittagong 6.21	1.64	300	1 TEU/semi-trailer	$\frac{300}{1.64}$ X1X2=366 TEU/semi-trailer

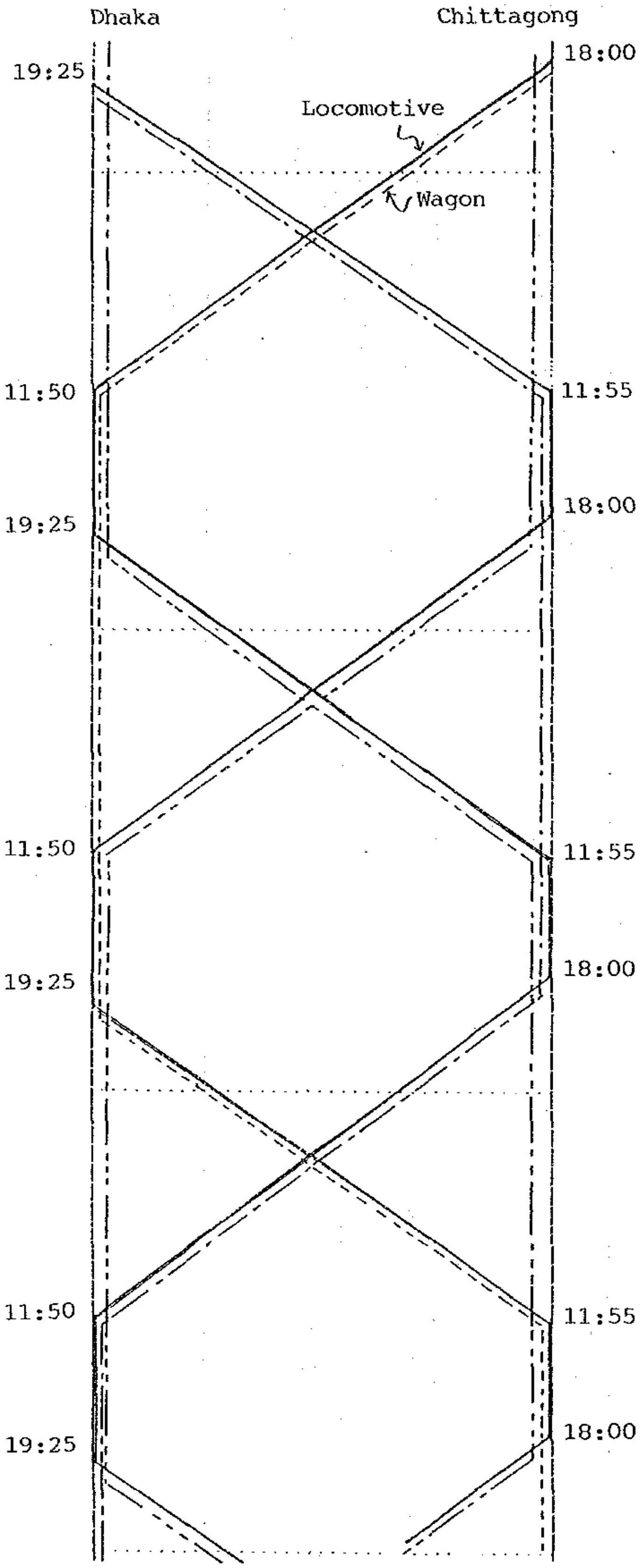
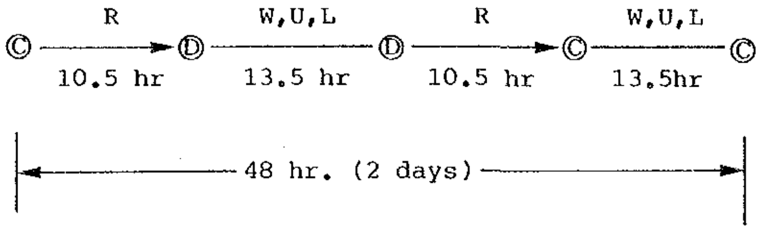
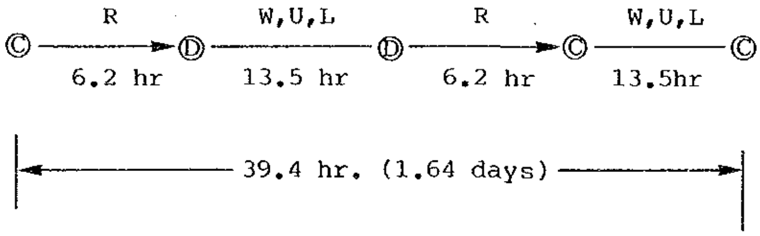


Fig. 9.3 Container Train Diagram between Dhaka and Chittagong

(A) Present state by trucks



(B) Future state in 2005 by semi-trailar combinations



C : Chittagong

D : Dhaka

R : Running

W : Waiting

U : Unloading

L : Loading

Fig. 9.4 Round Trip Days by Road Transport on the Dhaka-Chittagong Highway

9.1.2 Marginal Costs of Inland Waterway Transport

(1) Dhaka-Chittagong Route

The marginal costs for the container traffic by inland waterway on the Dhaka-Chittagong Route are calculated as follows:

1) Annual operating costs of one container vessel

① Vessel costs

a. Depreciation expenses

The acquisition costs of one container vessel are as follows:

Price of vessel	TK.155,148,730
Towing charge	TK. 3,248,430
Survey costs & Insurance for towing	TK. 484,840
Total	TK.158,882,000

The service life is 30 years.

b. Interest

The average annual interest during the service life comes to as follows:

$$\text{Average annual interest} = \text{Principal} \times 11.5\% \times \frac{1}{2}$$

[N.B.] Average Annual Interest

The total interest on a loan is as follows:

$$I = AR + \frac{n-1}{n}AR + \frac{n-2}{n}AR + \ldots\ \ldots + \frac{2}{n}AR + \frac{1}{n}AR$$

$$= \frac{AR}{n}[n + (n-1) + (n-2) + \ldots\ \ldots + 2 + 1]$$

$$= \frac{AR}{2}(n + 1)$$

Where I: Total interest

A: Principal

R: Interest rate

n: Repayment period (year)

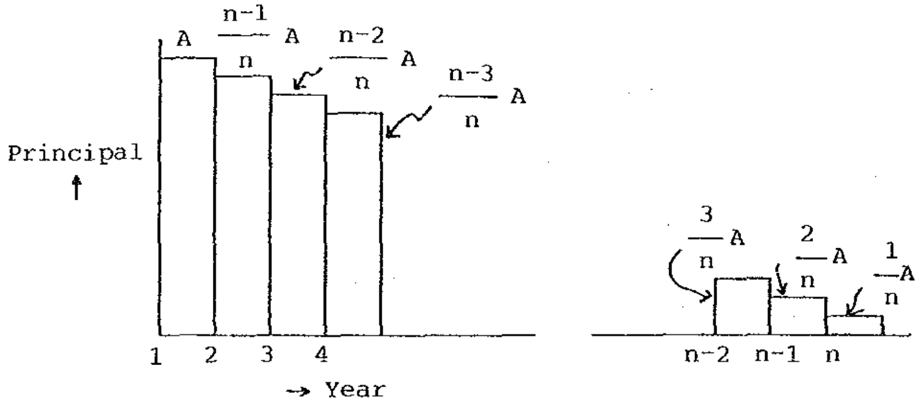
The average annual interest, therefore, is as follows:

$$i = \frac{I}{n} = \frac{AR}{2}(1 + \frac{1}{n})$$

Where i: Average annual interest

When n is large, the average annual interest is as follows:

$$i \fallingdotseq \frac{AR}{2}$$



② Labour costs

The crew costs depend on the BIWTC's wage table.

2) Additional investment costs

① Dhaka Port CT(Container Terminal)

The financial construction costs of the Dhaka Port CT are estimated as follows:

1991-2005 Tk.2,261,000,000

Each item of the construction costs is supposed as shown in the left-hand columns in Table 9.3. Accordingly, the depreciation expenses of Dhaka Port CT become as shown in the right-hand columns in Table 9.3.

② The annual operating costs of the Dhaka Port CT are calculated as shown in Table 9.4.

③ As a result of repeated calculation, the approximate value of the handling volume of the Dhaka Port CT in 2005 is estimated as 153,656 TEU.

④ The additional investment costs by the Dhaka Port CT for one TEU of container are as follow:

Tk.397,820,000/153,656 TEU = 2,589 Tk./TEU

⑤ Multi-purpose Terminal at Chittagong Port

According to Chittagong Port Authority's "Year Book '88", the total construction costs of Multi-purpose Terminal are Tk. 3,498,300,000, which are converted into Tk.4,479,479,000 at 1990 prices, using the same ratio of the local currency as for the Kamalapur ICD. The annual operating costs of the Multi-purpose Terminal at Chittagong Port are calculated as shown in table 9.5. The ratio of the maintenance & repairing expenses, fuel costs, labour cost and indirect costs is assumed as 0.3365 of the depreciation expenses and interest, the same as for the Dhaka Port CT. The annual handling volume at the Dhaka-Chittagong Route is 373,045 TEU. It is assumed that about 76% of these containers will be transported to Dhaka.

Table 9.3 Depreciation of the Dhaka Port CT

(Tk. in thousands)

Investments		Depreciation expenses
Non-depreciable assets	211,000	0
Pavements	296,000	296,000 X 0.9 / 10 = 26,640
Quaywalls	374,000	374,000 X 0.9 / 30 = 14,220
Buildings	172,000	172,000 X 0.9 / 50 = 3,096
Gantry cranes	493,000	493,000 X 0.9 / 15 = 29,580
Cargo handling equipment	520,000	520,000 X 0.9 / 5 = 93,600
Utilities	195,000	195,000 X 0.9 / 50 = 3,510
Total	2,261,500	167,650

Table 9.4 Annual Operating Costs of the Dhaka Port CT

(Tk. in thousands)

Items	Costs
Depreciation expenses	167,650
Interest	2,261,000 X 11.5% / 2 = 130,008
Maintenance & Repairing expenses	Handling equipment 1,013,000 X 4% = 40,520 Other depreciable assets 1,037,000 X 1% = 10,370
Fuel costs	Handling equipment 1,013,000 X 1% = 10,130
Labour Costs	30,109
Indirect expenses	Labour costs X 30% = 9,033
Total	397,820

Note: 1) $\dfrac{\text{Maintenance \& repairing expenses + Fuel costs + Labour costs + Indirect costs}}{\text{Depreciation expenses + Interest}}$

= 0.3365

Table 9.5 Annual Operating Costs of the Multi-purpose Terminal at Chittagong Port

(Tk. in thousands)

Items	Costs
Depreciation expenses	4,479,479 X 0.9 / 45 = 89,590
Interest	4,479,479 X 11.5% / 2 = 257,570
Maintenance & repairing expenses/ Fuel costs / Labour cost / Indirect expenses	(89,590+257,570) X 0.3365 = 116,819
Total	463,979

Accordingly, the additional investment costs by the Multi-purpose Terminal for one TEU of container are as follows:

Tk.463,979,000 X 0.76 / 373,045 TEU = 945 Tk./TEU

Finally, the marginal costs of inland waterway transport for one TEU of container is 5,343 Tk./TEU, as shown in Table 9.6.

Table 9.6 Marginal Costs of Inland Waterway Transport between Dhaka and Chittagong Ports for 1 TEU in 2005

Items				Marginal costs (Tk./TEU)
Annual operating costs of one container vessel	Vessel costs	Depreciation expenses	Tk. 158,882,000X1.57X0.9/30 =Tk. 7,483,340	
		Interest	Tk. 158,882,000X1.57X11.5%/2 =Tk. 14,343,100	
		Insurance expenses	Tk. 158,882,000X1.57X2.5% =Tk. 6,236,120	
		Repairing expenses	Tk. 817,440	
	Fuel costs	Fuel costs	3.9(tons/day)X16.60hr.X2/72hr. X10,823(Tk./ton)X341days =Tk. 6,637,010	
		Lubricant costs	Tk. 6,637,010/15 =Tk. 442,467	
	Labour costs	Crew costs	Officer 1,995Tk./monthX4persons; Crew 1,254 X8 } X12months =Tk. 216,144	
	Subtotal		Tk. 36,175,600	
Operating costs per TEU			Tk. 36,175,600/20,005 TEU =	1,808
Additional investment costs	Dhaka Port CT			2,589
	Multi-purpose Terminal at Chittagong Port			945
	Subtotal			3,534
Total				5,343

(2) Dhaka-Mongla Route

The marginal costs for the container traffic by inland waterway on the Dhaka-Mongla Route are calculated as follows:

1) Annual operating costs of one container vessel

The vessel costs and the labour costs are the same as those on the Dhaka-Chittagong Route, except the fuel costs. The fuel costs on this route are slightly lower than those on the Dhaka-Chittagong Route, because of the smaller distance.

2) Additional investment costs in Mongla Port

① FFYP

The investments in Mongla Port for the FFYP are as follows, according to Table 5.2.7 (1):

(A.1) Tk. 126,233,000 + (B.3) Tk. 12,128,000 = Tk. 138,361,000

② Investment costs

The annual investment costs in Mongla Port for the FFYP are Tk. 14,330,000, as shown in Table 9.7.

Table 9.7 Annual Investment Costs in Mongla Port for the FFYP

(Tk. in thousands)

Items	Costs
Depreciation expenses	138,361 X 0.9 / 45 = 2,767
Interest	138,361 X 11.5% / 2 = 7,955
Management/Repairing expenses, labour costs and indirect costs	(2,767 + 7,955) X 0.3365 = 3,608
Total	= 14,330

The ratio of maintenance & repairing expenses, labour costs and indirect costs is assumed as 0.3365 of the depreciation expenses and interest, the same as for the Dhaka Port CT. On the other hand, the containers handled at Mongla Port going to and from Dhaka Port CT in 2005 is estimated as 29,195 TEU, as shown in Table 9.20. Accordingly, the investment costs for one TEU at Mongla Port are assumed as follows:

Investment costs for one TEU = Tk. 14,330,000/29,195 TEU = 491 Tk./TEU

Finally, the marginal costs of inland waterway transport between Dhaka and Mongla ports for one TEU of container are Tk. 4,885, as shown in Table 9.8.

[References]

Existing vessels such as Ramus, BB-1121s and Mini-bulkers can be converted into container vessels.

Data concerning converted Ramus is as follows:

Service life	18 years
Cargo capacity	45 TEU
Book value and conversion cost	Tk.42,908,320
Round trip day	4 days
Service speed	8.5 knots
FO consumption	4.05 tons

The marginal costs of converted Ramus, which are the most economical among the converted vessels, are shown in Table 9.9. It shows that the marginal costs of the converted Ramu are expensive than those of the newly-built container vessels.

Table 9.8 Marginal Costs of Inland Waterway Transport between Dhaka and Mongla Ports for 1 TEU in 2005

Items				Marginal costs (Tk./TEU)
Annual operating costs of one container vessel	Vessel costs	Depreciation expenses	Tk. 158,882,000X1.57X0.9/30 =Tk. 7,483,340	
		Interest	Tk. 158,882,000X1.57X11.5%/2 =Tk. 14,343,100	
		Insurance expenses	Tk. 158,882,000X1.57X2.5% =Tk. 6,236,120	
		Repairing expenses	Tk. 817,440	
	Fuel costs	Fuel costs	3.9(tons/day)X16.43hr.X2/72hr. X10,823(Tk./ton)X341days =Tk. 6,569,040	
		Lubricant costs	Tk. 6,569,090/15 =Tk. 437,936	
	Labour costs	Crew costs	Officer 1,995Tk./monthX4persons Crew 1,254 X8 }X12months =Tk. 216,144	
	Subtotal		Tk. 36,103,100	
Operating costs per TEU			Tk. 36,103,100/20,005 TEU =	1,805
Additional investment costs	Dhaka Port CT			2,589
	Multi-purpose Terminal at Chittagong Port			491
	Subtotal			3,080
Total				4,885

Table 9.9 Marginal Costs of Inland Waterway Transport by Converted Ramu between Dhaka and Chittagong Ports for 1 TEU

Items				Marginal costs (Tk./TEU)
Annual operating costs of one container vessel	Vessel costs	Depreciation expenses	Tk. 42,908,320X1.57X 0.9 /8 =Tk. 3,368,303	
		Interest	Tk. 42,908,320X1.57X11.5%/2 =Tk. 3,873,549	
		Insurance expenses	Tk. 42,908,320X1.57X 2.5% =Tk. 1,684,152	
		Repairing expenses	Tk. 3,636,299	
	Fuel costs	Fuel costs	4.05(tons/day)X19.53hr.[1]X2/96hr.X10,823(Tk./ton)X341days =Tk. 6,081,603	
		Lubricant costs	Tk. 6,081,603/15 =Tk. 405,440	
	Labour costs	Crew costs	Officer 1,995Tk./monthX 5persons; Crew 1,254 X16 } X12 months =Tk. 360,468	
	Subtotal		Tk. 19,409,813	
Operating costs per TEU			Tk. 19,409,813/7,673 TEU [2]=	2,530
Additional investment costs	Dhaka Port CT			2,589
	Multi-purpose Terminal at Chittagong Port			945
	Subtotal			3,534
Total				6,064

[Notes]

1) Voyage time 307.4 Km/8.5 knots=19.53hr.

2) Annual transport capacity 45 TEUX341daysX2/4days=7,673 TEU

9.1.3 Marginal Costs of Railway Transport

The marginal costs for container traffic by the railway are calculated as follows:

1) Annual operating costs of container trains

The annual operating costs of a formation of 2 locomotives and 30@4 wagons are calculated here.

① Depreciation expenses

a. Purchase prices

The purchase prices of container trains are as follows:

Price of one locomotive Tk.45,849,930

Price of one wagon Tk. 1,719,370

Total Tk.45,849,930 X 2 + Tk.1,719,370 X 30 X 4

= Tk.298,024,000

b. Depreciation expenses

The service lives of a locomotive and a wagon are 20 years and 30 years, respectively. The scrap values are 10.0%. Accordingly, the depreciation expenses are as follows:

Tk.45,849,930 X 2 X 0.90 / 20 + Tk.1,719,000 X 30 X 4 X 0.90 / 30

=Tk.10,316,225

② Interest

The interest rate for purchasing the locomotives and wagons is assumed as 11.5%, as with ship building.

③ Crew costs

The crew costs of the container trains are shown in Table 9.10.

2) Handling volume

The annual handling volume by 2 locomotives is as follows:

30wagons X 2 TEU X 2directions X 300days = 36,000 TEU

3) Additional investment costs

① Kamalapur ICD

The Bangladesh Railway has a expansion plan of the Kamalapur ICD that is expected to be financed by the ADB. The plan aims at handling 76,800 TEUs in 2006 with construction costs of Tk.764,236,000.

a. Depreciation expenses

Depreciation expenses of the Kamalapur ICD are shown in Table 9.11.

Table 9.10 Crew Costs for Express Freight Train

(Unit:Tk.)

Position	Number	Pay per month							Grand total
		Basic pay	Allowances					Total	
			House rent A.	Mrdical A.	Rationing A.	Conveyance	Subtotal		
Locomtive master	1	1,215	607.5	100	25	40	772.5	1,987.5	1,987.5
Asst. locomotive master	1	1,057.5	528.8	100	25	40	693.8	1,751.3	1,751.3
Train guard	1	1,640	738	100	25	40	903	2,543	2,543
Security	5	757.5	416.6	100	25	40	581.6	1,339.3	6,696.5
Total	8							7,621.1	12,978.3

[Source] Bangladesh Railway

Table 9.11 Depreciation of the Kamalapur ICD

(Tk. in thousands)

Items	Capital Costs	Depreciation expenses
Civil works	293,151	293,151 X 0.9 / 30 = 8,795
Wagon workshop	15,654	15,654 X 0.9 / 30 = 470
Container handling equipment	415,687	415,678 X 0.9 / 5 = 74,824
Preliminary expenses	31,572	31,572 X 0.9 / 30 = 947
Initial working capital requirement	8,173	8,173 X 0.9 / 30 = 245
Total	764,236	85,280

[Source] ADB, "Rail Container Transport Study-Bangladesh, Final Report", February 1988

b. The annual operating costs of the Kamalapur ICD in 2006 are shown in Table 9.12.

Table 9.12 Annual Operating Costs of the Kamalapur ICD

(Tk. in thousands)

Items	Costs
Depreciation expenses	85,280
Interest	764,236 X 11.5% / 2 = 43,944
Management & repairing expenses, labour costs and indirect costs	109,296
Total	238,520

[Source] ADB, "Rail Container Transport Study-Bangladesh, Final Report", February 1988

c. Handling volume

According to the ADB Plan, the maximum handling volume of the Kamalapur ICD is 76,800 TEU.

d. Additional investment costs

The additional investment costs by the Kamalapur ICD for one TEU of container are as follows:

Tk.238,520,000 / 76,800 TEU = 3,106 Tk./TEU

② FFYP

The investments on the Dhaka-Chittagong Rail Route for the FFYP are Tk.1,125,805, as shown in Fig.9.2, based on Table 5.3.8 (No.2,5,6). Accordingly, the annual investment costs for the Dhaka-Chittagong Rail Route are as shown in Table 9.13.

Table 9.13 Annual Investment Costs on the Dhaka-Chittagong Rail Route for the FFYP

(Tk. in thousands)

Items	Costs
Depreciation expenses	1,125,805 X 0.9 / 45 = 22,516
Interest	1,125,805 X 11.5% / 2 = 64,734
Total	87,250

On the other hand, the liability ratio of the container trains is as follows:

$$\text{Liability Ratio} = \frac{W_F}{W_R + W_F + W_B} = 0.741$$

W_F : Weight of containers

W_R : Weight of general cargoes

W_B : Weight of passengers

Then, the additional investment costs by FFYP for one TEU of container are as follows:

Tk.87,250,000 X 0.741 / 127,510 TEU = 507 Tk./TEU

③ Maintenance costs of rail tracks

The track maintenance works consist of making up embankment shoulders, replacing of sleepers, refixing loose rail spikes, replacing and/or tightening loose fishplates, bolts and fastenings re-ballasting throughout and track alignment. The maintenance costs of rail tracks are estimated as Tk.208,726/km.

Accordingly, the maintenance costs for one TEU of container are as follows:

Tk.208,726 X 320.7 km X 0.741/127,510 = 389 Tk./TEU

Finally, the marginal costs of railway transport for one TEU is 6,999 Tk./TEU, as shown in Table 9.14.

9.1.4 Marginal Costs of Road Transport

The marginal costs for the container traffic by the Dhaka-Chittagong Highway are calculated as follows:

1) Annual operating costs of one semi-trailer combination

① Vehicle costs

a. Purchase prices

The purchase price of one semi-trailer combination is Tk.2,919,948, of which 70% is the price of the tractor and 30% is the price of the trailer.

b. Depreciation expenses

The service lives of the truck-tractor and the trailer are assumed as 5 years. Accordingly, the depreciation expenses of a semi-trailer combination are as follows:

Tk.2,919,948 X (0.7 X 1.155 + 0.3 X 2.505) X 0.9 / 5

= Tk.819,921

c. Fuel costs

Fuel consumption 3.0 km/ℓ

d. Insurance rate

The insurance rate is supposed as 1.54% according to the "Feasibility Study of Dhaka-Khulna National Highway (Bhanga-Khulna Portion) Vol.I" by Development Design Consultants Ltd., January 1990.

e. Repair and maintenance costs

The ratio of repair/maintenance costs is assumed as 9.5% of the purchase prices according to the "Feasibility Study of Dhaka-Khulna National Highway (Bhanga-Khulna Portion) Vol.I" by Development Design Consultants Ltd., January 1990.

Table 9.14 Marginal Costs of Railway Transport for 1 TEU in 2005

Items			Marginal costs (Tk./TEU)
Annual operating costs of a formation of 2 locomotives and 30 wagons X 4	Depreciation expenses	Tk. 10,316,225X1.57 =Tk. 16,196,500	
	Interest	Tk. 298,024,000X1.57X11.5%/2 =Tk. 26,904,100	
	Insurance expenses	Tk. 298,024,000X1.57X 2.0% =Tk. 9,357,950	
	Repairing expenses	Tk. 45,849,930X2X5.0%+Tk. 1,719,370X30X4X2.0% =Tk. 8,711,480	
	Fuel costs	320.79KmX7.0(ℓ/Km)X9.2(Tk./ℓ)X300daysX2 =Tk. 12,395,300	
	Crew costs	Tk. 311,479	
	Subtotal	Tk. 73,876,800	
Operating costs per TEU		Tk. 73,876,800/36,000 TEU =	2,052
Additional investment costs	Kamalapur ICD		3,106
	Maintenance costs of rail tracks		389
	Fourth Five Year Plan		507
	Multi-purpose Terminal at Chittagong Port		945
	Subtotal		4,947
Total			6,999

2) Additional investment costs

① ICD

The investment costs of the ICD for the semi-trailer combination are obtained by referring to the costs of the Kamalapur ICD.

② ADB Project

a. Annual investment costs

The construction costs for the ADB Project are converted into 1990 prices as Tk.1,454,950,000, based on Table 5.4.6.

Table 9.15 Annual Investment Costs of ADB Project

(Tk. in thousands)

Items	Costs
Depreciation expenses	1,454,950 X 0.9 / 20 = 65,472
Interest	1,454,950 X 11.5% / 2 = 83,660
Total	149,132

b. Liability ratio for container cargo

The ratio of trucks on the Comilla-Daudkandi Highway is shown in Table 9.16 and the average containerization ratio in 2005 is 79.3%, as shown in Tables 8.30 and 8.31.

Accordingly, the liability ratio of container is as follows:

$$\frac{\text{Trucks}}{\text{All vehicles}} \text{ X (Containerization ratio)} = 0.611 \text{ X } 0.793 = 0.484$$

Table 9.16 Annual Traffic Survey on the Comilla-Daudkandi Highway

{Unit : Number of vehicle(PCE)}

	1985-86	1987-88	Average
(A) Truck	1,520	2,237	-
(B) Truck(PCE)(A X 3)	4,560	6,711	-
(C) All vehicles(PCE)	7,338	11,189	-
(D) Ratio of trucks(B/C)	0.621	0.600	0.611

[Source] Roads & Highways Department, "Annual Traffic Survey Report From 1985-86 to 1987-88"

c. Liability costs

The liability costs for the container are as follows:

Tk.149,132,000 X 0.484 = Tk.72,179,890

As a result of repeated calculation, the approximate value of containers on the Dhaka-Chittagong Highway in 2005 is estimated as 121,074 TEU. Accordingly, the liability costs is assumed as follows:

Liability costs for one TEU

= Tk.72,179,890 / 121,074 TEU = 596 Tk./TEU

③ Maintenance costs of the Dhaka-Chittagong Highway

The maintenance costs of the Dhaka-Chittagong Highway are Tk.118,620,000 per year according to the BRTC. Accordingly, the maintenance costs for one TEU of container are as follows:

Tk.118,620,000 X 0.484 / 121,074 = 474 Tk./TEU

Finally, the marginal costs of road transport on the Dhaka-Chittagong Highway for one TEU of container are 10,263 Tk./TEU, as shown in Table 9.17.

Table 9.17 Marginal Cost of Road Transport on the Dhaka - Chittagong Highway for 1 TEU in 2005

Items				Marginal costs (Tk./TEU)
Annual operating costs of one semi-trailer	Vehicle costs	Depreciation expenses	Tk. 2,919,948X(0.7X1.155+0.3X2.505)X0.9/5 =Tk. 819,921	
		Interest	Tk. 2,919,948X(0.7X1.155+0.3X2.505)X17%/2 =Tk. 387,185	
		Insurance expenses	Tk. 2,919,948X(0.7X1.155+0.3X2.505)X1.54% =Tk. 70,149	
		Repair & maintenance expenses	Tk. 2,919,948X9.5% =Tk. 277,395	
	Fuel costs		248.3KmX300daysX9.2(Tk./ℓ)/3(Km/ℓ) =Tk. 228,436	
	Labour costs	Crew costs	Driver: 2PersonsXTk. 4,500X12months =Tk. 108,000	
	Subtotal		Tk.1,891,090	
Operating costs per TEU			Tk. 1,891,090/366 TEU =	5,167
Additional investment costs	ICD			3,081
	ADB Project			596
	Multi-purpose Terminal at Chittagong Port			945
	Maintenauce costs of the Dhaka-Chittagong Highway			474
	Subtotal			5,096
Total				10,263

[Notes]

1) Speed 40.0 Km/hr.

2) Journey Time between Chittagong and Dhaka 6.21 hr.

3) Round Trip 1.64 days

9.1.5 Traffic Modal Split of Container Transport Through Dhaka

(1) 1st step --- Traffic modal split determined by marginal costs

The marginal costs for one TEU of container are shown in Fig.9.5.

In this Figure, the marginal costs by inland waterways are shown as the weighted average of those between Dhaka and two seaports, as follows:

Marginal costs by IW 5,256 Tk./TEU

= Dhaka-Chittagong 5,343 X 81% + Dhaka-Mongla 4,885 Tk./TEU X 19%

The traffic modal split will be basically determined in inverse proportion to the traffic costs, as a result of free competition. From the viewpoint of marginal costs, the traffic modal split between three traffic modes of the container transport between Dhaka and two seaports will be the same as the reciprocal ratio, as shown in Table 9.18.

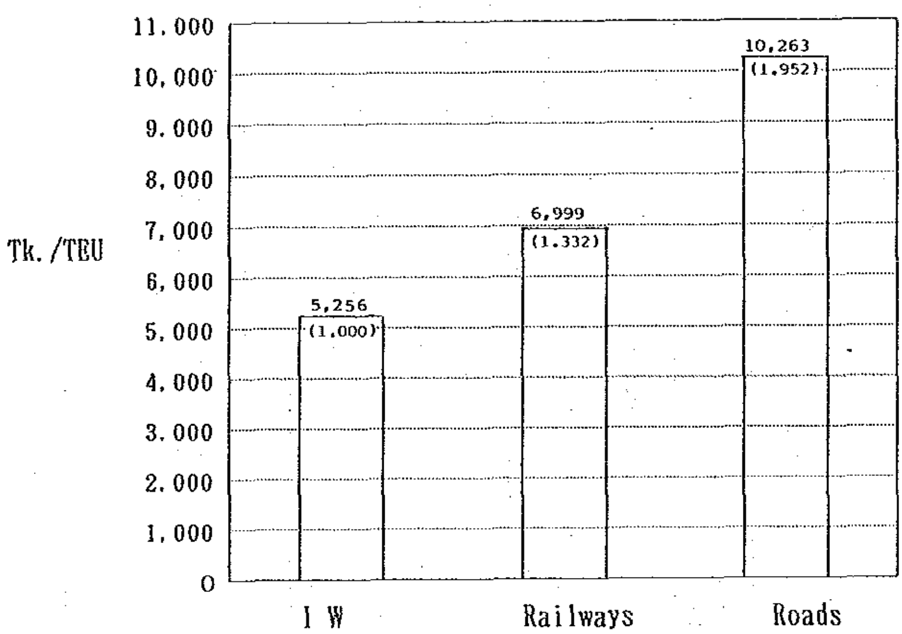


Fig. 9.5 Comparison of Marginal Costs by Traffic Mode

Table 9.18 Reciprocal Ratio by Marginal Costs

	Marginal costs	Reciprocal ratio
Inland waterway transport	5,256 Tk./TEU	44.2%
Railway transport	6,999	33.2
Road transport	10,263	22.6
Total		100.0

(2) 2nd step --- Traffic modal split considering time factor

Secondly, the transport time will influence the modal split.

The average time value for the transport of 1 TEU can be gotten by dividing the weighted average costs of three traffic modes by the weighed average transport time as follows, taking account of each traffic share:

Average time value 483.0 Tk./hr.

$$= \frac{5,256X0.442 + 6,999X0.332 + 10,263X0.226}{(16.60X0.81 + 16.43X0.19)X0.442 + 17.17X0.332 + 6.21X0.226}$$

This average time value is considered as the standard value of the time factor.

Considering the time factor, the traffic modal split will be in inverse proportion to the transport time. The time value costs are considered to be less influential than the marginal costs and therefore in the estimation of the traffic modal split, the time value is weighted half of the marginal costs. Accordingly, the traffic modal split will become the same as the reciprocal ratio of the total costs, which are the sum of the marginal costs and the half of time value costs, as shown in Table 9.19.

Table 9.19 Traffic Modal Split Considering Time Factor in 2005

Traffic mode	(A) Marginal costs	(B) Time Value costs	(C) = (A) + (B) Total costs	Reciprocal of total costs	Reciprocal ratio (Traffic modal split)
Inland waterway	Tk.5,256	Tk.480.0/hr.X (16.60 X 0.81 + 16.43 X 0.19)hr./2 = 4,001	Tk.9,257	0.0001080	38.2%
Railways	6,999	Tk.483.0/hr.X 17.17 hr./2 = 4,146	11,145	0.0000897	31.7
Roads	10,263	Tk.483.0/hr.X 6.21 hr./2 = 1,500	11,763	0.0000850	30.1
Total				0.0002828	100.0

N.B.
Time value costs = Average time value X$\frac{1}{2}$X traffic times

(3) Traffic Modal Split and Container Throughput

Based on the above, it is concluded that the future container throughput at Dhaka will be as shown in Table 9.20.

The Dhaka-Mongla Rail Route of the BR (Bangladesh Railway) has a limited rail capacity due to the partial single track, on which goods trains and passenger trains need to run adjusting their schedules carefully.

According to a report made by the ADB in 1988, it was proposed that the Kamalapur ICD at the Dhaka railway station handle 76,800 TEUs per annum in the beginning of the 21st century. If the BR keeps this target, the other traffic modes, namely IW and road transport, will have to handle a larger volume of containers than that shown in Table 9.20.

Table 9.20 Traffic Modal Split and Future Container Throughput at Dhaka in 2005

	Traffic modal split (%)	Container throughput (TEUs)		
		Import	Export	Total
Inland Waterway	38.2	76,828	76,828	153,656
Chittagong	(30.9)	(62,231)	(62,231)	(124,461)
Mongla	(7.3)	(14,597)	(14,597)	(29,195)
Railways	31.7	63,755	63,755	127,510
Roads	30.1	60,537	60,537	120,074
Total	100.0	201,120	201,120	402,240

9.2 Direct Shipping between Dhaka and Singapore Ports

9.2.1 Marginal Costs by Direct Shipping

Marginal costs for the container traffic by direct shipping that transports the containers directly from Singapore Port to Dhaka Port by oceangoing vessels are calculated as follows:

1) Acquisition costs of the vessel are as follows. Here, the towing charge and the survey costs/insurance for towing are assumed to be the same as those for the container vessels on inland waterways:

Price of vessel Tk.193,935,820

Towing charge Tk. 3,248,430

Survey costs & Insurance for towing Tk.484,840

Total Tk.197,669,190

2) Transport capacity

100 TEU for one vessel

3) Navigational distance

Singapore Port/Chittagong Port(1,554) + Chittagong Port/Dhaka Port (166) - Rivermouth of Karnaphuli River/Chittagong Port(18) = 1,702 nautical miles(3,152 km)

4) Voyage time for one way between Singapore and Dhaka ports

1,702 n.m./11 knots = 154.7 hr.

5) Port times at Dhaka Port

(72 hr. - 16.6 hr. X 2) X 100 TEU/88 TEU = 44.1 hr.

6) Round trip days

44.1 hr. + 154.7 hr. X 2 = 353.5 hr. = 14.7 days

7) Transport capacity in a year

341 days/14.7 X 100 TEU X 2 = 4,639 TEU

8) Crew costs

The crew costs of oceangoing vessels are assumed to be the same as for the BSC's wage table presented in Table 9.21.

Table 9.21 BSC'S Wage Table

(Unit:US$)

Classification	No. of crew members	Wage/Month	Total
Captain	1	1,112	1,112
Chief Officer	1	768	768
Second Officer	1	516	516
Quarter master	1	385	385
Chief engineer	1	1,109	1,109
Mechanic	1	261	261
Bosun	1	261	261
Greaser	1	120	120
Cook	1	261	261
Sailor	3	120	360
Total	12		5,153

9) Other conditions

The same conditions as those for container vessel for inland waterway are assumed for the other items.

Finally, the marginal costs by direct shipping between Singapore and Dhaka ports for one TEU are 14,979 Tk./TEU, as shown in Table 9.22.

9.2.2 Comparison of Marginal Costs between Direct Shipping and Transshipment Transport

The route and the traffic modes of the direct shipping and the transshipment transport are shown as follows:

[Direct shipping]

Singapore Port --- (oceangoing vessel 1,850DWT) --- Dhaka Port

[Transshipment transport]

Singapore Port --- (oceangoing vessel 6,500DWT) ---

Chittagong Port --- (IW vessel 1,400DWT) --- Dhaka

Chittagong Port --- (Railways) --- Dhaka

Chittagong Port --- (Roads) ------ Dhaka

The transport costs by the feeder vessel between Singapore and Chittagong ports are shown in Table 9.23.

The comparison of the transport costs by each route are shown in Table 9.24, which shows that direct shipping is less economical than the transshipment transport, except by roads. But, if the situation changes at Chittagong Port in the future, such as an increase in port charges, freight congestion or a disaster, direct shipping may become economical and realistic.

Table 9.22 Marginal Cost by Direct Shipping between Singapore and Dhaka Ports for 1 TEU

Items					Marginal costs (Tk./TEU)
Annual operating costs of one container vessel	Vessel costs	Depreciation expenses	Tk. 197,669,190X1.57X0.9/30	=Tk. 9,310,218	
		Interest	Tk. 197,667,190X1.57X11.5%/2	=Tk. 17,844,406	
		Insurance expenses	Tk. 197,667,190X1.57X2.5%	=Tk. 7,758,437	
		Repairing expenses		Tk. 817,440	
	Fuel costs	Fuel costs	5.7(tons/day)X34daysX(154.72hr.X2/353.54hr.)X10,823(Tk./ton)	=Tk. 18,412,585	
		Lubricant costs	Tk. 18,412,585/15	=Tk. 1,227,506	
	Labour costs	Crew costs	$ 5,153X34.06.X12months	=Tk. 2,106,134	
	Subtotal			Tk. 57,476,726	
Operating costs per TEU			Tk. 57,476,726/4,639 TEU =		12,390
Additional investment costs		Dhaka Port CT			2,589
Total					14,979

Table 9.23 Transport Costs by Feeder Vessel

Items		Values
Size of vessel		6,500 DWT
Cargo capacity		400 TEU
Service speed		15.0 knots
Costs per day	Navigation	Tk. 370,205
	Anchorage	Tk. 207,511
Navigation distance		1,554 n.m.
Round trip days		8.63 days
Anchorage days at port		1.59 days
Transport costs	Navigation	Tk.3,256,540
	Anchorage	Tk. 324,001
	Total	Tk.3,580,541
Ratio of unloading		0.5
Transport costs per TEU		4,881 Tk./TEU

Table 9.24 Comparison of Marginal Costs between Direct Shipping and Transshipment Transport

		Route	Marginal costs (Tk./TEU)
Direct shipping		Singapore/Dhaka	14,979
Trans-shipment transport	Inland waterway	Singapore/Chittagong+Chittagong/Dhaka	4,881+ 5,343=10,224
	Railways	Singapore/Chittagong+Chittagong/Dhaka	4,881+ 6,999=11,880
	Roads	Singapore/Chittagong+Chittagong/Dhaka	4,881+10,263=15,144

9.3 Sensitivity Analyses

9.3.1 Case 1

Before finalizing this Final Report, the comments on the Interim Report and the Draft Final Report were submitted by the BR. In the comments, the conditions of container transport by railways are described in detail. Therefore, the conditions between the JICA's study and the BR's comments were compared, especially in railway transport. Apart from minor differences, the major differences are found in interest rates, deprecation periods of ICD's facilities and cycle times of container trains between Dhaka and Chittagong which directly affects the required number of locomotives. The differences are summarized as follows:

	BR's Comments	JICA's Premises
1. Interest Rates	4%	11.5%
2. Depreciation Periods		
Pavement	45 yr.	10 yr.
Others	45 yr.	10 yr.
3. Train Cycle Times	24 hr.	48 hr. (ADB's Study:40-48 hr.)

For fair comparison between railways and inland waterways which are under the governmental authorities: the BR and the BIWTA, respectively, at least the same interest rate should be imposed. In terms of depreciation periods, the periods of the same facilities should be the same technically. Regarding the train cycle time between Dhaka and Chittagong, the cycle time proposed by the BR's comments seems somewhat ideal compared with the cycle time proposed by the ADB's study which is almost twice as long as the time proposed by the BR, and the time proposed by the ADB's study seems to be practical.

On the other hand, in order to estimate the cycle time of container ships to ply between the riverside ICD at Dhaka Port and the seaports: Chittagong and Mongla, exact computer simulation was conducted so as to simulate actual operation at the riverside ICD as precise as possible in recognition of the difficulty of estimating terminal turnaround times compared with journey times when estimating the total cycle time. It is also recognized that realistic estimation of operational conditions is vital to financial soundness without deficit.

Notwithstanding that, in order to examine competitiveness of the inland waterway system in such severe conditions proposed by the BR's comments, comparison between the different modes were dared to be conducted. In this comparison, the same interest rate for railways and inland waterways was adopted and the same depreciation periods are assumed for the same facilities. In terms of waterways' operational conditions, however, were left unchanged so as not to fall into undesirable competition of lower charges harming financial soundness of all transport modes. Such comparison can be regarded as a kind of a sensitivity analysis. In this case, the resulting share of inland waterways is estimated as 36% keeping almost the same share as 38% proposed in the Final Report indicating only slight reduction from the base case. Even in this case, it is still recognized that waterway is the most economical mode, though railways take the most share when time factor being considered in the condition of railways' cycle time reduced remarkable compared with the present operation. The resulting shares of the above comparison are summarized as follows:

Unit: %

	(1)	(2)	(3)
Traffic Modes	Case 1.1	Case 1.2	Case 1.3
IWT	38	36	38
Railways	32	42	50
Roads	30	22	12

Note (1): The shares of Case 1.1 as the base case was estimated by the JICA's study shown in the Final Report.

(2): The shares of Case 1.2 was estimated based on the BR's Comments and regarded as a result of the sensitivity analysis.

(3): The shares of Case 1.3 was estimated by the BR.

As mentioned above, the purpose of the modal split in this study is to estimate waterways' share and not to assess the other modes; railways and roads themselves. Thus, focusing on only waterways' share, it is recognized that the share in the range of 35-40% in the Master Plan seems to be reliable.

9.3.2 Case 2

In the case that the road improvement project on the Dhaka-Chittagong Highway financed by the ADB will not be completed until 2005, the container cargoes by roads will be transported by the trucks as the loose cargoes in 2005. In this case, the marginal costs of road transport for 1 TEU will be higher than these in the case of the container cargoes and consequently the traffic modal split and the container throughput of road transport will be lower than in the case of the container cargoes, as shown in Table 9.25 and 9.26. On the contrary, the traffic modal split and the container throughput of inland waterway transport will be higher. Though the difference of the container throughputs of inland waterway transport between two cases is small. Hence the inland waterway share estimated in the base case of the Master Plan is conservative.

Table 9.25 Reciprocal Ratio by Marginal Costs

	Marginal costs	Reciprocal ratio
Inland waterway transport	5,182 Tk./TEU	45.4%
Railway transport	6,984	33.7
Road transport	11,305	20.9
Total		100.0

Table 9.26 Traffic Modal Split and Future Container Throughput at Dhaka in 2005

		Traffic modal split (%)	Container throughput (TEUs)		
			Import	Export	Total
Inland waterway		39.3	79,040	79,040	158,080
	Chittagong	(31.8)	(64,023)	(64,023)	(128,045)
	Mongla	(7.5)	(15,018)	(15,018)	(30,035)
Railways		32.5	65,364	65,364	130,728
Roads		28.2	56,716	56,716	113,432
Total		100.0	201,120	201,120	402,240

9.4 Conclusion

In this chapter, the Study Team made a cost and time analysis concerning the future container traffic between Dhaka and two seaports and concluded that three traffic modes, namely inland waterway, railways and roads, should share the responsibility for container transport as a whole to meet the large forecast demand for the future in these two corridors. From the view point of the national economy and considering the existing insufficient infrastructures, it is necessary to promote the development of a full-scale container transport system consisted of three traffic modes.

In the case of container transport through inland waterway, it has the merits of large capacity and low transportation costs. Thus, inland waterways are expected to play an important role in inland container transport in the future.

9.5 Ratio of the Number of 20 - Foot Container and Ratio of FCLs

For coming to and from the Dhaka area, the ratio of number of 20 - foot containers to the total number of containers are estimated using the actual data at Chittagong port by timer series analysis.

The equation is as follows:

$$Y=88.239 \times e^{-0.0184848(x-1982)}$$

Where X:year

Y:Ratio of the number of 20 - foot container

The result of the estimation is shown in Fig. 9.6.

The ratio of the number of FCLs to the total number of containers is estimated using the result of the O/D survey.

The result of the estimation is shown in Table 9.25.

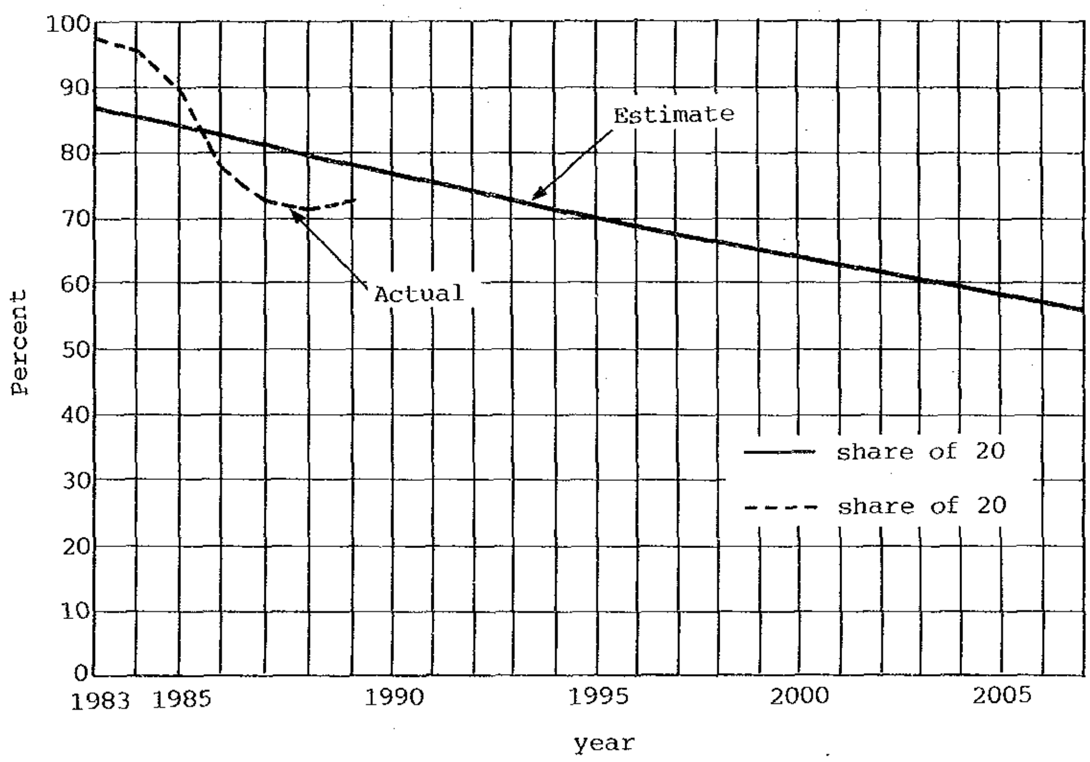


Fig. 9.6 Share of 20 Containers at Chittagong Port

Table 9.25 Ratio of the Number of 20-foot Container

(Unit: Percent)

Year	1995	2000	2005
Share of 20-foot	69.39	63.26	57.68

Chapter 10 FUTURE WATER TRANSPORT SYSTEM FOR CONTAINERS

10.1 Prospective Design of Container Vessels

10.1.1 General

Navigational waterways in Bangladesh are divided into three categories: class I, class II and class III, as per the description in paragraph 5.2.2.

For container handling, a gigantic container handling facility is required, and in this study, the facility is planned to be constructed in the Dhaka/ Narayanganj area.

Consequently, there are distinct differences in type of vessel and system of container cargo handling between the vessels for Dhaka in class I waterways and the vessels for extended waterways.

In this study, the following trunk channels are examined as objects:

for the domestic operation:

Chittagong - Dhaka/Narayanganj

Mongla - Dhaka/Narayanganj

for the international route:

Singapore/Colombo - Dhaka/Narayanganj

10.1.2 Conversion of Existing Vessels to Container Vessels

(1) Design concept

The following conditions are required for modifying some existing vessels to container feeder vessels:

1) The ship's breadth shall be sufficiently large and the ship's stability shall be made endurable even considering the rise of the center of gravity of a ship with containers loaded on the deck.
2) Good seaworthiness shall be provided to withstand an increased lateral wind area.
3) Ship's steering maneuverability should be satisfactory since narrow and sharply bent channels exist even in the trunk channels.
4) Hatch openings shall be sufficiently large so that as many containers as possible can be loaded in the holds by only lift-on/off (vertical movement) without the lateral movement of the containers in the holds.
5) There shall be no obstructions to container loading such as derricks or winches for loading containers on the upper deck.
6) The bridge shall be high so that a forward unobstructed view from the bridge can be ensured even when containers are loaded on the upper deck.
7) The ship shall preferably be relatively new.

A conventional ship, designed to be suitable for the stowage of cargoes in the conventional style of packing, will not be able to accommodate so many containers even after conversion.

When a hatch opening is planned to be enlarged so that many containers can be loaded in a hold, a large amount of modification costs are needed for hull construction, such as reinforcement to compensate for the decrease in strength caused by the enlargement of the hatch opening, and new construction of a hatch coaming and a hatch cover, etc. This is thus unrealistic from an economic point of view.

In this study, implementation of the following minor modifications needed to stow containers is examined for coasters: the mounting of the stacking corners for the container corner castings in a hold and on a hatch cover or on deck and the attachment of metal fittings for container lashing with reinforcement of the mounting places.

(2) Coaster

1) M/V RAMU type vessel

This vessel owned by the BIWTC is selected for our study on conversion, because her particulars are suited to the design criteria as mentioned below.

- The two cargo hatch openings are large, although their length and width do not meet the dimensions of a multiple of the container sizes.
- The vessel is the newest ship among the bay crossing coasters in Bangladesh.
- The vessel is operated efficiently at present because its maintenance time is less compared with other vessels.

2) Mini-Bulker type vessel

The vessels were built in Japan about twenty years ago, and designed for carrying multi-cargoes including containers as well as steel products lumber, and other bulky cargoes.

Originally the vessel was designed to load containers athwartships on the hatch cover of wooden board and tarpaulins. However the containers loaded athwartships are easily damaged by green water when the vessel encounters rough weather in the open sea. Also, the containers have to be handled with the ships crane, which means the vessel would occupy the berth for a long time.

Consequently, it is necessary to replace the existing hatch cover consisting of wooden boards and tarpaulins with weather-tight steel pontoon type covers so that the containers will be stored in Longitudinal direction in order to secure them safely and to save time at the berth by handling the containers with the shore gantry crane.

It is necessary to load water ballast in double bottom tanks to obtain enough stability when the containers are loaded on the hatch covers for both types of vessels.

The vessels particulars, including the number of carrying containers, are shown in Table 10.1.in 10.1.2(5) summary.

(3) Bay crossing barge

The following types of bay crossing barges are available as typical barges:

* five holds, five hatches with five derricks built in 1975.
* two holds, two hatches with four derricks built in 1972.

Since these types have a simple hull construction and a low ship's depth, it is possible to stow containers by completely closing the hatch openings with steel plates to make the upper deck flush, instead of loading containers in the hold, and dismantling the cargo gears on the upper deck.

In this case, the hull itself becomes a buoyant body as a void space. Consequently a large quantity of solid ballast (150 - 200 t) must be loaded in the ship's bottom to compensate for the rise of the center of gravity of the vessel due to the stowage of containers.

The conversion work was studied on the BB-1121 series barges having five hatches because these barges can load larger number of containers and are newer than the other series. The bridge has to be raised up by two floors to ensure a forward view when containers are loaded on the upper deck.

The number of carrying containers on the barge after conversion is shown in Table 10.1 in 10.1.2(5) summary.

At present, bay crossing barges are towed by one 1,000 ps tug boat with two barges alongside in the dry season and one barge in the monsoon season. However when containers are loaded, one barge will be towed in all seasons because of the increase in the lateral wind area.

(4) Inland flat

The inland flats were constructed early in this century. They are beyond the scope of this study because of their obsolescence though their hull types are suitable for container loading.

At present almost all inland flats are used as landing jetties.

(5) Summary

Particulars of existing vessels, at present and after conversion, are shown in Table 10.1 and sketches are shown in Fig. 10.1, 10.2, 10.3.

These vessels are now old and when the container terminal goes into the operation in 1995, their remaining operating years will be few.

These vessels will have the following problem:

- The number of carrying containers is not enough compared with a new vessel.
- The number of days when the vessel can operate is small, because of unavoidable trouble due to the age of the vessel.
- The cost of running the vessels excludes amortization of he initial investment, will be higher than a new vessel due to the large amount of maintenance cost, the low efficiency of the machinery and the large number of crew.
- A considerable amount of funds for conversion is needed.
- It will be difficult to operate the vessel according to a tight schedule, which is an essential factor for a container ship operating a shuttle service, because the possibility of unexpected trouble is high.

Due to the above reason, it is not recommended to carry containers by the converted existing vessels, as it is not economical and difficult to realize the anticipated capability of the container terminal according to the circumstance.

Table 10.1

Particulars of existing vessels

present and after conversion

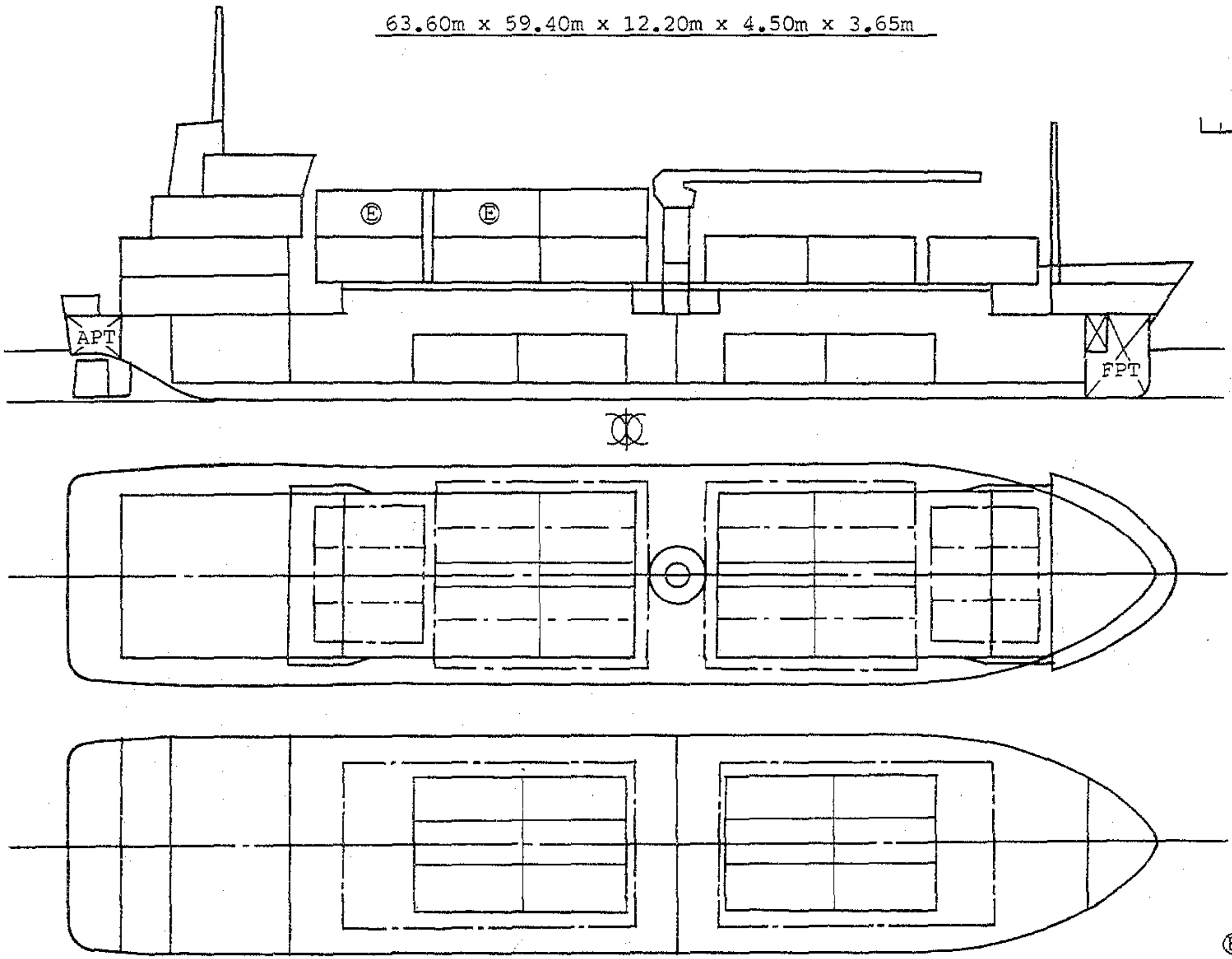
Ship's Type	M/V RAMU		Mini-Buker		BB-1121 series	
Owner	BIWTC		Private owndres		BIWTC	
Built	1982		1970		1975	
Length o.a.	63.60 m		65.50 m		60.00 m	
Length p.p.	59.40 m		62.80 m			
Breadth mld.	12.20 m		15.30 m		8.65 m	
Depth mid.	4.50 m		6.60 m		3.52 m	
	Present	After Conversion	Present	After Conversion	Present	After Conversion
Draft	3.68 m	2.28 m	4.96 m	3.44 m	2.14 m	1.56 m
Deadweight	*1.726^{t}	*820^{t}	3.066^{t}	1.700^{t}	750^{t}	335^{t}
Cargo D.W.	*1.605^{t}	*542^{t}	2.880^{t}	1.320^{t}		330^{t}
No of Container						
Loaded	38		94		20	
Empty	7				20	
Total	45^{TEU}		94^{TEU}		40^{TEU}	
Main engine	1 x 1.085 ^{PS}		2 x 750 ^{PS}			
Water ballast when container loading	170^{t}		240^{t}		150$^{t\ S.B.}$	

N.B. * marked values show in FW

S.B. means solid ballast

M/V RAMU

63.60m x 59.40m x 12.20m x 4.50m x 3.65m



NO OF CONT

LOADED	38	
EMPTY	7	
TTL	45	TEU

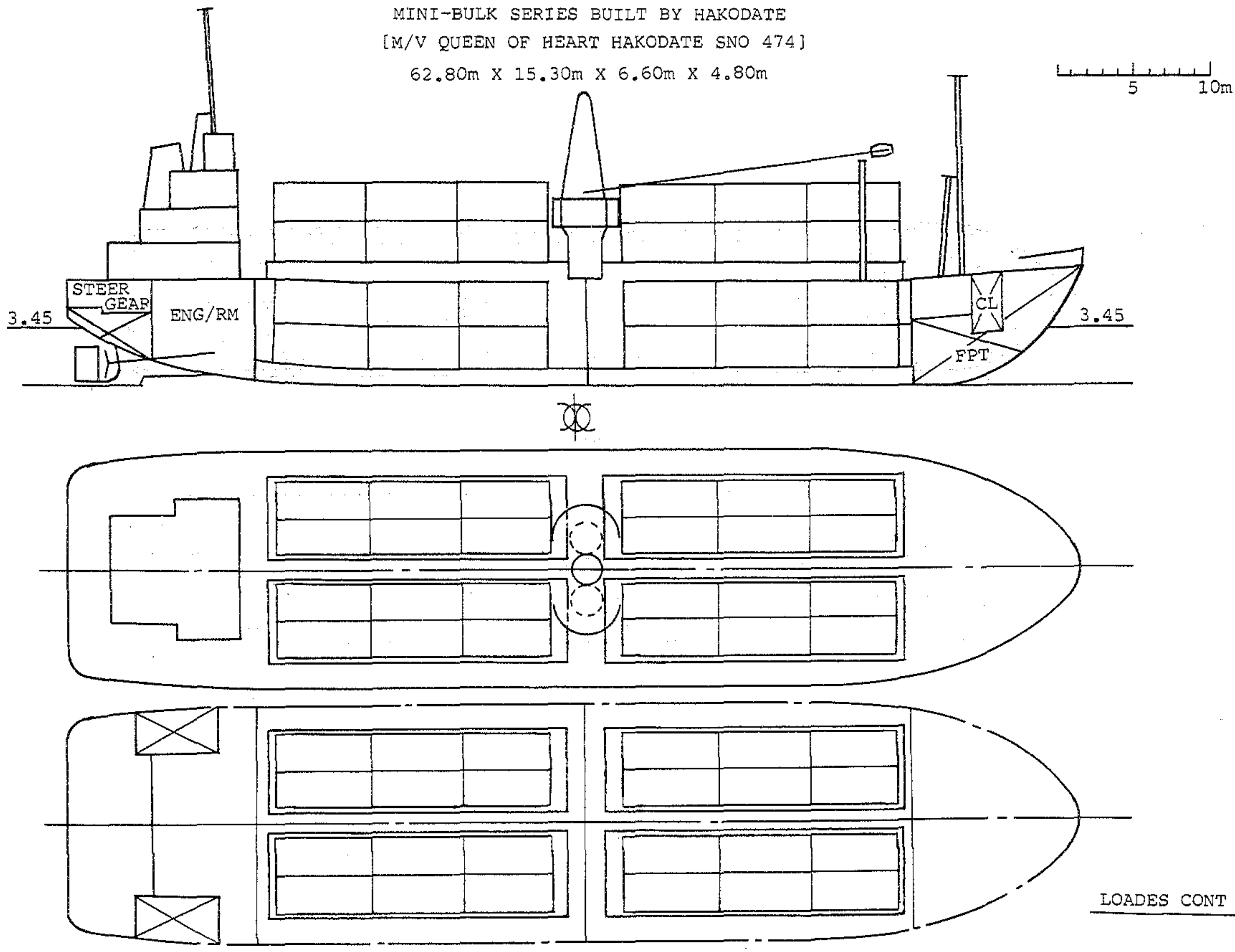
Ⓔ:EMPTY CONT

Fig. 10.1

MINI-BULK SERIES BUILT BY HAKODATE

[M/V QUEEN OF HEART HAKODATE SNO 474]

62.80m X 15.30m X 6.60m X 4.80m



	ONDK	46
LOADES CONT	HOLD	48
	TTL	92

Fig. 10.2

BB - 1121 SERIES

60.00m X 8.65m X 3.52m X 2.14m

196' - 9" X 28' - 4" X 11'-6" X 7' - 0"

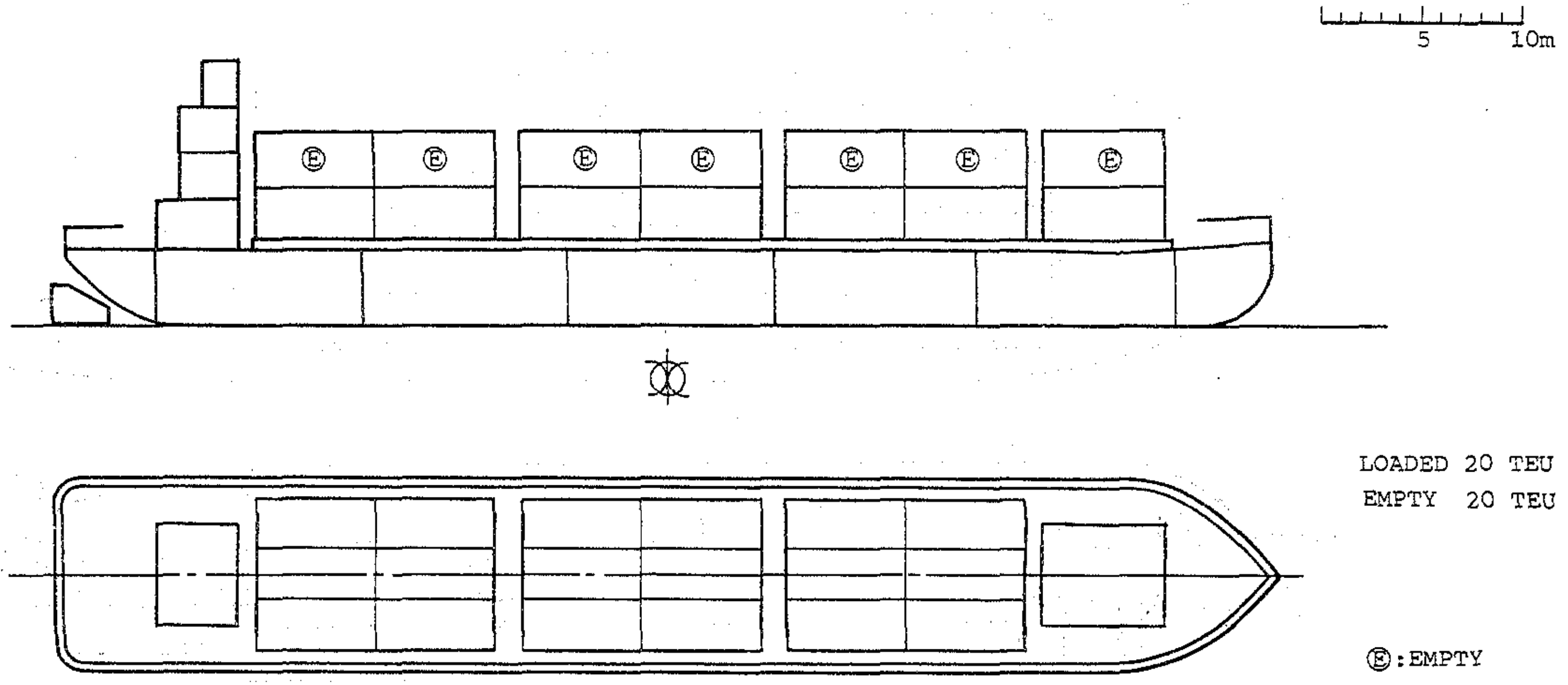


Fig. 10.3

10.1.3 Building New Vessels

(1) Container Handling System of Container Vessels

According to the kind of container vessel itself, container handling systems of container vessels are divided into the following two systems:

1) Lift on /Lift off system

Loading and discharging of containers are carried out one by one using a gantry crane on the vessel or on the pier apron.

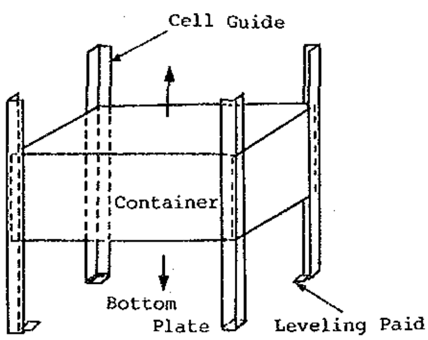
In this system, containers are lifted and moved only vertically in the vessels' hold without lateral movement.

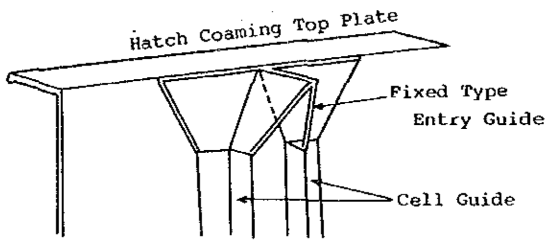
Therefore, vessels' holds are equipped with vertical cell guides made of angle bars (4"x4" or 6"x6" in size) in accordance with the size of the containers.

Containers are stowed along the cell guides and secured by them at their four corners from ships' laboring at sea.

As the clearance between the cell guide and the container is very narrow, hopper guides are provided at the top of the cell guides for easy adjusting of the container to the cell guides.

This type of hold construction is called "cellular hold".





2) Roll on / Roll off system

Loading and discharging of the containers are carried out using chassis, trailers and forklifts via a ramp-way spanning the gap between the port of the vessel and the wharf.

In this system, the containers are moved only horizontally and are easily shifted in the vessels' hold. But they should be secured by lashing to prevent shifting in the hold due to ships' motion at sea.

This system is not suited for ports where the water level changes greatly through the year.

In comparison with the lift on / lift off system, a bigger-capacity cargo hold is required for vessels in this system in order to carry the same quantity of cargo. A wider space is also required for container terminals in this system to handle the same number of containers because the containers are not stacked in tiers in vessels' cargo holds and container stocking yards.

Based on the above, the Study Team considers that the Lift on / Lift off (LO/LO) System is suitable for the Dhaka Container Terminal.

(2) Maximum size of vessels that can navigate to the Dhaka/Narayanganj area

The navigation channels considered in this study are class I waterways, and the following values are informed by the BIWTA.

Controlled depth : 3.66 m (12')

Minimum horizontal clearance : 76.2 m (250')

Minimum vertical clearance : 15.8 m (52')

There are sand bars in the vicinity of Hatia at the estuary of the lower Meghna River in the course of the channel from Chittagong to Dhaka. Though places having water depth of 2.1 - 3.0 m below C.D. are found about a 30 km stretch. Even in the dry season, a vessel of 3.66 m (12') draft is navigable at high tide.

There is a place where ship maneuvering is difficult in the vicinity of Fatulla - Hariharpara - Gange direct downstream of Dhaka in the Buriganga River, At that place the river bends at a 90° or more angle and the effective width of the bending point is very narrow, that is, 90 -100m (300 - 330') in the dry season.

Besides this, considering the flow in the river, current, the large lateral wind area is a feature of a container vessels and the turning in the water area in front of a container yard, and judging from the information obtained from the persons concerned, and investigation at the site, the maximum dimensions of self-propelling vessels navigable in the Dhaka/Narayanganj area are thought to be as follows:

Length overall : 70.0 ~ 76.0m (230~250')

Breadth : 12.1 ~ 13.6^{m} (40~45')

Draft : less than 3.66^{m} (< 12')

The most important parameter is a ship's draft. Since a vessel's draft in fresh water is deeper by 0.09 m than in sea water at a 3.66 m draft of a vessel and if 0.2~0.3 m degree of a ship's trim is counted, the designed moulded drat of the vessel in SW is restricted to 3.50^{m} (11' -6").

(3) Design concept

The following points are considered necessary in the design of an economical container feeder vessel in the shuttle service to/from Dhaka.

- The vessel must have larger principal dimensions and be navigable as far as Dhaka so as to load as many containers as possible.
- The cargo handling time and works to be reduced so that the rotation of the vessel is kept high and the congestion at the berth is mitigated.
- Machinery and equipment to be installed on the vessel should have high reliability.

i) Domestic service vessel

An open top type vessel as per Fig. 10.4 is preferable.
This type of vessel has the following features:

- Due to the adoption of a coverless hatch, containers on upper layer can be loaded in a lower position by the thickness of a hatch cover compared with conventional hatch covered ship and the center of gravity of the vessel is lowered. This ensures better stability.
- On these routes sailing times over one round trip are short, consequently cargo work frequency is high throughout the year. The work and time needed for hatch cover opening/closing are excluded, and moreover the problem of providing stowage space for large-size hatch covers while handling cargo is eliminated.
- Container of the three layers from the bottom are loaded along the cell guides in the hold, and lashing work is required for the upper most one layer only.

- When a vessel enocounters rough weather in the open sea, seaworthiness can be improved by filling water ballast into double bottom tanks or side tanks.
- Hull is constructed in double in way of the hold. However savings of the initial investment are expected duo to the hatch coverless design.

Thus this type of vessel is suitable for shuttle service.

However it is important to design a hull form with better seaworthiness, because the inflow of rain water or sea water into a cargo hold can be assumed. And counter measures such as installing the bilge pumps capable of auto -start/stop with the large bilge wells provided in the fore and aft parts of the hold should be considered.

Moreover designing should proceed after sufficient discussion with the government concerned and a classification society on design problems since this type of vessel has not actually been realized as an operational ship, and there are no regulations or rules governing this type of ship on ILLC '66 (The International Convention of Load Line) and SOLAS '83.

Althougth the bay crossing coasters must have certificates of ILLC '66 and SOLAS '83 as far as safety Construction and Safety Equipment, in accordance with Bangladesh government rules, the government has the authority to permit the operation of this type of vessel based on their judgment after consult with a classification society.

N.B. SOLAS '83 means SOLAS 1974 and its related protcol 1978 with amendment 1981 and 1983.

ii) International service vessel

International trading vessel must follow international maritime regulations, such as the ILLC and SOLAS. Thus vessels of the conventional type having hatch cover are under study, since it takes about one week for one single trip, which means the frequency of the operation of hatch cover is low.

In order to obtain an economical vessel that can compete with foreign vessels, the following items are incorporated in the design in addition to the general design concept as mentioned before :

- Adoption of full-automation by introducing new technology.
- Improving crews performance through education and training.
- Reducing the complement of a vessel.

(4) Proposed new container vessels

Container vessels for domestic service and for international service, for example, are designed in accordance with the design concept mentioned above in 10.1.3.(2) & (3).

Their principal particulars and outline of these vessels are shown in table 10.2 and Fig 10.4 and 10.5, respectively.

Table 10.2

Particulars of New Ships

Type of ship	Domestic Service Open Top Type Without hatch cover	International Service Conventional with hatch cover
Length o.a.	68.00 m (223'-0")	75.00 m (246'-1")
Length p.p.	63.00 m (206'-8")	70.00 m (229'-8")
Breadth mld	13.00 m (42'-8")	13.50 m (44'-3")
Depth mld	8.00 m (26'-03")	6.00 m (19'-8")
Draft mld.	3.40 m (11'-2")	3.50 m (11'-6")
Draft mld at the sea	3.80 m (12'-6")	3.80 m (12'-16")
Dead weght	1,400 t (3.40 m dr.)	1,650 t (3.50 m dr.)
Gross Tonnage	1,700	1,650
No. of Containers		
Loaded	80	92
Empty	8	8
Total	88 TEU	100 TEU
Main Engine	1 x 1,200 PS	1 X 1,800 PS
Service Speed	10 kts	11 kts
Complement	12	12
Navigation instrument	Conventional	Modern
Automation	Simple - System	Full - Automation

References : 'Open topped container ships' would save time and money
The Motor Ship June 1987
'Container Ships' The Bulletin Technique du Bureau Veritas
No.1,1990

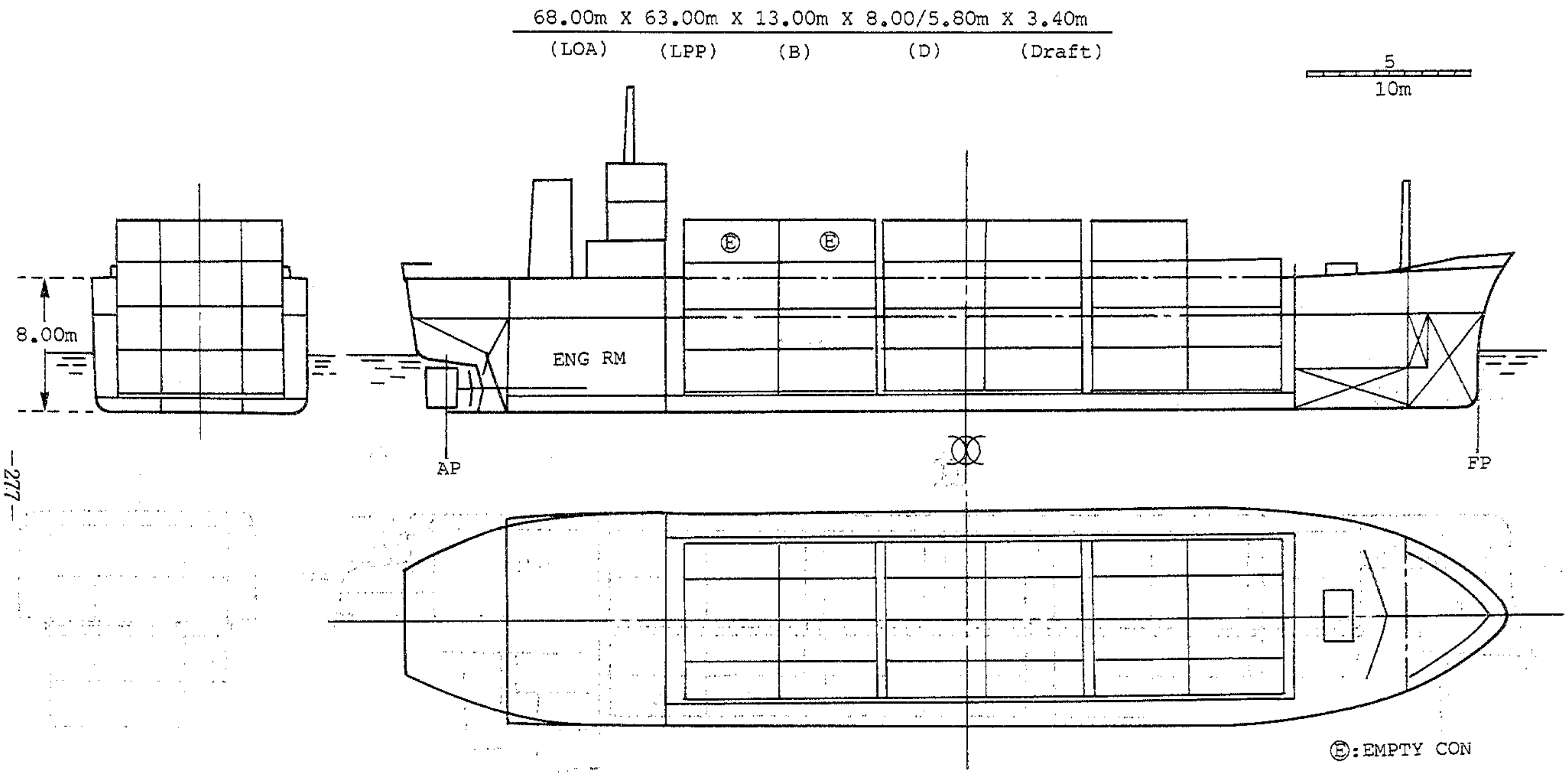

68.00m X 63.00m X 13.00m X 8.00/5.80m X 3.40m
(LOA) (LPP) (B) (D) (Draft)
5
10m
8.00m
ENG RM
AP
FP
Ⓔ:EMPTY CON

Fig.10.4

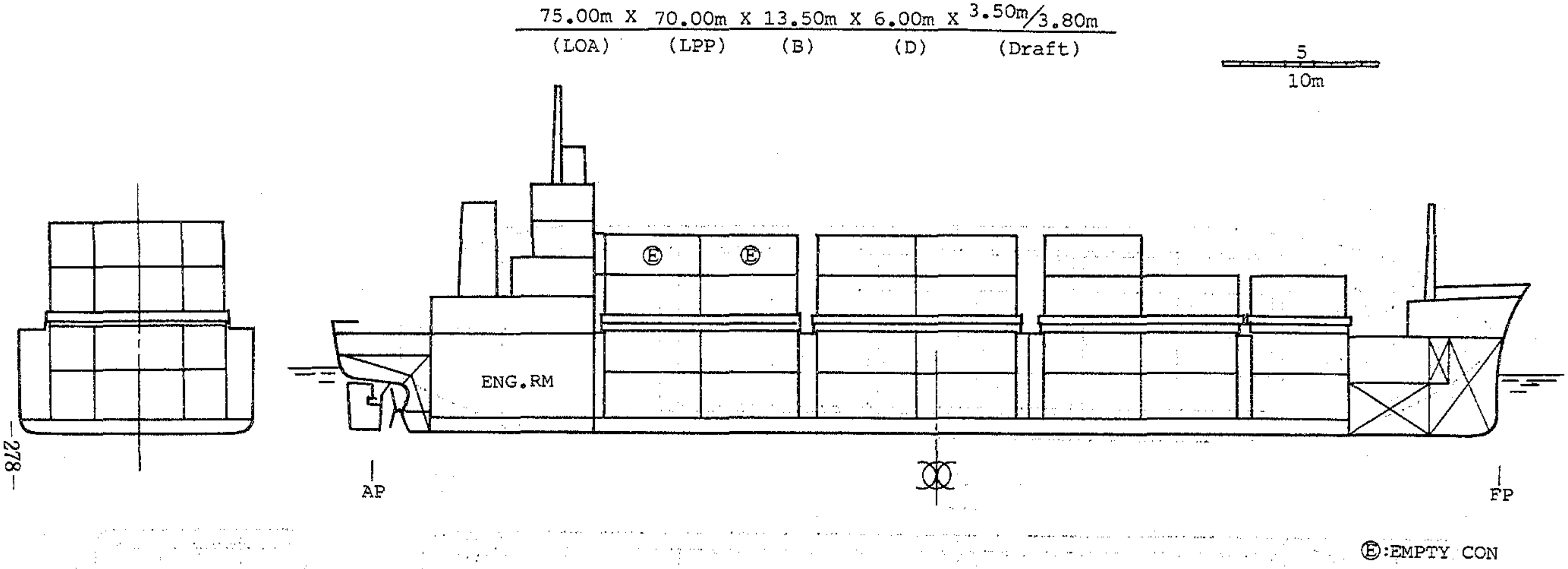

75.00m X 70.00m X 13.50m X 6.00m X 3.50m/3.80m
(LOA) (LPP) (B) (D) (Draft)
5
10m
ENG.RM
AP
FP
Ⓔ:EMPTY CON

Fig.10.5

(5) Required Number of Container Vessels

Based on the results of the modal split of container traffic forecast, the required number of container feeder vessels servicing the route between the ports of Dhaka and Chittagong or Mongla in 2005 is worked out as follows:

Data from the modal split of container traffic forecast:

i) Container throughput at Dhaka port in 2005

from and to Chittagong port	124,319 TEUs.
from and to Mongla port	29,161 TEUs.

ii) Carrying capacity of planned vessel in 2005

Dhaka--Chittagong route

341 working days ÷ 2.82 days for one trip x 2 ways x 88 TEUs
= 21,828 TEUs

Dhaka--Mongla route

341 working days ÷ 2.80 days for one trip x 2 ways x 88 TEUs
= 21,434 TEUs

From the above, the required number of planned container vessels

for Dhaka--Chittagong route is to be:

124,319 TEUs ÷ 21,282 TEUs = 5.84 vessels = 6 vessels

and

for Dhaka--Mongla route is to be:

29,161 TEUs ÷ 21,434 TEUs = 1.36 vessels = 2 vessels

Therefore, a total of 8 container vessels are required.

(6) Improvements in international service ships in the future.

There is a possibility that more economical vessels may navigate as far as Dhaka/Narayanganj area even in the dry season, if the ships steering facility were to be improved and developed in the future.

Shore facilities in the container terminal, especially the shore gantry crane, should be designed at the initial stage in connection with this matter.

The principal particulars of this type of more economical container vessel are shown by way of example in Table 10.3 and the outline sketch in Fig 10.6.

Table 10.3

Particulars of connsiderable

International Serivce Ship in the Future

Length o.a.	83.00 m	(272'-4")
Length p.p.	78.00 m	(255'-11")
Breadth mld.	15.50 m	(50'-11")
Depth mld.	8.50 m	(27'-11")
Draft mld.	3.50 m	(11'- 6")
at the sea	4.00 m	(13'- 1")

Deadweigh at 3.50 m draft 2,000 t

No of Containers	
Loaded	140
Empty	16
	156 TEU

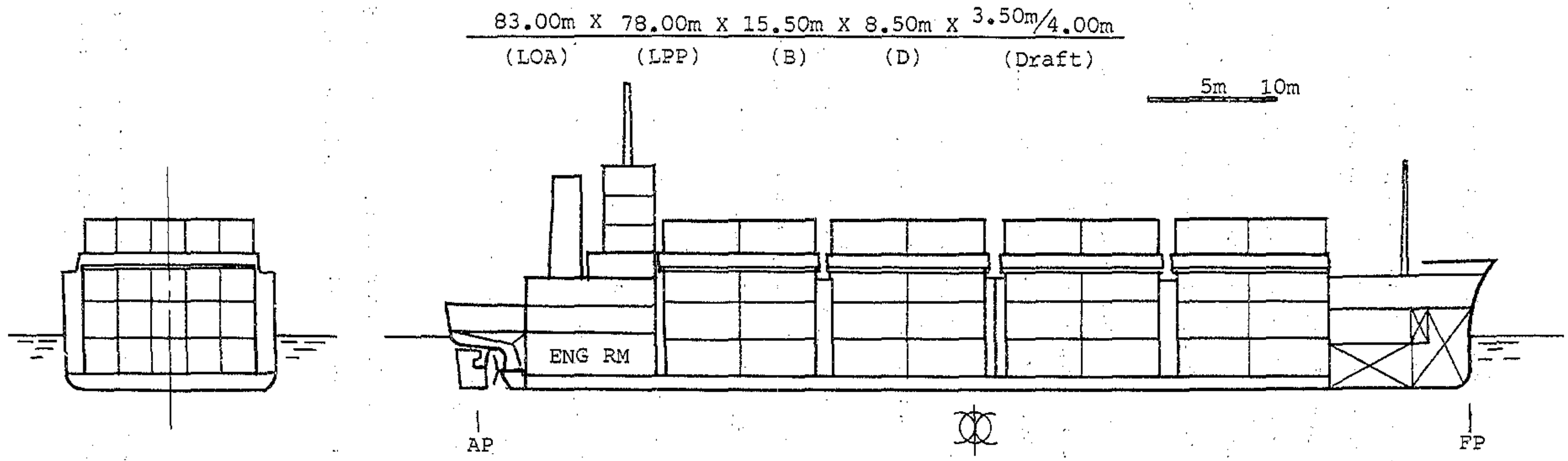

83.00m X 78.00m X 15.50m X 8.50m X 3.50m/4.00m
(LOA) (LPP) (B) (D) (Draft)
5m 10m
ENG RM
AP
FP

Fig.10.6

(7) Pusher/Tug -Barge System

Generally this system has the following advantages compared with self-propelling ships.

- In case where the cargo handling time is longer compared with the navigation time. it may be possible to avoid idling main engine while ship's cargo handling is carried on.
- In case navigable waterways are wide enough, and there is a smooth, slow current and easy curves for the steering system, one pusher/tug can navigate along with more than one barges which means high efficiency.
- In case the principal dimensions of the barges are large compared with those of the pusher, better propulsive efficiency may be obtained when the barges and pusher are connected in one line.

However, the following features should be considered on this project.

- The cargo handling time of the container at the berth is to be short.
- There are places where the rivers bend sharply and the effective width of the river is very narrow in the dry season such that tugs cannot tow the barges. Consequently, the bay crossing barge are towed by the tug alongside.
- Propulsive efficiency and steering ability of the tugs alongside barges are low compared with self-propelling ship. Furthermore, another crew member must be on the barge to take care of the steering of the barge.
- The costs of investment as well as operation of pusher/tug - barge system are expensive on this project.

The pusher / tug -barge system has many disadvantages, as mentioned above, as far as on this project. Thus this system will be excluded from this study.

10.1.4 Shipyards in Bangladesh

Four shipyards - Chittagong Dry Dock Ltd., Khulna Shipyard Ltd., High speed Shipbuilding & Heavy Engineering Co. Ltd., and BIWTC Narayanganj

Dry Dock No.1 – have been visited.

The consultant could not spare enough time to study the yards' capability, but could obtain the following information:

(1) Chittagong Dry Dock Ltd.

The yard is managed and operated under the jurisdiction of the Bangladesh steel and Engineering cooperation. The yard is sited adjacent to Chittagong port to repair vessels up to 16,500 DWT that call at the port, and began trial operation in 1981.

The Yard has the largest ship repair facilities in Bangladesh with a dry dock of 173 ^{m} x 23 ^{m} x 11 ^{m} equipped with 1 x 50 ^{t} crane and 1 x 15 ^{t} crane. The outfitting quay, about 350 ^{m} in length with 1 x 50 ^{t} crane and 1 x 15 ^{t} crane, will be useful for the anticipated increased volume of activity. The machine shop has modern machinery capable of fabricating all type of steel structures and pressure vessels, etc.

The yard is now busy, and the rotations of the dry dock and the outfitting quay are high.

(2) Khulna Shipyard Ltd.

The yard is managed and operated under the jurisdiction of the Bangladesh Steel and Engineering Cooperation. The yard began operation in 1957, builds and repairs various type of river crafts.

The main facility of this yard is a slip way system both for building ships and repairing ships, which can display its full capacity when vessels of the same design are constructed continuously. The maximum size of vessels is restricted due to the dimensions and capacity of the slip way, that is, vessels of a length up to 350 feet and a light weight (launching weight) up to 750 tons.

It seems that the yard could not reach its full capacity because of a lack of works and rather old facilities.

(3) Highspeed Shipbuilding & heavy Engineering Co. Ltd.

This is a private company managed by the Highspeed Group. The yard is situated on the west bank of he Buriganga River about 6 Km down stream from the Buriganga Bridge.

The yard commenced operations in 1981 for building and repairing river and coastal vessels, steel structures and equipment such as pressure vessels, etc.

The yard is equipped with modern facilities and can obtain technical assistance from Mitsui Engineering & Shipbuilding Co. Ltd., which is one of the leading shipbuilders in Japan.

(4) BIWTC Narayanganj Dock Yard No.1

The yard is owned by the BIWTC, and its major work is repairing tugs and barges. The yard is situated on the east bank of the Lakya River about 4 Km up stream from Narayanganj.

The yard was constructed during World War II. Thus the facilities are very old.

(5) Summary

To improve the present productivity of the shipyards, the following measures should be studied:

- Modernizing the facilities.
  Most of the yards are suffering from a long term lack of investment.
- Reducing the time needed to obtain spare parts.
  It takes about six monthes to obtain imported spare parts. Even in case of emergency two to three monthes are needed.
- Procuring proper materials in proper time.
  For example, max. size of steel plate produced by Bangladesh Steel & Engineering Corporation is 4 feet by 8 feet, which is too small for shipbuilding.

All work involving converting existing vessels to container vessels can be carried out in Bangladesh.

As for building new ships, joint projects with industrialized countries are recommended. That is, the first vessel should better be designed and built in an industrialized country such as Japan and engineers and workers in Bangladesh will stay in the Japanese yard to learn how to proceed with the design and construction. From the second vessel on, ship building will take place in Bangladesh. This way will be better for technical transfer to Bangladesh.

10.2 Management and Operating System of Container Vessels

10.2.1 The Problems in Existing Management and Operating System of Shipping

(1) Inefficiency of Public Sector

The BIWTC is operated at a loss every year due to insufficient cargo. The loss is made up by the subsidies from the government. One of the reasons is that its services are often operated on some non-economic routes under government instructions. But the main reason may be that its services do not satisfy the needs of the users and are operated under an inefficient management and operating system.

On the other hand, the BSC has also been operating at a loss since 1985/86. The reasons for this are similar to those regarding the BIWTC.

It should be considered that the public sector is inclined to follow an easygoing way of thinking in which it is expected that financial losses will be made up by government subsidies. So the operations of the public sector lack the incentive to be efficient. Their pay system also lacks incentives to hard work. The excessive interference of the government in the operations of the public sector prevents it from making an effort to streamline the management and operations and to find develop new business.

(2) Insufficient Navigational Aids and Communication System for Safe Night Navigation

Navigational aids in inland rivers, such as light beacons and buoy lights, etc., are not sufficient for safe night navigation. The masters of most vessels are obliged to slow down their ships or simply not navigate at night. The communication system between vessels and inland river ports is also not sufficient to ensure safe navigation in inland rivers.

10.2.2 Basic Concept of the Optimum Management and Operating System

(1) Introduction of Privatization

Container waterway transport will be confronted with severe competition from trucks and railways. In order to compete with their services, it is necessary to establish an excellent service for users and an efficient management and operating system. Consequently, it is recommended that not only public but also private shipping companies should manage and operate container waterway services.

In order to increase the competitive position of the waterway container transport, waterway container services should be supplied by more than one company.

On the other hand, as far as the building of container vessels is concerned, low-rate interest loans or subsidies from the government may be considered. That is because the financial abilities of private shipping companies in Bangladesh are not big enough to build container vessels using their own funds.

Technical, financial or operational tie-up between foreign shipping companies operating main or feeder services of international container trade should also be considered.

(2) Establishment of Safe Night Navigation

It will take 16 to 18 hours for projected container vessels to navigate from Dhaka to Chittagong/Mongla and vice versa at a speed of 10 knots. In order to hold a dominant position in inland container transport, it is recommended that safe night navigation should be established in waterway transport. Navigational aids or communication system for safe night navigation of container vessels in inland rivers should be developed.

10.2.3 Responsibilities and Liabilities of Shipping Companies

At one time, maritime carriers had no responsibilities or liabilities toward cargo owners except the collection of freight, adding many immunity clauses to the contract of carriage of goods.

However, the International Convention for the Unification of Certain Rules Relating to (Ocean) Bills of Lading, also known as "The Hague Rules" was effected and signed by many shipping countries at Brussels in August, 1924.

According to this convention, the responsibilities and liabilities, the rights and immunities, the limitation of responsibilities, etc., of the ocean carriers were stipulated as follows:

(1) Period of transportation

"Carriage of goods" covers the period from the time when the goods are loaded on to the time they are discharged from the ship.

Generally speaking, they say "from tackle to tackle".

(2) Responsibilities and Liabilities

1) The carrier should be bound before and at the beginning of the voyage to exercise due diligence to:

(a) Ensure the ship is seaworthy;

(b) Properly man, equip, and supply the ship;

(c) Make the hold, refrigerating and cool chambers, and all other parts of the ship in which goods are carried, fit and safe for their reception, carriage and preservation.

2) The carrier should properly and carefully load, handle, stow, keep, care for, and discharge the goods carried.

3) After receiving the goods into his charge the carrier or the master or agent of the carrier shall, at the request of the shipper, issue to the shipper a bill of lading showing the number or quantity, the apparent order and condition of the goods.

(3) Rights and Immunities

1) Neither the carrier nor the ship shall be liable for less or damage arising or resulting form unseaworthiness unless caused by want of due diligence on the part of the carrier to make the ship seaworthy

and to secure that the ship is properly manned, equipped, and supplied and to make the holds, refrigerating and cool chambers, and all other parts of the ship in which goods are carried, fit and safe for their reception, carriage, and preservation in accordance with the provisions of item (2)-1)-a), b) and c).

Whenever loss or damage has resulted from unseaworthiness, the burden of proving the exercise of due diligence shall be on the carrier or other person claiming exemption under this article.

2) Neither the carrier nor the ship should be responsible for loss or damage arising or resulting from:

(a) Act, neglect or default of the master, mariner, pilot or the servants of the carrier in the navigation or in the management of the ship.

(b) Fire, unless caused by the actual fault or privity of the carrier.

(c) Perils, dangers, and accidents of the sea or other navigable waters.

(d) Act of God.

(e) Act of war.

(f) Act of public enemies.

(g) Arrest or restraint of princes, rulers, or people or seizure under legal process.

(h) Quarantine restrictions

(i) Act or omission of the shipper or owner of the goods, his agent, or representative.

(j) Strikes, lockouts, stoppage or restraint of labor from whatever cause, whether partial or general.

(k) Riots an civil commotions.

(l) Saving or attempting to save life or property at sea.

(m) Wastage in bulk or weight or any other loss or damage arising from inherent defect, quality, or vice of the goods.

(n) Insufficiency of packing.

(o) Insufficiency or inadequacy of marks.

(p) Latent defects not discoverable by due diligence.

(q) Any other cause arising without actual fault or privity of the carrier, or without the fault or neglect of the agents or servants of the carrier, but the burden of proof shall be on the person claiming the benefit of this exception to show that neither the actual fault or privity of the carrier nor the fault or neglect of the agents or servants of the carrier contributed to the loss or damage.

3) Any deviation in saving or attempting to save file or property at sea or any reasonable deviation shall not be deemed to be an infringement or breach of this convention or of he contract of carriage, and the carrier shall not be liable for any loss or damage resulting therefrom.

4) Neither the carrier nor the ship shall in any event be or become liable for any loss or damage to or in connection with goods in an amount exceeding 100 pounds sterling per package or unit (Package Limitation) or the equivalent of that sum in other currency unless the nature and value of such goods have been declared by the shipper before shipment and inserted in the bill of lading.

According to the Hague Rules it is the great principle that carriers are responsible an liable for loss or damage to carried goods during loading, storage, navigation and discharging arising or resulting from commercial fault namely actual fault of their agents or servants but free from navigational fault in the management of the ship.

Nowadays, most shipping countries have ratified the Hague Rules and enacted their own laws and / or regulations based on the rules.

However the contents of the Hange Rules have not kept up with the demands of the times, especially the advent of the combined transportation system of containers.

Then, in answer to requests from the shipping and trading world the Hague Rules were amended at Brussels in 1968 and the amended rules were called the "Hague Visby Rules".

The characteristics of the new amended rules are as follows:

i) Increase of package limitation

The package limitation of carrier's liability was increased from 100 pounds sterling per package or unit to 10,000 Poincaré francs per package or 30 Poincare' francs per 1 Kg gross of the cargo.

ii) Depending on the development of new transportation system, regulations regarding containers and pallets were added.

In cases where shippers pack cargo into containers if the number of packages in a container is mentioned on the B/L, the number mentioned is regarded as the base of package limitation.

iii) Expansion of period of transportation

In the case of container transportation, coverage of "carriage of goods" is expanded.

"Carriage of goods" covers the period from the time when the goods are received by carriers at the container yard (CY) or container freight station (CFS) to the time when the goods are delivered by carriers at the CY or CFS at the destination, or, broadly speaking, from door to door.

The "Hague Visby Rules" were ratified only by European countries. The U.S.A. and Japan have not ratified the new rules for the reason that the new rules are very strict from the point of view of shipping companies.

Generally speaking, the shipping company (ocean carrier) is responsible to shippers and consignees for the transportation of the cargo between the places mentioned on the Bill of Lading (B/L) as the place of receipt (or port of loading) and the place of delivery (or port of discharge).

When containers are transported by inland vessels, by railway or by trailers between Chittagong or Mongla and Dhaka, there arises the question of who is responsible to shippers and consignees for this transportation.

In case, when Dhaka Port or the Dhaka Container Terminal is clearly mentioned on the B/L issued by the shipping company as the place of receipt for export or the place of delivery for import, it is very clear, in accordance with international trade rules, that the shipping company is responsible to shippers an consignees for transportation of the cargo.

However, in cases where the shipping company issues a B/L on which the place of receipt or the place of deliver is not Dhaka but Chittagong or Mongla, it is necessary to make this point clear in order to shippers and consignees to utilize the Dhaka Container Terminal without hesitation.

This is because the Study Team recognized that the management and operation of the transportation between Dhaka Container Terminal and Chittagong or Mongla are to be implemented under the control and supervision of the ocean-shipping companies who should issues a B/L on which the Dhaka Container Terminal is mentioned as the place of receipt or the place of delivery.

Of course, such shipping companies are able to charge shippers or consignees for further and additional freight transport between Dhaka and

Chittagong (Mongla).

It should be understood that the above shipping companies are responsible to shippers and consignees for this transportation.

10.2.4 Security of Transportation

It is generally reported that there are many cases of pilferage and contraband in Bangladesh. In light of the long distance of about 300km between Chittagong and Dhaka, railway transportation and truck transportation are likely to involve some possibility of theft, smuggling or other difficulties. Inland water transportation controlled by the BIWTA is still considered to be safer than railway and the truck transportation.

In order to prevent such criminal acts, a surveillance network along the main route should be established by both customs and the police, and inland water transportation should be steadily conducted by reliable shipping companies.

Moreover, the undermentioned facilities and systems should be improved by the BIWTA between Dhaka port and Chittagong port or Mongla port to ensure safer and more punctual navigation.

i) Navigational aids such as buoys, lighthouses, beacons, etc.

ii) Communication system between the container vessels and the container terminal at Dhaka.
Container vessels have to inform the container terminal of their position or movement in order to plan their unloading / loading schedule.

iii) Vessels' route
A 12-foot deep route should be maintained through the year because the draft of designed container vessels is planned to be 3.5m.

iv) Present regulations such as the Port Act, the Port Rules, the Inland Shiping Ordinance, etc.
New regulations should be established for sailing and berthing / unberthing of container vessels.

Besides the about, shipyards in Bangladesh should also be improved in order to be able to maintain, survey and repair container vessels.

CHAPTER 11 MASTER PLAN FOR THE CONTAINER TERMINAL DEVELOPMENT

11.1 The Basic Concept of the Container Terminal Development

The purpose of the Master Plan with the target year of 2005 is to serve as a target and guideline for phase plans including the Short-term Plan with the target year of 1995. In formulating the Master Plan for a water-oriented container terminal at Dhaka Port, the following aspects concerning the development are recognized:

- Seaports of Chittagong and Mongla

Since the start of container transport at Chittagong Port in 1976/77, there has been a steady increase in the volume of container cargos through the seaports, namely Chittagong and Mongla. Recently, the volume has increased sharply, showing an average growth rate of 33% per annum in the last five years, with around 91,000 TEUs being handled at the ports in 1988/89. Presently, most of containers are handled at break-bulk berths at Chittagong Port without a specialized terminal for container handling. This causes serious congestion in container handling at the port. Insufficient inland transport systems for container cargos add to the congestion. Consequently, dwelling times of imported container cargoes are excessively long, at around one month on an average.

In order to reduce the present congestion and cope with the further progress of containerization in the future, multipurpose berths with a spacious backyard of 18 ha, intended to be used as a container terminal, are now under construction by the CPA and are scheduled to be completed in 1992. On the other hand, the MPA is also developing container handling capacity, including new berths, at Mongla Port within the spacious port premises owned by the MPA.

Thus, at least, the seaports will have sufficient capacity to meet demands for container handling in the foreseeable future, should an efficient management and operation system be developed, including improvement of necessary procedures such as customs clearance and training for personnel along with the development of the infra- and super-structures mentioned above.

- Transport System for Containers by Road

On the other hand, there are still no concrete plans for resolving the current problems with the inland transport systems for containers. Presently, a large quantity of container cargo is destined for and originates from the Dhaka area, being transported by trucks as loose cargos on the Dhaka-Chittagong highway. Usually, 20-ft. container cargos are carried by 2-3 trucks, due to limited loading capacities of the trucks and the small lot-sizes of cargoes. Consequently, shippers and consignees cannot take full advantage of container transportation for economic, swift, safe and convenient transportation by carrying cargoes in boxes as close as possible to their premises in bond.

Along the Dhaka-Chittagong highway, the Meghna Bridge was completed and the Meghna-Gumuti Bridge is expected to be completed by 1995. Furthermore, pavement and foundation of the existing highway are now being improved at the required stretches and will be completed by 1992. After the completion of the above construction work, infrastructures of the highway will be improved remarkably. However,this does not mean that full-scale container transport by trucks can start immediately thereafter. For a start, massive investment for numerous tractor-trailer units for container transport is necessary. Besides, an inland container depot equipped with at least a CFS in the Dhaka area needs to be prepared, taking account of the fact that local access roads to individual traders' premises are unsuitable for accommodating long and heavy units.

On the other hand, in terms of road communication between Dhaka and Mongla, the Jamuna Bridge is expected to connect the Dhaka area and northwest part of Bengal by land. The route via the new bridge, however, is over 500 km long, and too roundabout. Though there are alternative routes, these are disrupted by several large rivers where ferries are the only means of crossing. Accordingly, container transportation by trucks on the route is unlikely to be developed in the near future.

- Transport System for Containers by Railway

As for container transport by railway, the Kamalapur ICD was established by BR in 1987. Since the start of transport between Chittagong and Dhaka, the number of containers carried has increased gradually, but still remains within a few percent of the total volume through the seaports in spite of the recent sharp increase in the container traffic, registering around 2% in 1988/89. So far, it is rather difficult to say whether the current level of container transport by railway is fully successful. The cost of transporting containers by railway is much more attractive than by truck, nevertheless, traders seem likely to hesitate to make good use of the railways due to the fear of unpredictable journey times. Generally, valuable cargos are carried by containers, and accordingly, when selecting the means of transport from among several alternatives, the first priority is swiftness of transport and predictability of journey times, rather than slight differences of costs between the different means of transport compared with the values of cargoes themselves. Presently, containers are transported on railway wagons, joined to ordinary cargo trains which do not shuttle directly between Chittagong and Dhaka and are often forced to wait on sidings to allow passenger trains to pass by on the single-track lines. Using such a system to transport containers might be partly responsible for the above fear, though the service has been improved to some extent recently through the efforts of the BR. Notwithstanding this, the railway seems to have great potential in terms of development of container transport for the reason that the Kamalapur ICD could easily be expanded along with increased demand for use of the BR's premises at Kamalapur Station. The increase in demand might make operations of container unit trains viable, which could help remove the above fear. Needless to say, in order to start full-scale container transport, a large level of investment would be required along with the development of efficient operating and management systems from the standpoint of the customer's convenience.

- Inland Waterways and Principal River Ports

Presently, container transport by inland waterways does not exist. The principal river ports have no facilities to handle containers. The bearing capacities of the existing jetties are insufficient for heavy container loads as one unit, and there are no spacious backyards, which are indispensable to container handling. There is no concrete jetty nearby the proposed sites of a container terminal. Moreover, most of the existing coasters and cargo vessels currently in operation cannot accommodate container loading due to their narrow holds and the lack of the necessary fittings to fix container boxes. These vessels carry mainly bagged cargos such as food grains, cement and fertilizer which have large bulk density and are generally less valuable compared with container cargoes transported mainly by trucks as loose cargoes after being unstuffed from or before being stuffed into container boxes at seaports. Consequently, the cargoes transported by inland water are essentially unsuitable for container cargoes. Conversely, relating to the possibility of diversion of the above cargoes presently transported by land to the existing vessels, most vessels currently in operation are unsuitable for holding valuable cargoes due to insufficiency or nonexistence of outfitting in the holds, such as bottom ceilings, side sparring and ventilation which are indispensable in preventing damage to containers. Accordingly, it is rather difficult to imagine that container transport by inland waterways could be started using the existing system.

Nevertheless, the potential for container transport by inland waterway in Bangladesh draws strong attention. The seaports, Chittagong and Mongla and the Dhaka area as the major origin and destination of container cargoes are connected by Class I waterways, most of which are maintained by natural river flow without maintenance dredging. By using such natural waterways, establishing a riverside container terminal at Dhaka Port and preparing vessels specialized for container transport or modifying the existing vessels, an attractive container transport system by inland water, simple and less polluting, could be created.

- Fair and Healthy Competition between Different Transport Modes

Thus, regarding inland container transport, all the transport modes: road, railway and water, have potential in terms of establishing full-scale inland transport systems for containers in their respective ways to meet the large demand forecast for the future. In this study, emphasis is put on the container transport system by inland waterways, considering competitiveness vis-a-vis other transport modes. Though fair and healthy competition among the different transport modes might upgrade the level of service offered to customers, competition in and of itself should not be taken as an aim, taking account of the lack of the capacity of the existing inland container transport systems to meet future demand. The development of a full-scale container transport system of all transport modes seems necessary to meet demand as a whole.

- Improvement of Investment Atmosphere for Export-oriented Industries

The establishment of inland container transport systems, by which traders can take full advantage of container transport, is one of the preconditions for improving the investment atmosphere, especially for export-oriented industries such as the growing garment industry and the electronics and toy industries, which are also expected to grow. Well-developed inland transport systems linked to favorable industrial zones, such as a "Free Trade Zone", would draw the attention of foreign investors and local entrepreneurs.

- Regional Development by the Port Development

From the standpoint of regional development, establishment of an inland container terminal at Dhaka Port, as a part of the port development, would greatly contribute to regional development in and around the project site by developing industrial zones linked with the container terminal, generating massive employment opportunities, though a container transport system itself is a streamlined system that can be operated by fewer workers than existing systems.

- Potential of Establishing Container Terminals at the Principal River Ports

Regarding the potential of establishing container terminals at the principal river ports except for Dhaka and Narayanganj, there is hardly any possibility of doing so in the near future, considering the existing level of cargo traffic by inland water mentioned above. Taking into account that presently there is no actual container traffic by inland waterway and the financial resources for the new project are limited, only Dhaka Port should be focused on as a potential container port, at least at this stage, without distributing the limited amount of resources to several ports, which would making this project unjustifiable.

- Justifiability of Deepening Inland Waterway by Capital Dredging

The maximum permissible draft is determined based on the minimum water depth maintained naturally or guaranteed by maintenance dredging. Presently, a water depth of 3.7 m. (12 ft.) in the routes between the seaports and Dhaka Port is guaranteed by the BIWTA, as mentioned in Section 5.2.2. Taking account of under keel clearance including trim, 3.5 m. (11 ft. 6 in.) is considered as the maximum draft to be designed in this study. As to the possibility of handling container ships with deeper drafts on the routes, the major obstacle is the shallowness in the waterway between Sandwip and Hatia, as described in Section 5.2.2 in detail. Apart from a shallow draft container ship to be designed specially in this study, the drafts of most small container feeder vessels in operation internationally, with carrying capacities of 150-400 TEUs, are in the range of 6-7 m.. Considering the under-keel clearance, a water depth of at least 8 m. is necessary to receive even the above small container vessels and for that, more than 14 million cub. m need to be dredged only for capital dredging through the waterway over a 50 km. stretch. Moreover, subsequent maintenance dredging will also be necessary without any guarantee of maintaining the deepened channel against immediate siltation after floods and strong wave force in the monsoon season. Thus, such channel deepening should not be attempted.

11.2 Container Flow at a Container Terminal

11.2.1 General

The conditions of container flow at a container terminal such as fluctuation of the number of container boxes dwelling at a marshaling yard and the volume of container cargos at a container freight station (hereinafter referred as CFS) depend mainly on the following factors:

- Number of containers handled at the terminal for the target year
- Arrival distribution of container ships
- Cargo-handling productivity at the terminal
- Arrival distribution of trucks that bring in container cargos
- Time spent for necessary procedures such as customs clearance

In the first stage of planning, the above factors are studied and necessary values are assumed in order to determine the required scales of the terminal facilities.

11.2.2 Number of Containers Handled at a Container Terminal

The number of containers handled at a container terminal in Dhaka Port is assumed according to the demand forecast and the modal split described in Chapters 8 and 9, respectively. The numbers divided into imports and exports, and loaded and empty categories are summarized as follows:

Unit:Thousand TEUs

Year	Import			Export			Total		
	Loaded	Empty	Subtotal	Loaded	Empty	Subtotal	Loaded	Empty	Total
2005	66	11	77	24	53	77	90	64	154

11.2.3 Arrival of Container Ships

It is known from experience that ships' arrivals at wharves for public use is conformable to a Poisson distribution. Using the arrival record of container ships at Chittagong Port in 1989, conformability to a Poisson distribution as to the record was verified (see Fig 11.1).

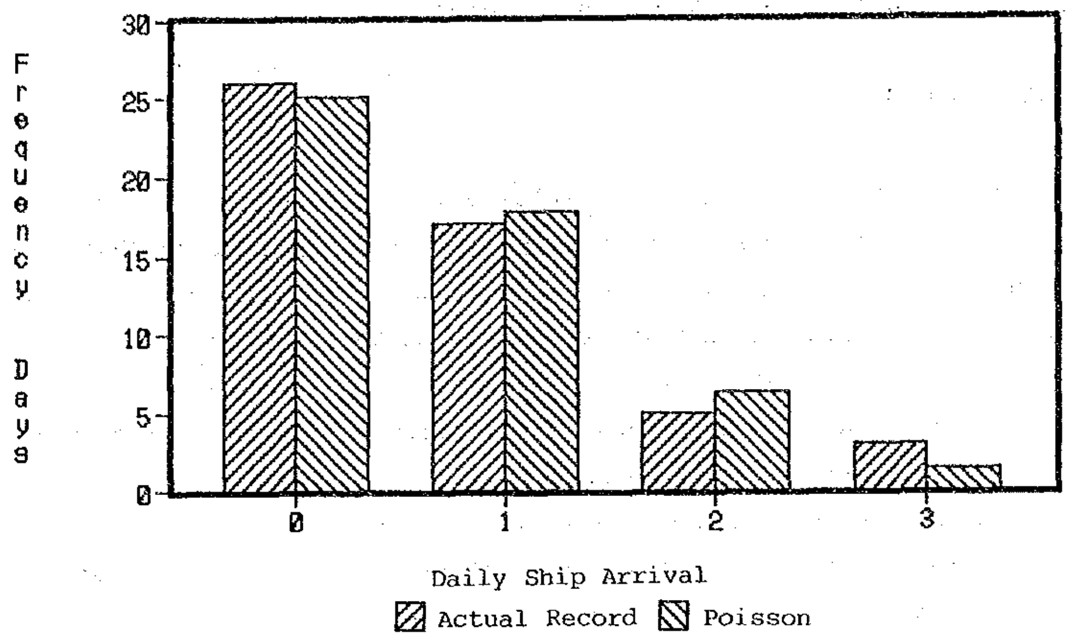


Fig. 11.1 Ship Arrival Distribution
Data at Chittagong Port in 1989

In this study, referring to the actual distribution form for container ship arrival at the existing container ports including Chittagong Port, a Poisson distribution for a new container terminal at Dhaka Port is adopted.

11.2.4 Cargo-handling Productivity of Container Gantry Cranes

It is said, based on experience, that average cargo-handling cycle time at leading container ports in the world is in the range of hourly 20-30 boxes. Actual productivity, however, fluctuates in every operation, and its distribution form is said, based on experience, to conform to a Erlan distribution of some degree. As to the actual operational record at Chittagong Port in 1989, the most conformable distribution form, namely a sixth degree Erlan distribution, was selected analytically (see Fig.11.2). Referring to the result, the same degree of Erlan distribution with the average of hourly 20 TEUs for a new container terminal at Dhaka Port is adopted.

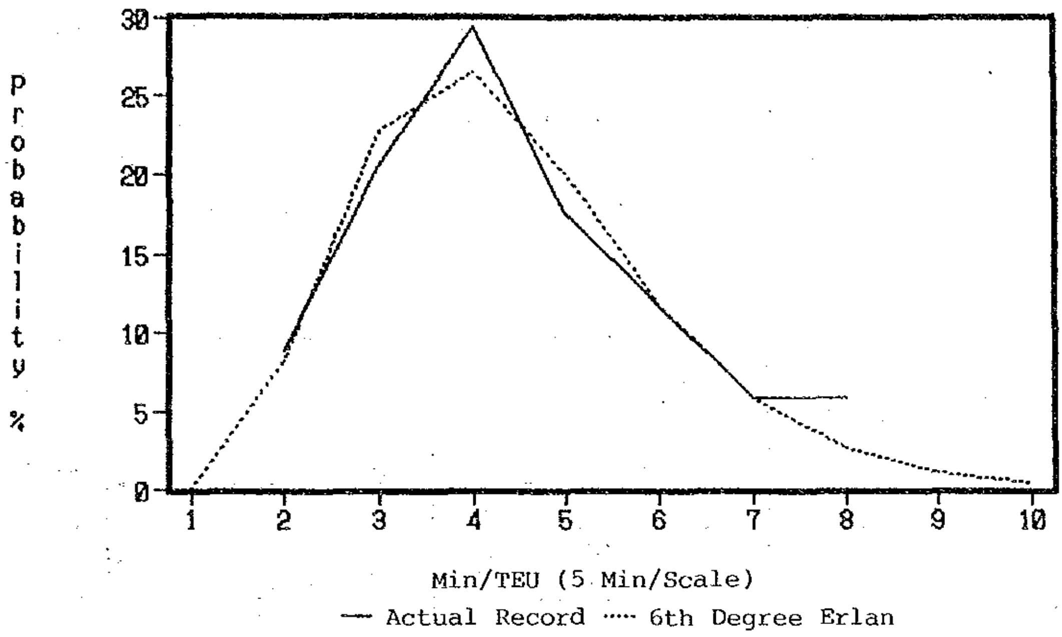


Fig. 11.2. Cycle Time Distribution Data at Chittagong Port in 1989

11.2.5 Arrival of Trucks Loading Container Cargos

LCL cargos for export are brought into a container terminal as loose cargos by trucks. On the other hand, FCL cargos for export are delivered partly in container boxes by tractor-trailer units and partly as loose cargos by trucks, namely as CFS cargos. As for arrival distribution form of trucks and tractor-trailer units for exports, assuming random arrival on the safe side, a Poisson distribution is adopted in this study.

11.2.6 Flow of Container Boxes and Cargos

After being unloaded from container ships by gantry cranes, container boxes are laid or stacked on a marshaling yard temporarily to wait for necessary procedures for import, including customs clearance. LCL cargos are unstuffed from container boxes and brought into a CFS to be sorted for consignees and then brought out as loose cargos by trucks. Import procedures for LCL cargoes are finished in the CFS. On the other hand, exported container cargos are brought into a container terminal by trucks or tractor-trailer units. Exported LCL and a part of FCL cargos are brought into the CFS, and after finishing export procedures, they are stuffed into container boxes and are brought out to a marshaling yard to wait to be shipped. FCL cargos excluding CFS cargos are stuffed into container boxes outside of the terminal, such as at a shipper's premise, and then are brought into and stacked on a marshaling yard of the terminal. Exported containers are then finally loaded into container ships (see Fig 11.3).

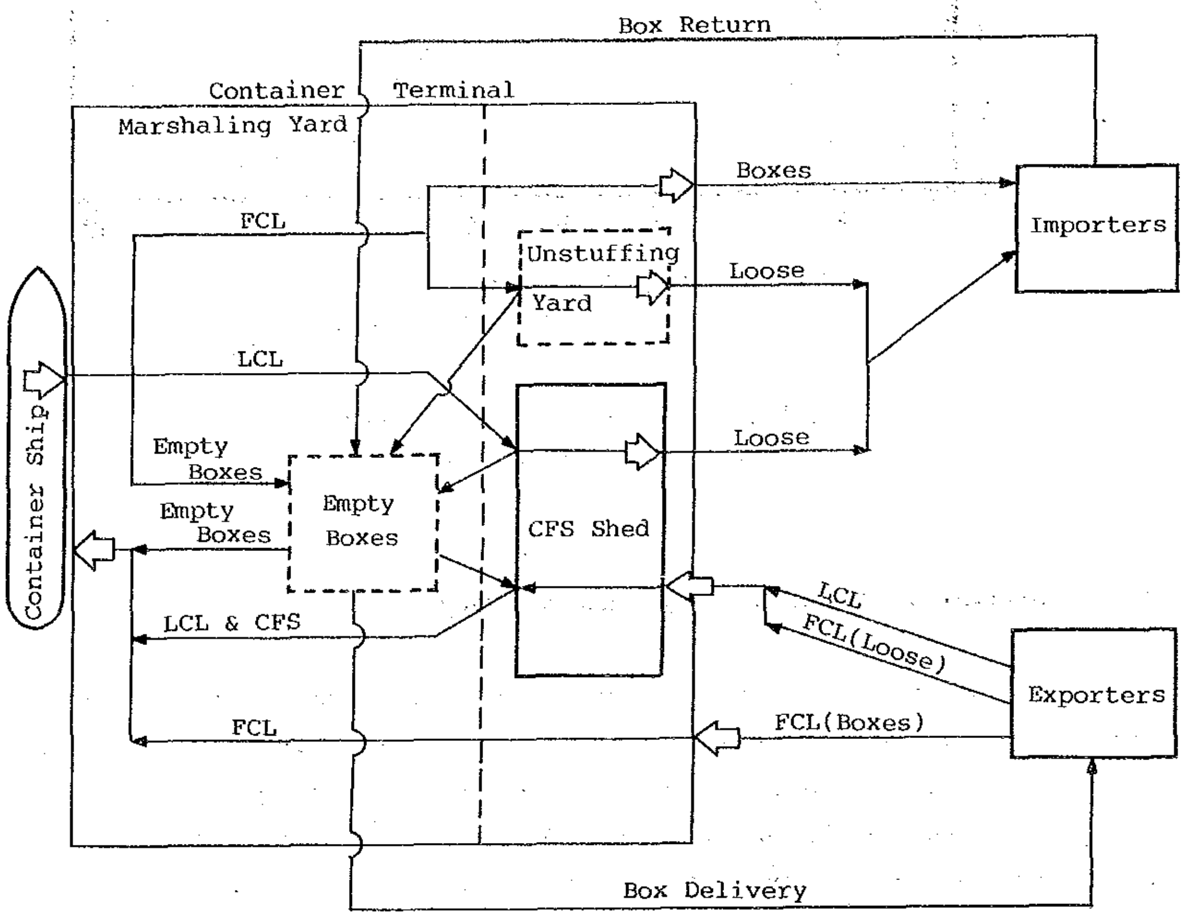


Fig. 11.3 Container Flow at a Container Terminal

Since the movement of container cargos and boxes mentioned above is too complex to be calculated analytically, computer simulation is conducted in this study so as to reveal the movement in the new container terminal with some accuracy.

11.3 Required Scale of Main Facilities of the Container Terminal

11.3.1 General

Required scale of the main facilities are determined by using computer simulation and referring to experiential values such as peaking factors at leading container ports. When simulating container flow at the new container terminal in the target year of the Master Plan, the conditions described in Section 11.2 are adopted.

11.3.2 Berths

Principal dimensions of a berth are determined to accommodate the following container ships studied in Section 10.1:

- Container Ship Sizes
  - Dead Weight Tonnage: 1,400
  - Gross Tonnage: 1,700
  - TEU Capacity: 88
  - Length Overall: 68 m.
  - Breadth Moulded: 13 m.
  - Full Draft: 3.4 m.

Length and water depth along a berth are as follows:

- Length per Berth: 90 m.
- Water Depth along a Berth: 4 m. below Average LLW

The optimum number of berths is determined by comparing alternative numbers and their respective costs comprising port costs and ship waiting costs. The ship waiting costs are computed using the computer simulation conducted through the period of the target year. The conditions for the simulation are as follows:

- Arrival of Container Ships
  - 892 Ships per annum
  - Average Arrival Interval: 9.5 h.

- 20 ft. Box Ratio: 0.57

- Crane
  - Type: Container Gantry Crane
  - Number per Berth: 1
  - Cycle Time: 20 Boxes per Hour on an Average
  - Maintenance and Repair of Cranes: 3.75 Days per Month
  - Cargo-handling Efficiency: 0.95

- Operation Conditions at the Container Terminal
  - Annual Working Days: 348 Days
  - Daily Working Hours: 7:00-17:00 and 20:00-4:00
  - Hours for Necessary Procedures, Mooring and Unmooring, Preparation for Stevedoring, etc.: 4 Hours

The results are indicated in Table 11.1.

Table 11.1 Comparison between Alternative Berth Numbers

Unit: Million TAKA

Berth Number	(1)			(2)		
	Average Berthing Hours	Average Waiting Hours	Berth Occupancy Ratio (%)	Construction & Maintenance Costs of Berths	Ship Waiting Cost	Total Cost
2	14.2	33.0	87.4	611	629	1,240
3	14.2	2.6	62.6	916	50	966
4	14.2	0.4	50.2	1,222	8	1,230

Note (1): The period of regular maintenance and repair for container gantry cranes is counted.

Note (2): Ship waiting cost is discounted to the Present Value through a project life of 30 years. A sensitivity analysis adopting a project life of 50 years shows the same selection.

Comparing the above total costs, three is selected as the optimum number of berths. The total berth length is 270 m.

11.3.3 Marshaling Yard

Required number of containers stored at a marshaling yard is determined taking account of the fluctuating number of containers dwelling at the yard by using the computer simulation mentioned above. When conducting the simulation, in addition to the premises mentioned in Section 11.2.1-11.3.2, the following premises are adopted:

- Period of Customs Clearance on an Average: Import: 10 Days
  Export: 4 Days
- FCL Ratio: Import: 0.7
  Export: 0.9
- Berth Number: 3
- Operation Hours of Truck Transport outside the Terminal:
  10:30-15:30 and 19:30-6:30

The result of the simulation is indicated in Fig. 11.4. According to the result, the numbers of loaded and empty containers dwelling at the yard fluctuate to a great extent showing large peaking factors of 1.52 and 2.87 respectively. The total number of the loaded and empty containers, however, fluctuates only in the narrow range due to their converse movements. This can be easily understood by recognizing the flow of container boxes described in Section 11.2.4. According to the result, the required number of containers stored at the marshaling yard is determined 2,380 TEUs as the optimum number.

When determining required slot number of the marshaling yard to store the above containers, four alternative cargo-handling systems, namely straddle carrier system, transfer crane system, forklift system and chassis system, are considered to be compared. The following premises are adopted to determined the number:

- Cargo-handling Efficiency: 0.75

- Numbers of Layers of Stacked Containers:

	Straddle Carrier	Transfer Crane	Forklift	Chassis
Import(dry)	2	3	2	1
Export(dry)	3	4	2	1
Reefer(stuffed)	2	1	1	1
Empty	3	4	3	1

Thus, the required slot numbers are shown as follows:

Unit: TEU

	Straddle Carrier	Transfer Crane	Fork Lift	Chassis
Slot Number (Reefer)	1,542 (34)	1,081 (69)	1,596 (69)	3,173 (69)

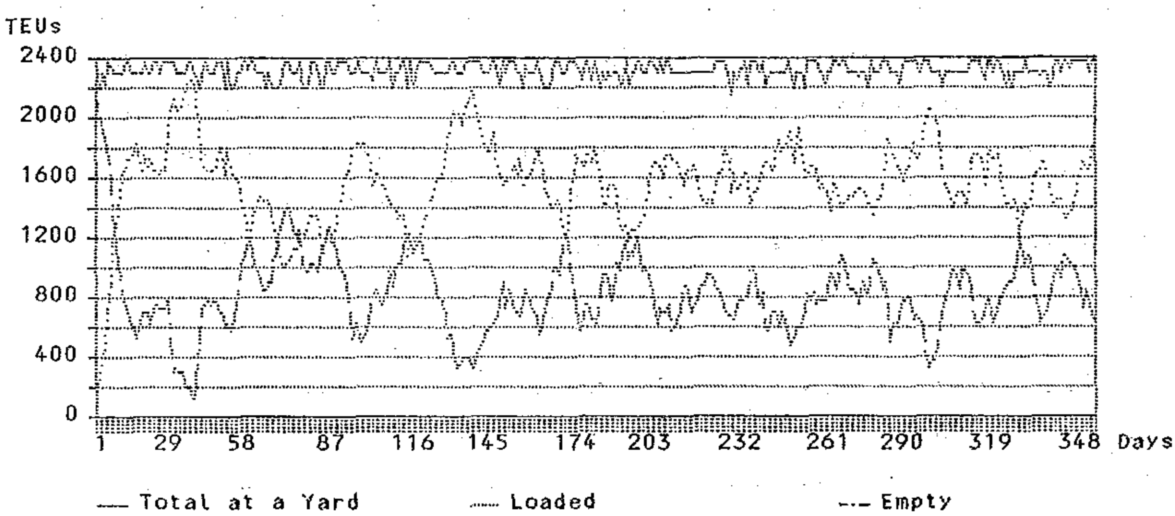


Fig. 11.4 Number of Containers Dwelling at a Marshaling Yard

11.3.4 Container Freight Station

In order to determine required area and bay number, the result of the above simulation is also adopted (see Fig.11.5). According to the result, the cargo volume dwelling in CFSs fluctuates largely, showing the maximum volume equivalent to 1,151 TEUs and the peaking factor of 1.40. In order to avoid overinvestment for CFSs, a moderate service level of 95% non-excess probability is adopted. In this level, the volume equivalent to TEUs is 1,043 TEUs with the reduced peaking factor of 1.27 to the average of 819 TEUs, indicating a similar figure to the experiential figure adopted in leading container ports (see Fig. 11.6).

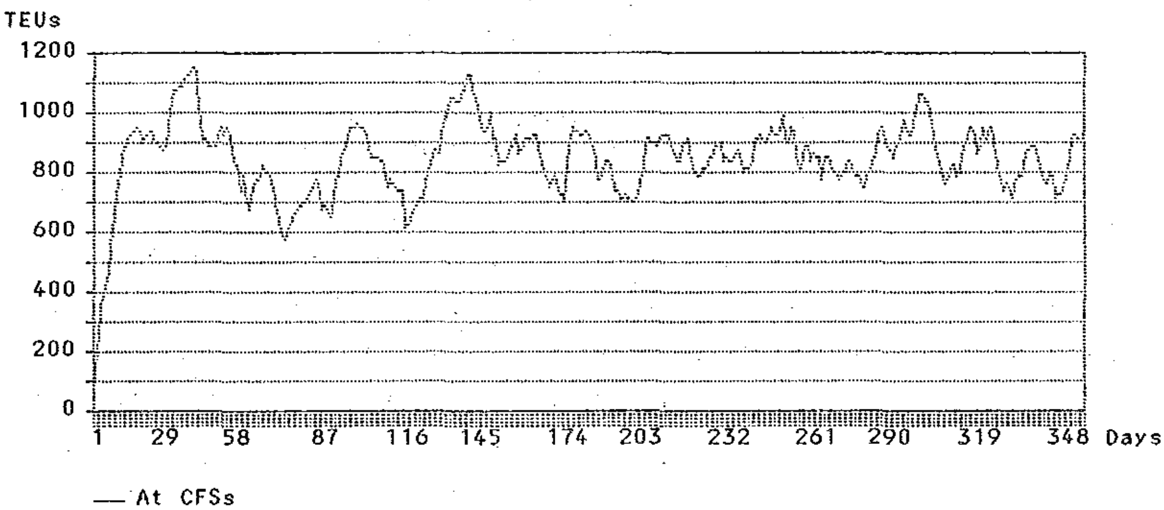


Fig. 11.5 Volume of Cargo Dwelling at CFSs Equivalent to TEUs

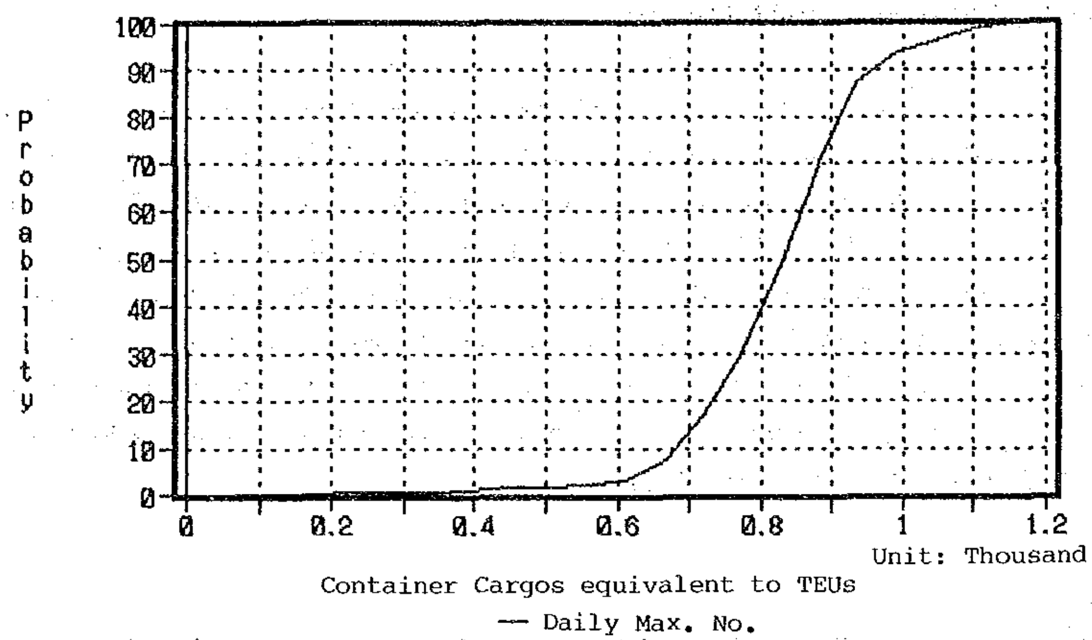


Fig. 11.6 Probability of Container Cargos Dwelling at CFSs in TEU

The required number of bays at CFSs is determined considering the fluctuation of the cargo volume passing through CFSs (see Fig. 11.7). According to the result of the simulation, the maximum volumes equivalent to TEUs at container side and truck side are 205 and 210 TEUs, respectively, with the peaking factors of 1.71 and 1.77, respectively. Adopting the service level of 95% non-excess probability, the figure of 172 TEUs, with a reduced peaking factor of 1.43 to the average of 115 TEUs, is considered as the target for bay number planning (see Fig. 11.8). The peaking factor of 1.43 is in the range of the experiential figures at the leading container ports.

Thus, the principal dimensions of CFSs are determined and shown as follows:

- Total Number of Bays on each Side: 49
- Total Length excluding Office Space: 176 m.
- Width: 45 m.
- Area: 7,920 sq. m.

Taking account of a suitable size of one CFS building, two CFSs are arranged in the terminal.

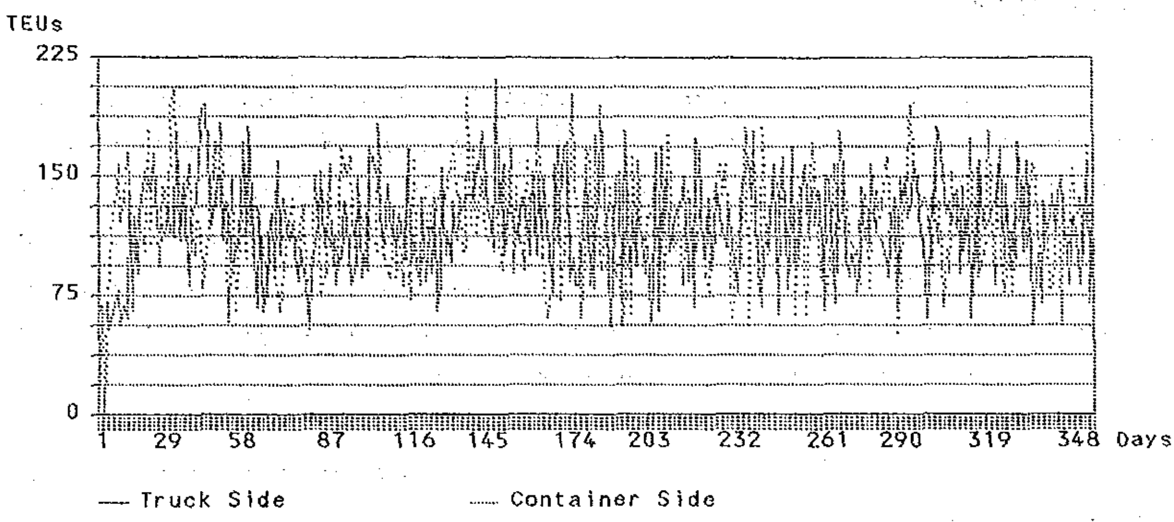


Fig. 11.7 Cargo Volume Passing through CFSs Equivalent to TEUs

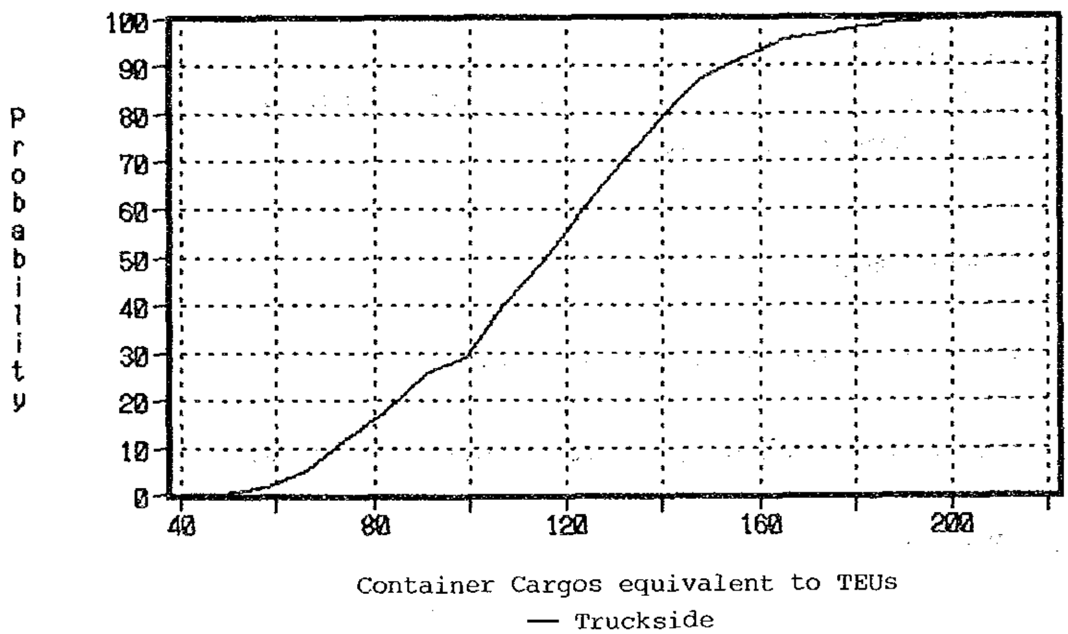


Fig. 11.8 Probability of Daily Throughput of Container Cargos

11.3.5 Apron

An apron where containers are loaded and unloaded onto or from container ships by gantry cranes is planned considering the installation of the cranes and efficient cargo-handling for relaying containers between the cranes and tractor-trailer units or straddle carriers. Taking account of comparatively narrow rail span of 10 m. as mentioned in Section 12.5, the minimum depth of the apron is estimated as around 35 m. though it differs slightly between different cargo-handling systems.

Apron length is determined based on the lengths of the berths and the marshaling yard.

11.3.6 Terminal Office

The head office of the container terminal is planned as follows:

- Stories: 3
- Site Area for Building: 30 m.x 25 m.= 750 sq. m.
- Floor Space: 2,250 sq. m.

11.3.7 Repair Shop

The following repair shop is planned:

- Site Area for Building: 40 m.x 25 m.= 1,000 sq. m.

11.3.8 Van Pool

A storage yard for empty container boxes (hereinafter referred to as the van pool) which are not scheduled to be shipped away from the container terminal will be needed to ensure efficient operation at the marshaling yard. Such a van pool can be leased to private-sector firms which possess the boxes, if so desired. For the above purpose, the van pool is planned to be allocated adjacent to the container terminal. The principal dimensions are as follows:

- Number of Layers of Stacked Containers: 3
- Storage Capacity of one Block: 75 TEUs
- Dimensions of one Block: Length: 32.5 m.

  Width: 13.5 m.
- Number of Blocks: 5

11.3.9 Access Road

In order to connect the container terminal with the nearest major road, an access road needs to be planned. According to the result of the computer simulation, the maximum daily traffic volume through the target year of 2005 is 2,144 vehicles per one way and 1,670 vehicles in the level of 95% non-excess probability (see Fig. 11.9-11.10). The following premises are adopted to estimate the required number of lanes of the access road:

- Number of Vehicle excluding Trucks/ Number of all Trucks: 0.5
- Daily Traffic each Way: 2,045 Vehicles (1,139 on an Average)
- Hourly Traffic each Way: 327 Vehicles (95 on an Average)

Thus, a two-lane access road will be sufficient to accommodate the above traffic volume. The width of the road's lanes and the total width of its paved part should be 3.25 m. and 6.5 m., respectively.

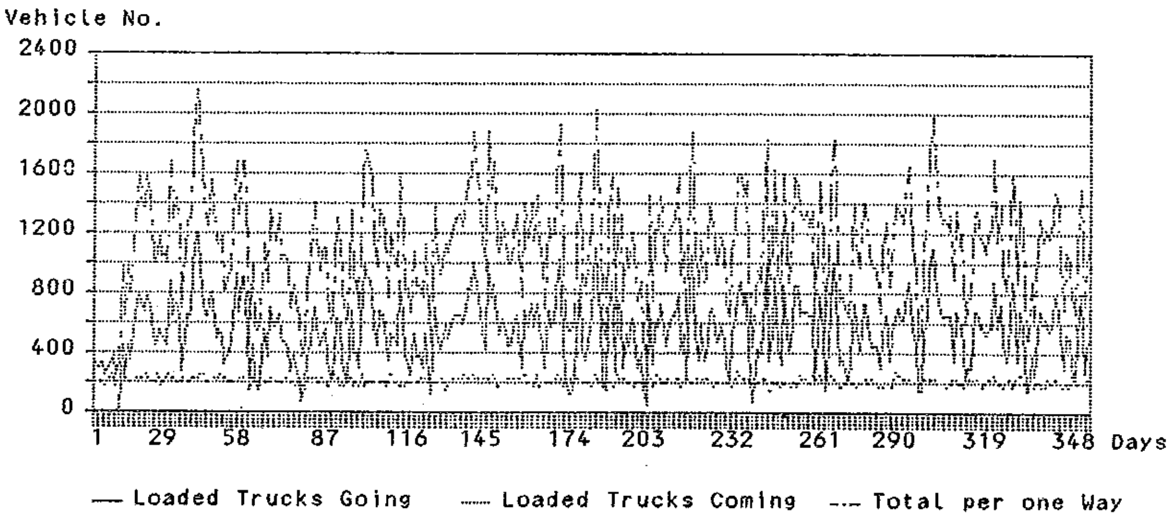


Fig. 11.9 Daily Traffic Volume from and to a Container Terminal

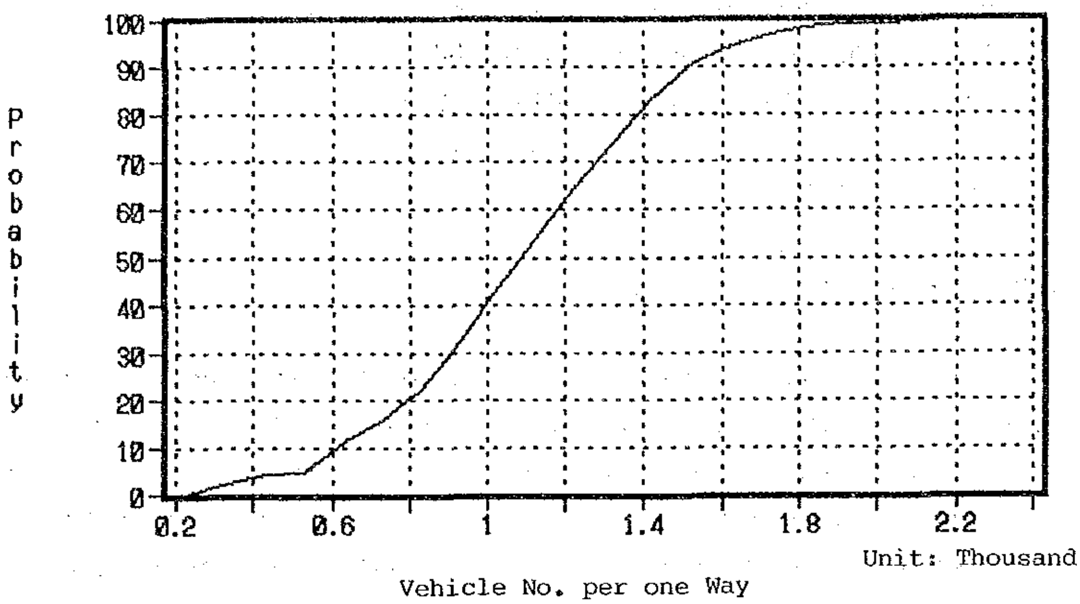


Fig. 11.10 Probability of Daily Traffic Volume on an Access Road

11.4 Layout of the Main Facilities of the Container Terminal

The main facilities of the container terminal, of which the required sizes are shown in 11.3, are arranged. Then the required terminal area as the main factor of the site selection is computed by different cargo-handling systems (see Fig.11.10-11.13). The required areas are summarized in Table 11.2:

Table 11.2 Required Terminal Area by Different Cargo-handling Systems

Unit: sq. m.

Cargo-handling System	Straddle Carrier	Transfer Crane	Forklift	Chassis
Total Area	124,750	112,200	178,000	234,500
(Length x Width)	(355 x 355)	(360 x 315)	(430 x 415)	(495 x 480)
Marshaling Yard				
Sub-total	62,835	52,000	108,700	171,400
Slot Area	36,700	23,000	29,800	82,000
Others	28,600	29,100	78,900	89,400
(Length x Width)	(355 x 177)	(360 x 145)	(430 x 250)	(495 x 345)
Apron	11,150	11,500	13,100	14,600
(Length x Width)	(355 x 35)	(360 x 35)	(430 x 35)	(495 x 35)
Backyard				
Sub-total	50,765	48,700	56,200	48,500
CFS	8,600	8,600	8,600	8,600
Head Office	800	800	800	800
Repair Shop	1,000	1,000	1,000	1,000
Open Yard	7,000	6,600	6,600	5,800
Others	33,365	31,700	39,200	32,300
(Length x Width)	(355 x 143)	(360 x 135)	(430 x 130)	(495 x 100)

Note(1): Parentheses give approximate values of yard dimensions, and so there are slight differences between their products and the areas in the Table.

(2): Van pool areas are excluded.

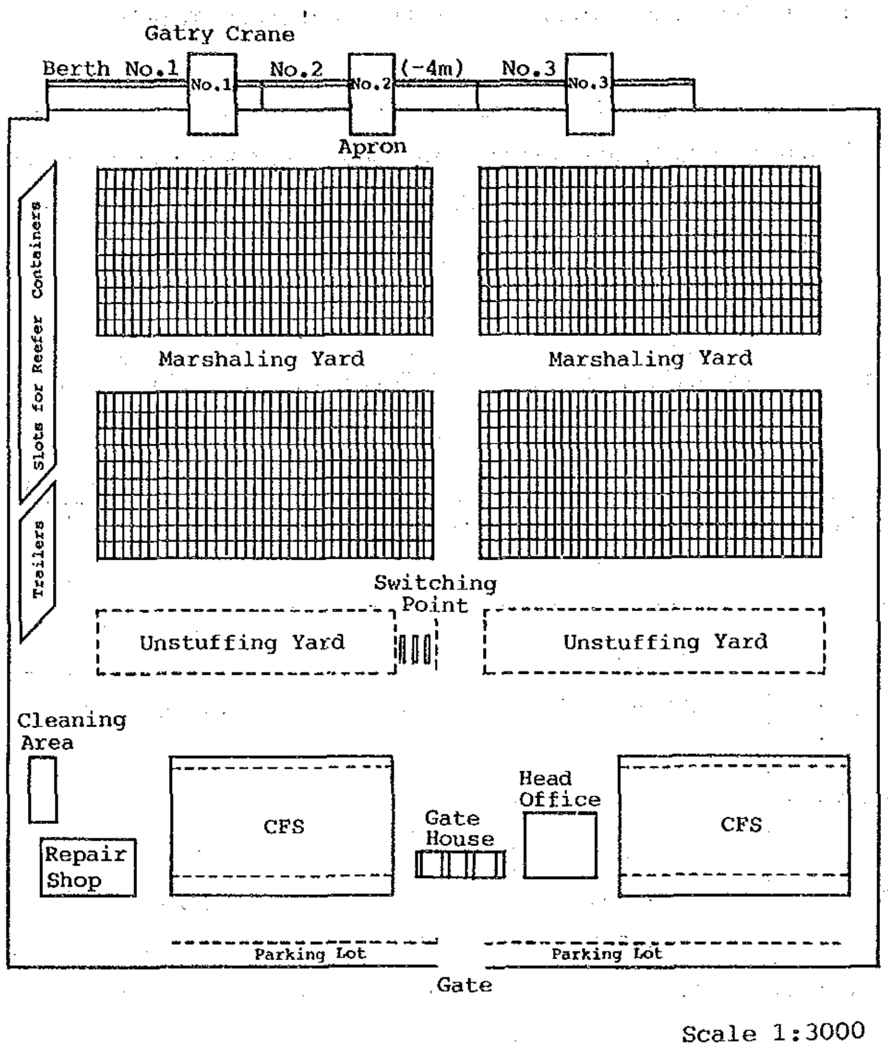


Fig. 11.11 Layout Plan of the Facilities of the Container Terminal for the Master Plan (Straddle Carrier System)

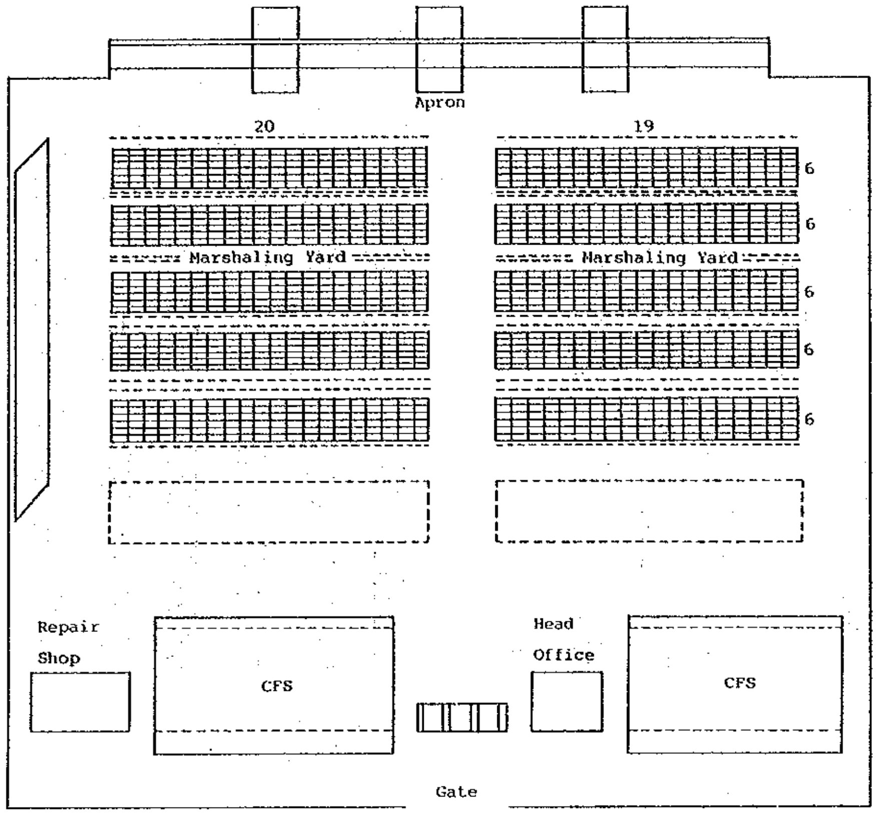


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Fig. 11.12 Layout Plan of the Facilities of the Container Terminal for the Master Plan (Transfer Crane System)

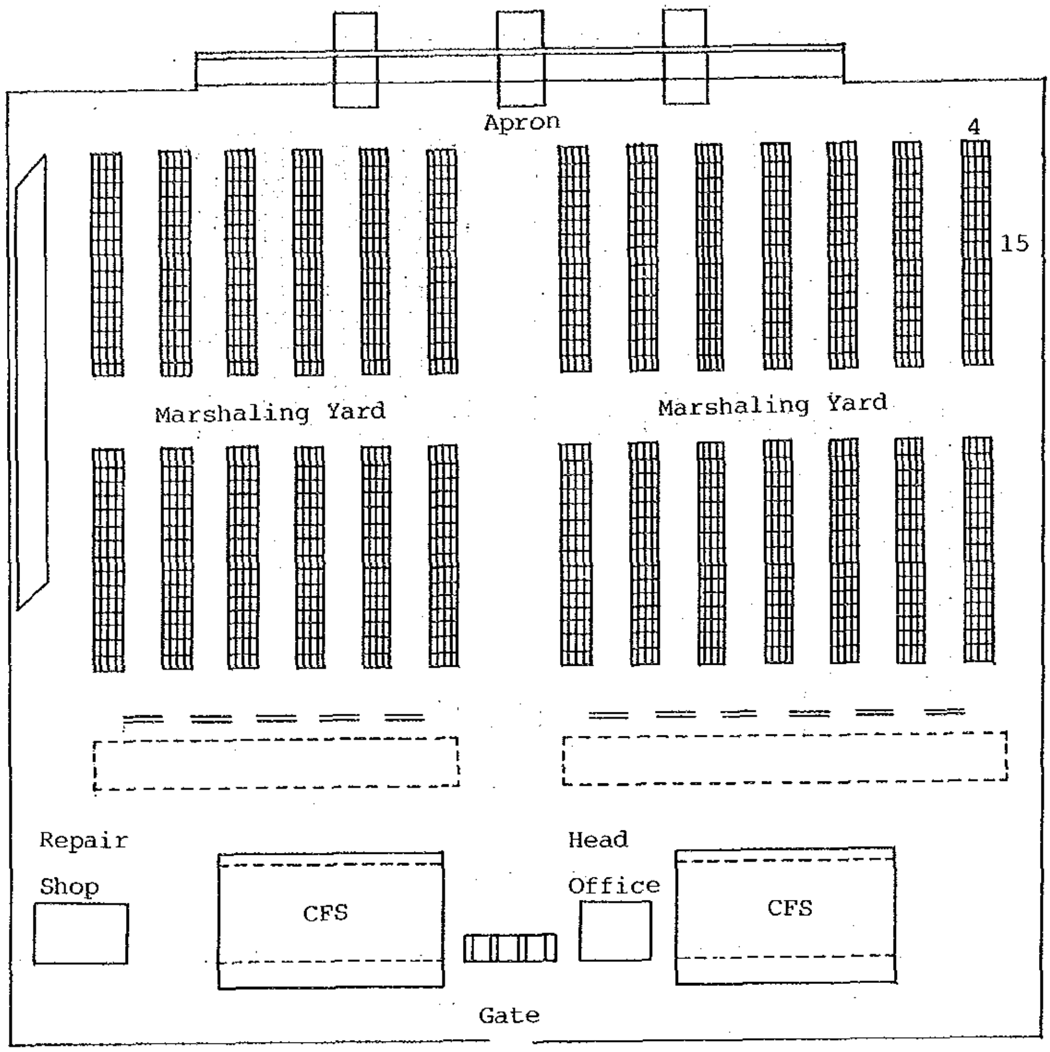

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Fig. 11.13 Layout Plan of the Facilities of the Container Terminal for the Master Plan (Forklift System)

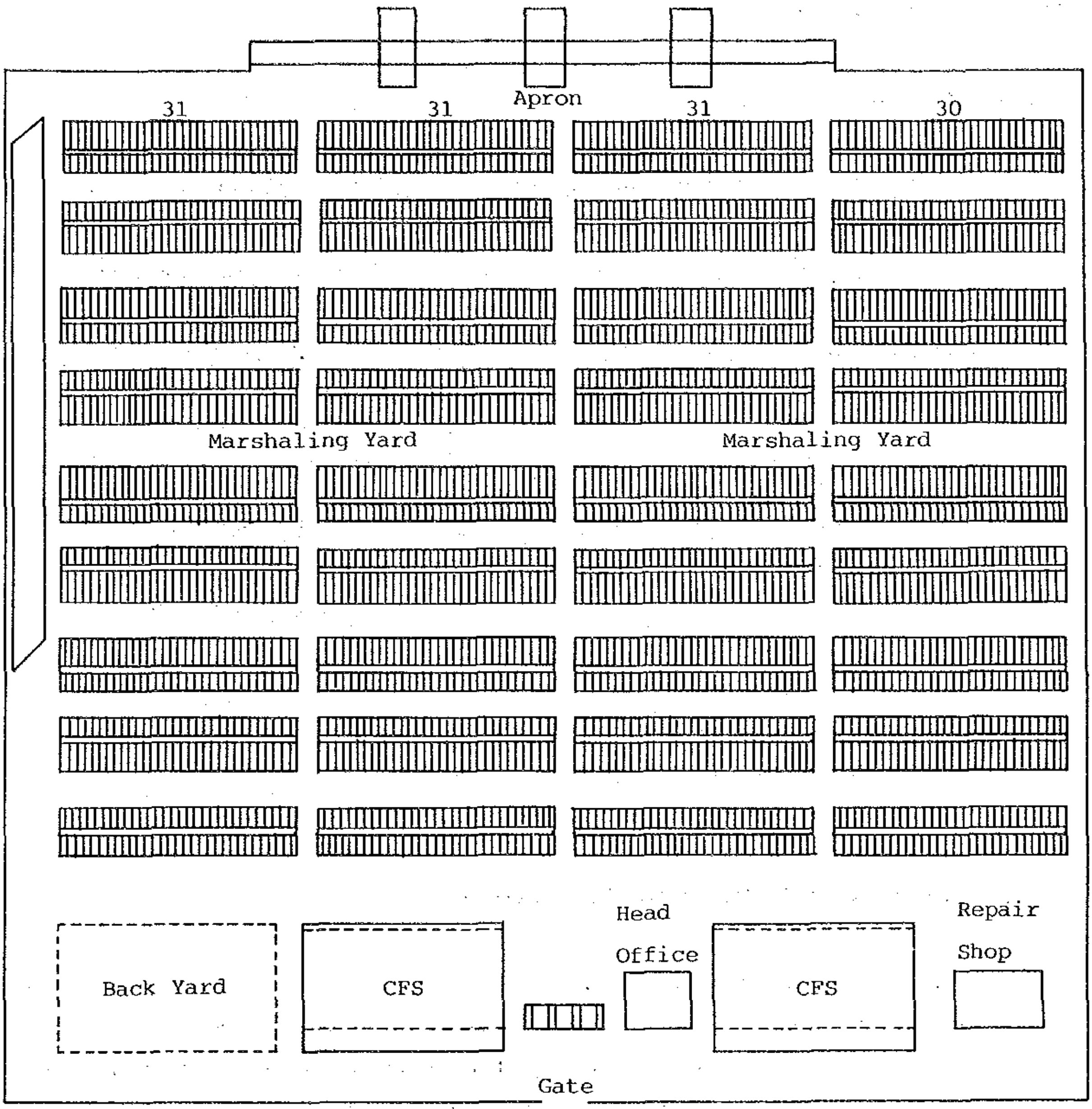

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Fig. 11.14 Layout Plan of the Facilities of the Container Terminal for the Master Plan (Chassis System)

Thus, the required area is in the range of 112,200 - 234,500 sq. m., and taking account of this range, site selection for this project as mentioned in Section 11.5 is conducted.

11.5 Site Selection

11.5.1 General

For selecting the most suitable project site for the container terminal at the ports of Dhaka and Narayanganj, it is necessary that potential project sites be considered in order to be compared as alternatives. In order to secure efficient container handling and financial soundness of the terminal management, the following points need to be considered when the potential project sites are chosen:

- Access traffic mode to the terminal,
- Possibility of acquisition of required land including space for future expansion of the terminal,
- Existing port facilities and port development plans at Dhaka and Narayanganj ports,
- Stability of Rivers
- Navigational waterways,
- Economical construction,
- Environmental impact on the areas adjacent to the terminal.

11.5.2 Access Traffic Modes to the Terminal

Transport in Bangladesh is susceptible to natural disasters during both the monsoon season and the dry season. Low-lying lands in deltaic areas are frequently flooded, causing the disruption of land transport during the monsoon season, whereas water transport is subject to draft restriction of river vessels in some parts of the country's inland waterways during the dry season. In order to ensure reliable container transport through the year, it seems essential that the Dhaka area and the seaports be connected by all the available traffic modes: water, road and rail.

In the previous study, "Transport of Containers in Bangladesh" made in December 1985 by the IBRD (hereinafter referred to as "the IBRD study"), Pagla on the north bank downstream of Postogola Bridge was selected as the only site for an inland container terminal in the Dhaka area with adequate water and rail connections in addition to road connection from among the proposed sites from the previously-mentioned standpoint. Subsequently, a study entitled "Rail Container Transport Study-Bangladesh" was conducted by the ADB (hereinafter referred to as "the ADB Study") in June 1987 for the same purpose of establishing an inland container terminal in the Dhaka area. The ADB Study, however, focused on railway transport, and Kamalapur Station, which has no water connection, was selected as the project site. The study, however, didn't deny the necessity of a water-served site for the inland container terminal, and suggested that the BIWTA open a riverside container terminal in the Dhaka area should it prove feasible.

Although there are currently no plans taking the shape of a full-scale project, the rail-oriented pilot project of the Kamalapur inland container depot (hereinafter referred to as the Kamalapur ICD) is now under way, after starting in April 1987. The Kamalapur ICD has been already designated as a Bill of Lading destination or origin. As for container transport by rail, therefore, Kamalapur ICD has great potential as a full ICD, should it be viable.

On the contrary, water connections to the project site are the main focus of this study in order to secure safe transport through the year and enable traders to choose their favorite traffic modes, which could optimize container flow. Accordingly, besides sites served by all traffic modes such as Pagla, sites connected only to water and roads are considered potential project sites. It may be found desirable that the container terminal be established at a site connected to all traffic modes. However, taking into account the difficulty of finding such sites meeting the access conditions within the limits of the ports of Dhaka and Narayanganj, and the fact that the Kamalapur ICD is actually in operation at present, sites connected only to water and roads should be also considered. If a riverside terminal without rail connections and a rail-served terminal apart from the foreshore should be established separately in the Dhaka area, inter-modal transfer of containers between water and rail could be implemented by trucks in bond, though that kind of transfer seems likely to be of minor significance in the foreseeable future.

11.5.3 Possibility of Land Acquisition

Steady land acquisition at a reasonable cost is one of the principal factors for the successful establishment of the inland container terminal at the ports of Dhaka and Narayanganj. Taking into account the fact that the execution agency of this project is the BIWTA, vacant land owned by the BIWTA is most preferable. Land owned by other governmental authorities is also suitable for the project site if available. If such land is not available, private land would have to be purchased. In this case, densely built-up land should be avoided.

11.5.4 Existing Port Facilities and Port Development Plans at the Ports of Dhaka and Narayanganj

Dhaka Port is located on the banks of the Buriganga River in the the southern part of Dhaka City. Public port facilities are mainly at Badamtali on the north bank upstream from Buriganga Bridge. On the other hand, Narayanganj Port is on the banks of the Sitalakhya River, about 25 km from Central Dhaka. Most public facilities are on the west bank. Dhaka Port handles bagged food grains and cement, iron and steel, petroleum oils, coal, construction materials, etc. Construction materials such as bricks, sand, gravel and cement are unloaded mainly at private wharfs on the north bank downstream from Buriganga Bridge. Petroleum oils are also discharged at private jetties on the north bank downstream from Pagla. Dhaka Port also serves passenger traffic. Thus, Dhaka Port supports the urban activities of Dhaka City adjoining the port. On the other hand, Narayanganj Port handles raw jute, jute goods, food grains, fertilizer, etc., serving various factories such as jute mills and distribution centers situated in the vicinity of the port.

The public port facilities at Badamtali at Dhaka Port are presently greatly congested due to a shortage of facilities and serious traffic congestion on the two-lane access road that runs parallel to the Buriganga River with residential and commercial areas on one side. It is also used as a general-purpose road. The space between the foreshore and the road is narrow and there is little land for future expansion of the port. In order to resolve these problems and cope with future demand for the service of Dhaka Port, the study "The Development Project of Dhaka and Narayanganj Ports" was conducted by the JICA in September 1987. The study proposes new general cargo berths and a passenger terminal at the site on the south bank downstream of Buriganga Bridge.

When choosing potential project sites of the water-connected container terminal under study, it is important to emphasize the need to make the most of the existing port facilities to reduce construction costs and operational and administrative costs by installing the terminal adjacent to them, if possible. From this point of view, Khanpur at Narayanganj Port might be chosen as a alternative site for the new container terminal, whereas Badamtali at Dhaka Port is not likely to be suitable because of the previously-mentioned problems. The area adjacent to the project site for general cargo berths and passenger terminal on the south bank downstream of Buriganga Bridge proposed by the previous JICA study is considered as an alternative site for this project. Should the former project materialize, part of the investment for infrastructures such as local access roads, water and electric supplies might be saved. Needless to say, not only these sites but other sites could be chosen as potential project sites, as the above conditions are not a prerequisite for the site selection, though desirable.

11.5.5 Stability of Rivers

When choosing suitable project sites within the limits of Dhaka and Narayanganj ports in view of maintenance of berthing facilities and basins along them, the stability of riverbanks and riverbeds in and around the project sites should be taken into account. The Buriganga River is a secondary river spilling from the Dhaleswari River which itself branches off from the Jamuna River. Consequently, the discharge of the Buriganga is low. Judging from the comparison between the hydrographic maps surveyed in 1964/1965 and 1988, the shoreline and riverbeds of the Buriganga River within the limits of Dhaka Port seem quite stable. The many factories located along the riverside also prove the stability of the river. The Sitalakhya River also seems stable within the port limits of Narayanganj Port judging from a similar comparison.

For the project site, the inner bends of the rivers, which are prone to siltation, should be avoided. Moreover, unstable areas such as confluences and sharp outer bends, where excessive siltation or erosion are apt to occur, should be also avoided.

11.5.6 Navigational Waterways

Navigational waterways relevant to this study are on the routes between the ports of Dhaka and Narayanganj and the two seaports, Chittagong