Though there is no designated berth for handling containers, they are mainly unloaded at the berth Nos.V and VI in the New port. The full load containers are unloaded by ship cranes and/or truck cranes with wire slings, and all containers are transported to and stacked in 2 tiers in the container yards by using stacker, forklift and crane. All of the cargoes in containers are delivered to consignees without unpacking in the port.

- Pipeline for bitumen

A subterranean pipeline and pipeline are laid from storage tanks within the port to berth Nos.V and VI, and the cargo is unloaded through rubber hose connecting between vessel's pipeline and the mouth of shore pipeline. There are two tank areas behind warehouse No.V which are managed by two private companies as concession.

- Petroleum products

There is one tanker berth for unloading of gasoline, fuel oils, diesel oil, etc. which is situated about 20 Km from the port, and the oil handling operation is managed by the two private companies. The offshore facilities are owned by the port and the shore area is as a concession area admitted by the Government. The cargo handling is done by piping systems which are leading from berths to inland storage tanks per kind of oil.

ii) Loading of cargo

- General cargo

Sixty-seven per cent of the general cargo for loading are brought into warehouse and open yard in the port by trucks and the remaining thirty- three per cent of cargo is directly brought alongside to vessels by trucks and loaded onto vessels in the usual manner.

- Container

Container is delivered from container yard to the shoreside by port's equipment and transported container at the shoreside is slung from tractor/chassis and loaded onto the vessel by ship's crane and truck crane.

5) Documentation flow

The flow of documents of import and export cargo are summarized as follows;

i) Import

Cargo from vessel to consignee (direct delivery);

- Import document is presented to KAMSAB by consignee (B/L).
- KAMSAB prepares a delivery order for consignee, and this order is sent to warehouse office.
- Warehouse office prepares delivery bill for consignee.
- Consignee submits delivery bill to business office.
- Business office prepares bill and handling charge for consignee, consignee pays handling charge.
- After being discharged general cargo is transported to the outside port by consignee's truck.

Cargo from vessel to warehouse or open storage yard;

- KAMSAB submits order (information of vessel and two manifests) to operation center.
- Operation center arranges stevedore and tally.
- After being discharged cargo is transported to the warehouse or open storage yard.
- Stevedoring and warehouse office send report of working result and receipt of cargo to business office, respectively.

Container from container yard to consignee;

- Consignee submits B/L to KAMSAB.
- KAMSAB checks documents and prepares delivery order for consignee.
- Consignee submits order to container yard.
- Container yard prepare delivery order for consignee.
- Business office prepares bill and handling charge for consignee, consignee pays handling charge.
- After being delivered container is transported to the outside port by consignee's truck.

General cargo from warehouse or open storage yard to consignee;

- Consignee submits B/L to KAMSAB.
- KAMSAB checks documents and prepares delivery order for consignee.
- Consignee submits order to warehouse office, office approves delivery order.
- Consignee submits approved delivery order to warehouse.
- Warehouse prepares delivery bill for consignee.
- Consignee submits delivery bill to business office.

- Business office prepares bill and handling charge for consignee, consignee pays handling charge.
- After being delivered general cargo is transported to the outside port by consignee's truck.

ii) Export

Container from outside the port to container yard;

- Consignee shows lot list at the gate.
- Consignee submits lot list to business office.
- Business office prepares container entrance document for consignee.
- Container is transported to container yard and is stored.

Container from container yard to vessel;

- Consignee submits license of exportation of cargo to Customs, Customs approves license of export.
- Consignee submits approved L/E to business office (contract loading).
- Consignee submits contract loading to container yard, container yard prepares loading plan.
- Container is transported to pier and is loaded.
- Container yard sends list of loaded container to business office.
- Business office prepares bill for consignee.

General cargo from outside the port to warehouse or open storage yard;

- Consignee shows lot list at the gate.
- Consignee submits lot list to business office (contract storing).
- Consignee submits storing contract to operation center, operation center prepares storing plan.
- General cargo is transported to warehouse or open storage yard and is stored.
- Business office prepares bill for consignee.

6) Present condition of storage

Storage facilities including four warehouses and container yards including open storage yards at the port are managed by warehouse office which consists of one hundred and eight employees.

i) Management of storage

- The delivery/receiving of general cargo from/to warehouse and open storage yard is carried out by three shifts, the same as the loading/discharging work at the pier.
- The delivery/receiving of container from/to outside the port is carried out from 07:00 - 11:00 and 14:00 - 17:30.
- Free storage periods for container are set in the following manner;

Imported container:	seven calendar days
Transit container and heavy lift:	fifteen calendar days

ii) Control of storage operation

- Operation at each warehouses is controlled the respective warehouse officer.
- Warehouse No. V is used by a private company as concession

iii) Inventory control of general cargo

The inventory of general cargo is managed by each warehouse, the allocation of cargoes is controlled using recording book which containsis mentioned cargo data such as date of delivery/receiving , name of the vessel, consignee, etc.

iv) Inventory control of container

Container yard operation is controlled by container yard office under the warehouse office.

The inventory of container is managed by container yard office, the allocation of containers is controlled using cards which are placed on a board. There is one card for each container by discharged vessel' name. Each card has specific container data such as date of delivery, name of the vessels, shipping agency, etc. When one container is delivered from the yard to Phnom Penh, card is shifted to another board. However, this card system is utilized at only one container yard, which is presented by a private company.

v) Control of gate

The following personnel are responsible for gate control:

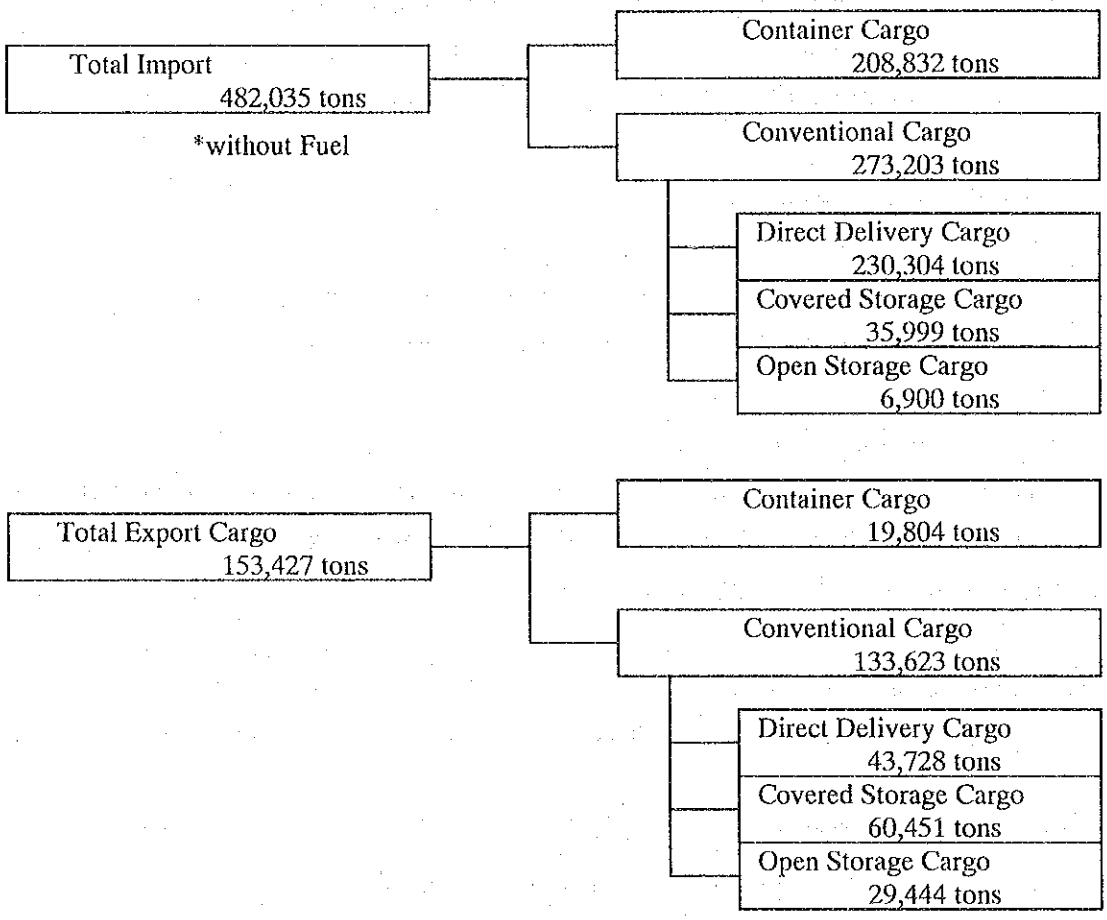
- Customs officer
- Police border
- Port security

7) Cargo movement at the port

i) Cargo throughput

The import/ export cargo handled at Sihanoukville Port can be calculated according to delivery/storage mode as in the following table.

Table - 2.5.4-11 Cargo throughput at Sihanoukville Port



Note: This table was made from port' basic data by the study team
Source: Sihanoukville Port

ii) Warehouse and open storage yard

As mentioned above, warehouse and open storage yard are controlled by warehouse office. Table - 2.5.4.-11 shows the delivered/received general cargo volume from/to warehouse and open storage yard in 1995.

Table - 2.5.4-12 Delivered /Received general cargo volume of warehouse and open storage yard in 1995

Warehouse / Commodities	No. I		No. II		No. III		No. IV		Total W.house		Open Yard	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Fertilizer	1,517	669			413				1,930	669		
Sugar			343	343			199	199	542	542		
Rice	616	616	7,903	7,903	9,667	9,667			18,186	18,186		
Plywood					3,847	3,847	4,845	4,493	8,692	8,340		
Sawn timber	7,764	7,764	15,691	15,691	26,026	28,492			49,481	51,947	7,127	7,109
Rattan			164	164					164	164		
Bitumen									0	0	567	567
Log									0	0	24,107	22,335
Steel	159	159			99	99			258	258	287	287
Equipment	2,555	2,555	1,146	1,689	151	147	7,221	6,931	11,073	11,322	5,390	5,186
Machinery	190	190	537	540	1,016	1,011	2,267	2,020	4,010	3,761	656	708
Total	12,801	11,953	25,784	26,330	41,219	43,263	14,532	13,643	94,336	95,189	38,134	36,192

Note: not include container cargo
Source: Sihanoukville Port

iii) Container Movement

Table - 2.5.4-13 shows the number of containers through the port in 1995.

Table - 2.5.4-13 Container movement through the port in 1995

Year: 1995

Month	Import				Export				Total					
	Full		Empty		Full		Empty		Full		Empty			
	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	Box	TEU
Jan.	988	381	-	-	113	59	794	275	1,101	440	794	275	2,610	3,325
Feb.	678	248	-	-	26	26	947	319	704	274	947	319	2,244	2,837
Mar.	1,052	321	-	-	110	61	713	281	1,162	382	713	281	2,538	3,201
Apr.	1,021	271	-	-	158	34	513	210	1,179	305	513	210	2,207	2,722
May	1,105	389	-	-	81	54	142	231	1,186	443	142	231	2,002	2,676
Jun	962	350	-	-	82	34	907	322	1,044	384	907	322	2,657	3,363
Jul.	1,022	363	-	-	92	61	1,014	386	1,114	424	1,014	386	2,938	3,748
Aug.	1,037	441	-	-	112	49	901	442	1,149	490	901	442	2,982	3,914
Sep.	1,067	400	-	-	121	57	610	257	1,188	457	610	257	2,512	3,226
Oct.	848	392	-	-	97	57	969	411	945	449	969	411	2,774	3,634
Nov.	897	444	-	-	92	67	930	252	989	511	930	252	2,682	3,445
Dec.	971	507	-	-	98	83	831	304	1,069	590	831	304	2,794	3,688
Total	11,648	4,507	-	-	1,182	642	9,271	3,690	12,830	5,149	9,271	3,690	30,940	39,779

Source: Sihanoukville Port

Table - 2.5.4-14 shows the number of container through the gate in March 1996.

Table - 2.5.4-14 Container movement through the gate

Month: March

Day	Gate In				Gate Out				Total					
	Full		Empty		Full		Empty		Full		Empty		Total	TEU
	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'		
1	5		31	24	35	12		1	40	12	31	25	108	145
2	1	3	21	17	3	1		2	4	4	21	19	48	71
3					12	9			12	9	0	0	21	30
4	1	3	25	9	13	7			14	10	25	9	58	77
5	2	5	25	5	7	14		1	9	19	25	6	59	84
6			15	6	21	20			21	20	15	6	62	88
7	1	1	16	5	17	13		1	18	14	16	6	54	74
8	1	7	11	11	14	14		2	15	21	11	13	60	94
9	3	7	7	26	9	7			12	14	7	26	59	99
10									0	0	0	0	0	0
11	4		10	16	16	19		1	20	19	10	17	66	102
12	4	5	15	15	19	27		1	23	32	15	16	86	134
13			18	7	11	11			11	11	18	7	47	65
14	2	2	4	11	27	13			29	15	4	11	59	85
15	6	6	13	9	15	16			21	22	13	9	65	96
16			7	5	16	7			16	7	7	5	35	47
17			2		14	1			14	1	2	0	17	18
18		3	34	20	10	3		2	10	6	34	22	72	100
19		1	17	5	20	8			20	9	17	5	51	65
20	4	2	14	4	18	8			22	10	14	4	50	64
21		2	8	6	39	13	2	2	39	15	10	8	72	95
22	5	2	14	15	29	17			34	19	14	15	82	116
23	3		20	6	65	12			68	12	20	6	106	124
24	1				1	3			2	3	0	0	5	8
25	5	1	32	8	7	3			12	4	32	8	56	68
26	3	1	29	6	38	4			41	5	29	6	81	92
27	1	5	37	6	31	21			32	26	37	6	101	133
28	5	2	44	12	14	16			19	18	44	12	93	123
29	4	4	26	13	32	10			36	14	26	13	89	116
30	3	4	19	9	25	8		1	28	12	19	10	69	91
31	2		6	2	6				8	0	6	2	16	18
Total	66	66	520	278	584	317	2	14	650	383	522	292	1,847	2,522

Source: Sihanoukville Port

iv) Dwelling time at the Port

Table - 2.5.4-15 shows the dwelling time of containers at the port. The average dwelling time of containers at present is as follows:

Import container (full): 6.2 days
Import container (empty): -
Export container (full): 4.3 days
Export container (empty): 8.4 days

Table - 2.5.4-15 Dwelling time of containers

Year: 1996

Dwelling Days	Import					Export									
	Full					Full					Empty				
	20'	40'	Total	TEU	%	20'	40'	Total	TEU	%	20'	40'	Total	TEU	%
0 TO 1	35	21	56	77	36.3	3	2	5	7	26.9	16		16	16	8.8
1 TO 2	10	5	15	20	9.4	1		1	1	3.8	7	1	8	9	5.0
2 TO 3	4	3	7	10	4.7	1	5	6	11	42.3	16		16	16	8.8
3 TO 4	5	3	8	11	5.2	1	1	2	3	11.5	21		21	21	11.6
4 TO 5	2	2	4	6	2.8					0.0	7	2	9	11	6.1
5 TO 6					0.0					0.0	1	2	3	5	2.8
6 TO 7	2	3	5	8	3.8	1		1	1	3.8	1	2	3	5	2.8
7 TO 8	6	3	9	12	5.7					0.0	2	9	11	20	11.0
8 TO 9	9	3	12	15	7.1					0.0	2	1	3	4	2.2
9 TO 10	1	1	2	3	1.4					0.0	1	1	2	3	1.7
10 TO 11	3		3	3	1.4					0.0	5	2	7	9	5.0
11 TO 12	2		2	2	0.9					0.0	1	3	4	7	3.9
12 TO 13	3	1	4	5	2.4					0.0	2	1	3	4	2.2
13 TO 14	3		3	3	1.4		1	1	2	7.7	3		3	3	1.7
14 TO 15	4	2	6	8	3.8					0.0		4	4	8	4.4
15 TO 16	2	2	4	6	2.8					0.0	1	2	3	5	2.8
16 TO 17		1	1	2	0.9					0.0	1	1	2	3	1.7
17 TO 18					0.0					0.0					0.0
18 TO 19	1		1	1	0.5					0.0	2		2	2	1.1
19 TO 20					0.0					0.0		1	1	2	1.1
20 TO 21		1	1	2	0.9					0.0		2	2	4	2.2
21 TO 22	1		1	1	0.5					0.0	1	2	3	5	2.8
22 TO 23	2		2	2	0.9					0.0		1	1	2	1.1
23 TO 24					0.0					0.0					0.0
24 TO 25					0.0					0.0					0.0
25 TO 26		1	1	2	0.9					0.0					0.0
26 TO 27		1	1	2	0.9					0.0	1		1	1	0.6
27 TO 28					0.0					0.0					0.0
28 TO 29	2	1	3	4	1.9					0.0					0.0
29 TO 30	1		1	1	0.5	1		1	1	3.8					0.0
29 TO 31	1		1	1	0.5					0.0					0.0
31 -	1	2	3	5	2.4					0.0	8	4	12	16	8.8
Total	100	56	156	212	100	8	9	17	26	100	99	41	140	181	100

Notes: This table was made from data of three selected vessels
Source: Port of Sihanoukville

b. Productivity of cargo handling

1) General cargo

As mentioned before, the general cargo handling at the port is divided into two categories, however, general cargo handling productivity per hour was calculated by selecting vessels at random because the handling time of general cargo laden with kind of cargo was clear.

Results of calculation are as follows:

Log:	25.3 tons/hrs	10.2 tons/gang/hrs
Cement:	51.3 tons/hrs	14.7 tons/gang/hrs
Sugar:	35.9 tons/hrs	17.9 tons/gang/hrs
Rice:	79.5 tons/hrs	19.9 tons/gang/hrs
Fertilizer:	82.4 tons/hrs	20.6 tons/gang/hrs
Sawn timber:	98.1 tons/hrs	32.7 tons/gang/hrs
Rolled Sheet:	121.0 tons/hrs	48.2 tons/gang/hrs
Various cargo:	67.0 tons/hrs	16.8 tons/gang/hrs (co-stowed)

2) Container

Container handling at the port is divided into two categories, the same as the general cargo, therefore, container handling productivity per hour is also calculated by selecting vessels at random.

i) By ship's crane

Thirteen vessels were selected at random and number of containers per hours and per gang per hours was calculated for each of the selected vessels.

Results of the calculation are as follows:

Average:	18.0 boxes/hrs	9.0 boxes/gang/hrs
	24.4 TEU/hrs	12.2 TEU/gang/hrs
Max.:	32.1 boxes/hrs	16.1 boxes/gang/hrs
	42.9 TEU/hrs	21.5 TEU/gang/hrs
Min.:	9.7 boxes/hrs	4.8 boxes/gang/hrs
	13.2 TEU/hrs	6.6 TEU/gang/hrs

The results are shown in Table - 2.5.4-16.

Table - 2.5.4-16 Productivity of container handling by ship's crane

No.	Vessel Name	Containers						No. of Cranes	Handl -ing Hours	Productivitiy			
		Full		Empty		Total				Boxes		TEU	
		20'	40'	20'	40'	Boxes	TEU			/Hrs	/G/Hrs	/Hrs	/Gig/Hrs
1	EQUATOR JADE	37	14	51	18	120	152	2	10.9	11.0	5.5	13.9	7.0
2	THOR MARIE	3		47	28	78	106	2	4.0	19.5	9.8	26.5	13.3
3	MINT ZOOM	78	44			122	166	2	5.8	21.2	10.6	28.9	14.4
4	MUARA MAS	54	40	20		114	154	2	5.0	22.8	11.4	30.8	15.4
5	MEKONG FORTUNE	41	34	15	26	116	176	2	7.5	15.5	7.7	23.5	11.7
6	MINT ZOOM	73	75	129	28	305	408	2	9.5	32.1	16.1	42.9	21.5
7	EQUATOR JADE	66	18	23	29	136	183	2	13.0	10.5	5.2	14.1	7.0
8	MUARA MAS	55	34	48	4	141	179	2	6.5	21.7	10.8	27.5	13.8
9	THOR MARIE	12	2	8	29	51	82	2	3.0	17.0	8.5	27.3	13.7
10	MEKONG FORTUNE	27	18	28	14	87	119	2	9.0	9.7	4.8	13.2	6.6
11	EQUATOR JADE	56	25	20	31	132	188	2	13.0	10.2	5.1	14.5	7.2
12	MINT ZOOM	54	38	50	4	146	188	2	6.3	23.4	11.7	30.1	15.0
13	MUARA MAS	94	38	50	8	190	236	2	10.0	19.0	9.5	23.6	11.8

Source: Sihanoukville Port

ii) By truck crane (Conventional vessel)

Eleven vessels were selected at random for calculation of productivity of container handling. Results of the calculation are as follows:

Average:	5.3 boxes/hrs	6.2 TEU/hrs
Max.:	8.3 boxes/hrs	9.4 TEU/hrs
Min.:	3.0 boxes/hrs	4.6 TEU/hrs

2.6 Present situation of the region and Sihanoukville city

2.6.1 Development plans of the region

For the urban development of Sihanoukville City, so far, two (2) plans have been prepared and approved by the authorities concerned:

a. "The master plan of land use" prepared by the National Committee in 1990 (see Fig. - 2.6.1-1), and
b. "Land development plan" prepared by Regional Development Department of Cabinet Office in 1995 (see Fig. - 2.6.1-2).

The latter plan was prepared by Professor, Dr. Gutton and his project team of the Univsersity of Paris (I.U.U.P) in France on the request of the governor of Sihanoukville through the government of Cambodia, after the UNTAC operation was over in 1993.

The structure of the report is based on the recommendations made by I.U.U.P., and describes, in detail, the zoning for land uses which comprises, categories, maintenance policy, allocation of land use plan, and etc. The plan reflects the following key elements of the sociocconomic activities in Sihanoukville:

a. Development of tourism in the city,
b. Factors of oil, gas, and chemical industries, and
c. Preservation of natural environment
   - preservation of Ream National Park,
   - preservation of water resources

The plan further defines the following 11 categories of zoning:

a. industries and petrochemicals, b. industrial zone, c. commercial activities,
d. airport, e. residence, f. tourism, g. port area, h. marine port
i. green area, j. reserved area, and k. city center.

The land use plan (1995) is often referred to by the local offices of national government and departments of the municipality of Sihanoukville as administrative guidelines for future land use.

In addition to the land use plan, various projects are presently being implemented and planned. Some of these are listed in Table - 2.6.1-1.

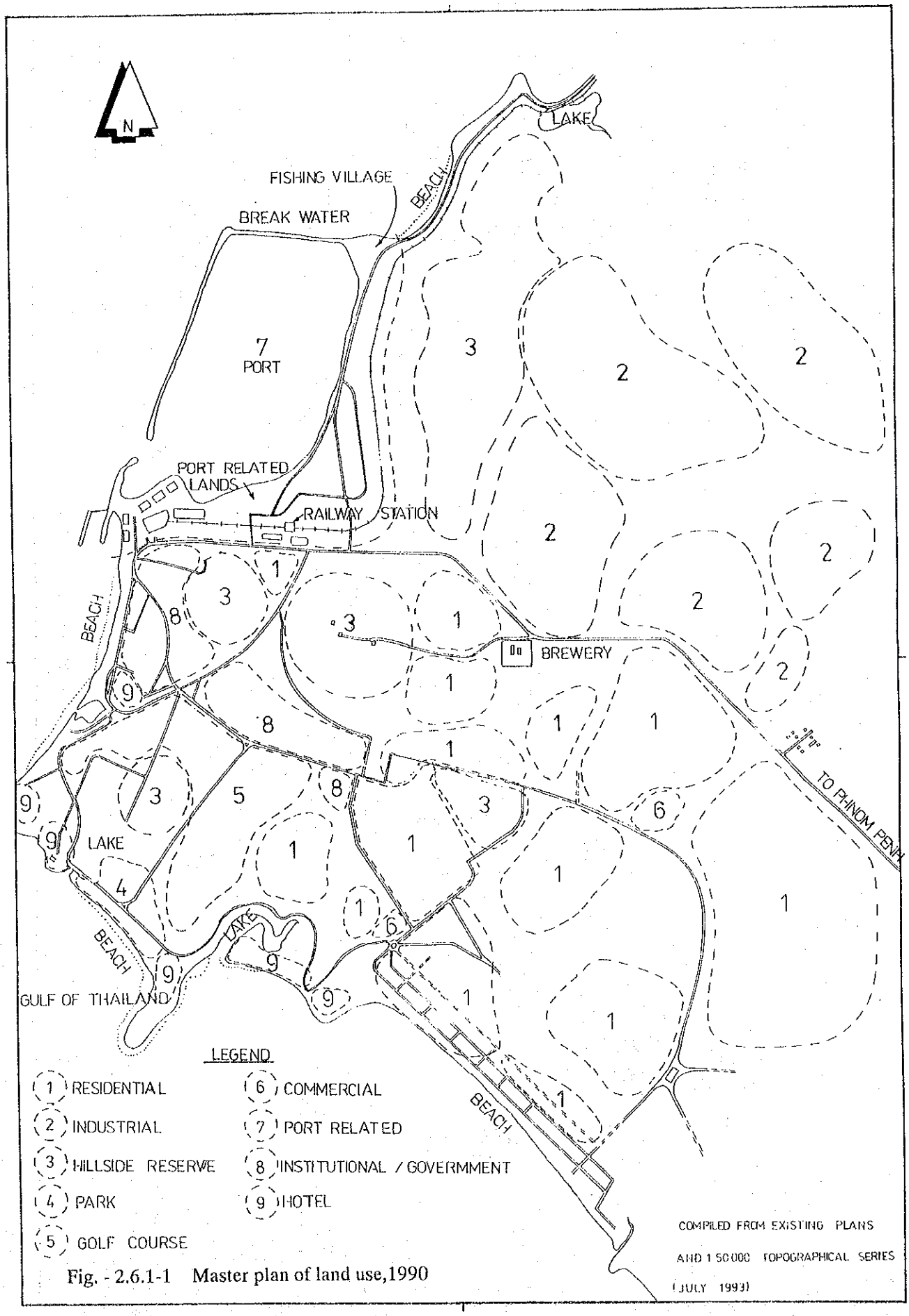


Fig. - 2.6.1-1 Master plan of land use,1990

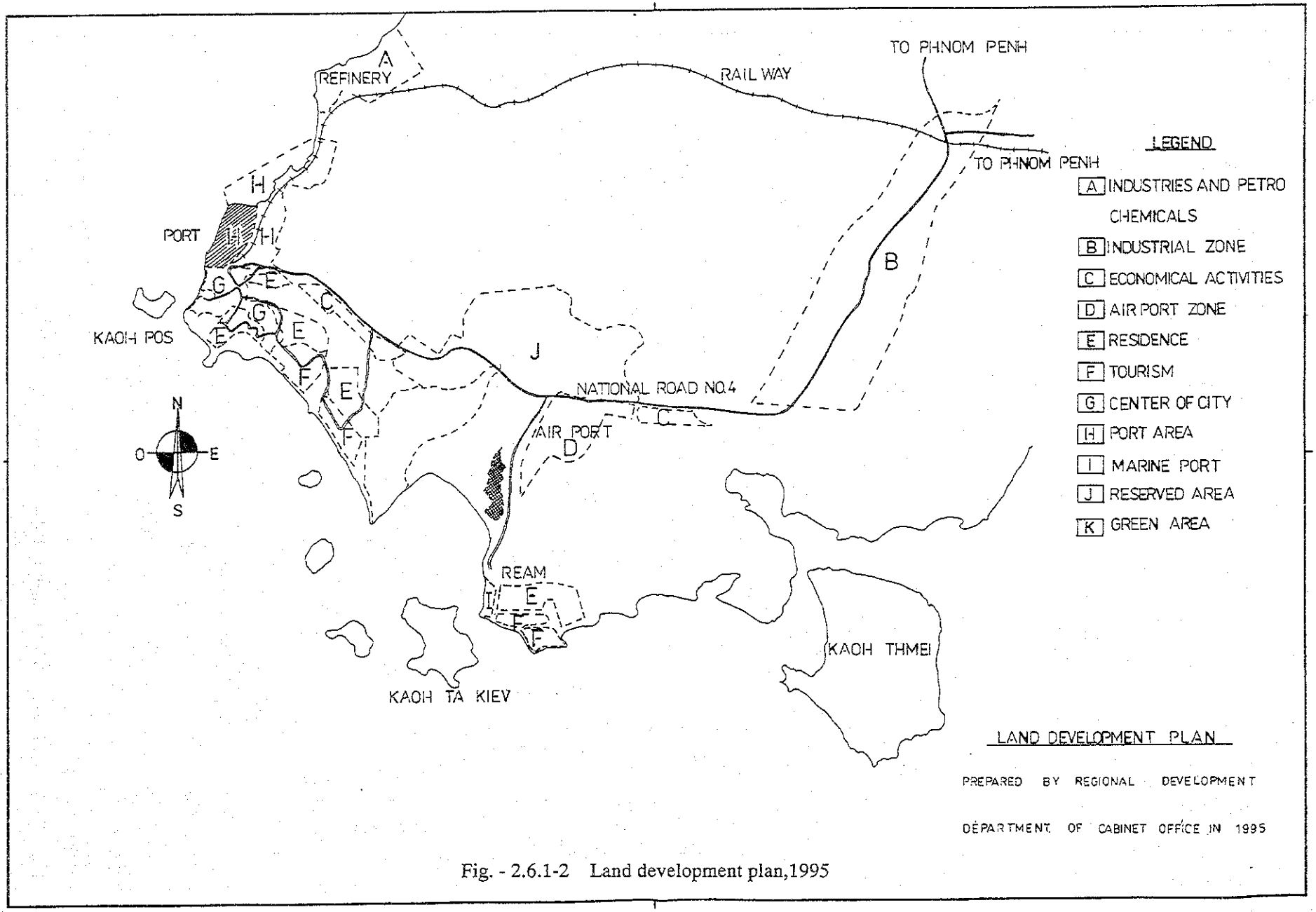


Fig. - 2.6.1-2 Land development plan,1995

Table - 2.6.1-1 List of regional development projects

No	Project title	Note	start	Originator
1	Tourism development plans Development of Koh Poah Island Modification and repair of existing Government hotel Construction of new resort hotel Construction of an aerial rope way Expansion of Sihanoukville Airport Construction of casinos in Koah Poah Island Development plan of Ream National Park	Site investigation in on-going	1997	Ariston(Malaysia) Co./Municipality
2	City planning Resettlement of habitants in the fishing villages Construction and repair of roads in the city	Committee was established		Municipality of SHV MPWT
3	Electricity, water, and sewage Construction of 5,000 KVA power Plant(Phase I) Construction of 5,000 KVA power Plant(Phase II) Expansion and modification of water supply system Construction of sewage pipelines in the city	World Bank funds W.B. Funds, Capacity 4,000t/day	1997	SHV Power Plant SHV Power Plant SHV Water Supply Aut. MPWT
4	Oil Port Construction of power supply cables to Oil Port Construction of new road between SHV and Steng How Construction of new oil berth Construction of oil storage tanks			SHV Power Plant MPWT Shell/CKC
5	Communications Installation of new telephone exchanges	Capacity: 1,000 lines		SHV telecommunication. Office

2.6.2 Socioeconomic activities in the port area of Sihanoukville

There are two public piers in the breakwater of Sihanoukville Port. One is under the control of the Ministry of Public Works and Transport (MPWT) Sihanoukville Branch and the other is under the control of the Ministry of Agriculture Forestry and Fishery. Cargo handling is performed at both piers. In addition, domestic passenger service to Koh Kong is offered at the former pier.

Also, at the former pier, food stuff, consumer goods and construction material are imported from Thailand by wooden boat (20 - 30 ton). Cargo volume and ship number in 1995 was about 36 thousand tons and 11.5 thousand ships. Number of passenger from Sihanoukville to Koh Kong was 30.5 thousand in 1995 (Koh Kong to Sihanoukville was unavailable).

At the latter pier, fishery products (such as fresh fish, shrimp, crab meat, shrimp meat, dry shrimp, cut fish, fresh crab, salted fish, dry fish and shrimp paste) are transported to Koh Kong. According to the Department of Agriculture Branch in Sihanoukville, these fishery products are transported to Thailand from Koh Kong.

2.6.3 Environmental aspect of the project area and vicinities of the city

(1) Resettlement of inhabitants

At present, there are 809 families and approximately 4200 habitants living at the fishing village, in the project area forming the local community. In this fishing village, there are small local factories of ice, ship building, saw mill, soy sauce and bricks for building construction. There are public administrative functions in the fishing village such as municipality port office, custom house, quarantine, immigration office, police, fishery inspection office, quarter office, elementary school, and the like.

In the Long-Term Plan, resettlement of fishermen who live nearby the project area is not required, also the long -term master plan over the period up to Year 2015 is not require resettlement of inhabitants.

(2) Economic activities

The biggest industry in Sihanoukville City is agriculture, with 45 percent of workers engaged in agriculture. The semi-government company, Angker Beer, is the biggest factory in the city employing 325 workers. There are also small-scale industries such as ice factory, saw mill, rattan factory, and garments factory.

Recently, visitors who seek beautiful coast lines have been increasing and 37 hotels have already been constructed for them. Hotel construction has increased after the election held by UNTAC in 1993.

As to fishery, the total fish catch of the province is recorded at approximately 9000 ton

per year. Part of fish caught particularly shrimps are being export to Thailand thus earning foreign currency.

(3) Traffic and life facilities

Most major road in the downtown area are paved by asphalt though it is observed that most require repair and maintenance. Access to Sihanoukville City by land is through National Route No.4 which leads to Phnom Penh. At present, transportation of cargo containers and oil products from the Sihanoukville Port are through this road.

Most of the existing infrastructures (electricity and water) in the city still use the original facilities constructed many years back.

In recent years, increase in the power demand due to economic recovery of the country and the decrease in the capacity of facilities due to aging lead to remarkable shortage of power supply. Major hotels and factories in the city therefore have been using private power generator units as countermeasure.

(4) Historical and cultural heritage

There are two temples, miscellaneous monuments and several seaside parks in the Sihanoukville City, though they are observed to be not of special historical and cultural heritage.

Radio antenna towers are constructed on the top of a small mountain in the city but no broadcasting is provided at present stage. As to local TV, broadcasting service is provided only a few hours a day, though major hotels in the city could receive programs from satellite such as CNN, Star-TV, and the like.

(5) Water right and common right

There are no water right and common right in sea area except the reservoir pond for the water supply authority and the nursery ponds. As to activities in the fishing village, no special organizations are observed at present stage.

(6) Waste and garbage

The waste and garbage of the city are collected in steel boxes installed at city streets. These boxes are then collected and transferred by big trucks of the Sihanoukville City. Raw garbages are disposed at and treated in the farms located in the suburbs.

(7) Risks and hazards

More than 500 mm/month rains are recorded during the rainy seasons, As to typhoon routes, most typhoons are passing far from the route of Indo-china peninsula, and as such, this area received no damages by typhoons. The damages by earthquake have not been observed in this area previously.

(8) Topography and geology

The downtown of Sihanoukville city is expanding in a hillside having a gentle slope. There are several reforestation areas which are planted with trees such as eucalyptus and coconut tree, though due to the poor quality of soil a lot of areas are covered only with weeds.

Beautiful coastlines having long shallows are utilized as recreational areas by foreigners and citizens. Coastal area is comprised of a little rock beach and a sandy beach with no observed erosion troubles.

(9) Underground water

Due to the insufficient capacity of water supply system, many families utilize water from artesian wells of 5m to 20m deep. The water supply authority have 4 numbers of deep well in the town for back up during dry seasons. It is observed that many houses install jars outside to collect rain water for domestic water consumption.

(10) Hydrological regime for rivers and lakes

There are many damp areas inland though water is dried up in dry seasons. There are three rivers adjacent to the project area. One river is flowing to Prek Toek Sap Lake and is utilized for drinking water by the water supply authority. The second river is located 2km far from breakwater of new port. The third river is flowing to the existing pond located beside the reservoir pond belonging to Sihanoukville Port. In addition to the above, during the rainy seasons, it is observed that there are small rivers which appear as drain channel after heavy rains.

(11) Coastal zone

There are many beautiful coast in the downtown of the Sihanoukville City, and presently utilized by citizens as recreational areas. Recently, there is an increasing number of tourists coming from other provinces who pursue these beautiful coasts. Both development plans prepared by the central government and Sihanoukville City assign these coastal zones as resort areas and recreational areas.

(12) Ecology, fauna, flora

According to "Areas Designated as Protected Area" prepared by Ministry of Environment, Ream, 20km far from Sihanoukville City and Bolum Sakor facing Kompong Saom Bay are designated as national parks. There was not observed precious fauna and flora in these areas.

(13) Meteorology

Yearly mean temperature at Sihanoukville City is 25℃ to 30℃ while humidity is more than 70% through out the year. December to April is dry season while May to November is rainy

season. In the peak of rainy season, it was observed that there are many days with recorded rain fall of more than 100mm/day.

(14) Landscape

The downtown of Sihanoukville is located on a hillside having gentle slope. No high-rise buildings are observed with almost all buildings below five stories high. Sihanoukville Port is located at the tip of the peninsula and is a hinterland area having gentle hills and small mountains. There are seaside parks in the south of the port which are utilized as recreational area by citizens.

(15) Air pollution

At present, only exhaust gas from automobiles are observed.

(16) Water pollution

All domestic sewage from habitants of the fishing village, port facilities and office north of new port are discharged to water area at new port without any treatment. As there are no public sewage treatment facilities such as pipelines and sewage treatment plants, raw sewage from buildings are treated by individual septic tank and cesspool. The municipality does not have any construction plan for sewage treatment facilities at present.

(17) Soil contamination

It was not observed in the port area and there are no factories which may possibly cause soil contamination in the city.

(18) Noise and vibration

It was not observed except for the noise of automobiles and the noise of private generators operated at night time.

(19) Land subsidence

No land subsidence was observed.

(20) Offensive odor

In the fishing village, it was observed that offensive odor occurs from the soy sauce factory and from factories processing dry fishes. There are no chemical factories in the Sihanoukville City.

3. Forecast of cargo traffic for the master plan

3.1 Socioeconomic framework in 2015

3.1.1 Population

There are no authorized or published figures on the future population of Cambodia in 2015. Therefore the future population is forecasted based on the population share of male and female by age group in 1994 through "Socio-Economic Survey of Cambodia 1993/94 (All Round), (Ministry of Planning)" which was based on UNTAC data.

The forecast will be carried out under the following conditions.

i) The population of Cambodia is 9.87 million in 1994 based on the "Key Indicators of Developing Asian and Pacific Countries" (Asian Development Bank)
ii) Maternal mortality ratio is 0.3 %, infant mortality ratio is 8 %, under five years children's mortality ratio is 18.1 % in 2000 based on the "First Socioeconomic Development Plan 1996 - 2000" (Ministry of Planning)
iii) Childbirths per woman are 4.9 in 1994 and 4.5 in 2000

The results of simulation in target years are shown in Fig. - 3.1.1-1. The average annual growth rate from 1994 - 2015 is 2.48 % and the population will reach 16.5 million in 2015.

Table - 3.1.1-1 Projected population

(Unit: thousand)

	1994 (actual)	1995	2000	2005	2010	2015
Population	9,870	10,107	11,403	12,964	14,763	16,504
Growth Ratio		2.4%	2.4%	2.6%	2.6%	2.3%

3.1.2 Economic framework

(1) Gross Domestic Products (GDP)

According to the "First Socioeconomic Development Plan 1996 - 2000 (Ministry of Planning)", GDP growth rate is estimated as 7.5 % till 2000 and there are no authorized or published figures of the future GDP after 2000 in Cambodia. Therefore the future GDP is forecasted by extrapolation of past seven years trend in each sector.

The correlation between the sectoral GDP of agriculture, industry and service and year is

expressed in the following equations respectively.

(Agriculture)

$$Y = 2E-24 \times \exp(0.029 \times X) \qquad (R=0.936)$$

where, Y: GDP of agriculture sector (1989's constant price, billion Riels)
X: Year
R: Correlation coefficient

(Industry)

$$Y = 3E-71 \times \exp(0.084 \times X) \qquad (R=0.964)$$

where, Y: GDP of industrial sector (1989's constant price, billion Riels)
X: Year
R: Correlation coefficient

(Service)

$$Y = 1E-54 \times \exp(0.065 \times X) \qquad (R=0.983)$$

where, Y: GDP of service sector (1989's constant price, billion Riels)
X: Year
R: Correlation coefficient

The result of these equations means that the average growth rate of agriculture, industry and service sectors is 3.0 %, 8.7 % and 6.7 % respectively.

Three cases are assumed for the future sectoral GDP as follows;

High Case; GDP growth rate of agriculture, industry and service sector is 5.0 %, 9.5 % and 8.5 % from 1996 respectively.

Low Case; GDP growth rate of agriculture, industry and service sector are 4.0 %, 8.0 % and 6.5 % from 1996 respectively.

Middle Case; GDP growth rate of agriculture, industry and service sector are 4.0 %, 8.0 % and 6.5 % from 1996 till 1999 respectively (same as Low Case). And from 2000, 5.0 %, 9.5 % and 8.5 % respectively (same as High Case).

The future GDP and GDP growth rate by each sector are shown in Table - 3.1.1-2. Average growth rate of whole GDP between 1995 and 2015 is 7.4 % in the High Case. This figure is similar to that proposed by the Ministry of Planning (7.5 %, mentioned above).

The future values of GDP in each case are as indicated in Table - 3.1.1-3.

Table - 3.1.1-2 GDP growth rate

CASE	Sector	-1995 (actual)	-1999	-2005	-2010	-2015	average
High Case	Agriculture	3.0%	5.0%	5.0%	5.0%	5.0%	5.0%
	Industry	8.7%	9.5%	9.5%	9.5%	9.5%	9.5%
	Service	6.7%	8.5%	8.5%	8.5%	8.5%	8.5%
	Total	5.2%	7.1%	7.3%	7.5%	7.7%	7.4%
Middle Case	Agriculture	3.0%	4.0%	5.0%	5.0%	5.0%	4.8%
	Industry	8.7%	8.0%	9.5%	9.5%	9.5%	9.2%
	Service	6.7%	6.5%	8.5%	8.5%	8.5%	8.1%
	Total	5.2%	5.7%	7.3%	7.5%	7.6%	7.1%
Low Case	Agriculture	3.0%	4.0%	4.0%	4.0%	4.0%	4.0%
	Industry	8.7%	8.0%	8.0%	8.0%	8.0%	8.0%
	Service	6.7%	6.5%	6.5%	6.5%	6.5%	6.5%
	Total	5.2%	5.7%	5.8%	5.9%	6.0%	5.8%

Table - 3.1.1-3 Value of GDP

(Unit: billion Riels)

CASE	Sector	1995 (actual)	2000	2005	2010	2015
High Case	Agriculture	144.7	200.9	256.3	327.2	417.6
	Industry	60.9	99.1	156.0	245.5	386.5
	Service	119.2	185.9	279.5	420.3	632.0
	Total	324.8	485.8	691.8	993.0	1,436.0
Middle Case	Agriculture	144.7	184.3	235.2	300.2	383.1
	Industry	60.9	87.2	137.3	216.1	340.2
	Service	119.2	161.5	242.8	365.1	549.0
	Total	324.8	432.9	615.3	881.3	1,272.2
Low Case	Agriculture	144.7	182.5	222.1	270.2	328.7
	Industry	60.9	86.0	126.4	185.7	272.8
	Service	119.2	158.5	217.2	297.5	407.6
	Total	324.8	427.0	565.6	753.4	1,009.1

3.2 Demand forecast

3.2.1 Methodology for demand forecast

There are two different methods of forecasting demand for port traffic in general. One is the so-called macro forecast method on the basis of socio-economic conditions, and the other is the so-called micro forecast method on the basis of the characteristics of cargo flow by each commodity group of cargo.

The former method forecasts the total cargo volume as a whole by statistical correlation

between the cargo volume and socio-economic indices such as GDP (gross domestic products) of the hinterland of the port and/or population and the past time trend.

The latter one is a cumulative method forecasting the cargo volume based on the analyses of the patterns of major commodities individually (related indices, the forecast demand and supply situation).

The demand of commodity is used with the grouping of cargo volume handled at Sihanoukville Port and Phnom Penh Port from 1987 to 1995 as shown in Table - 3.2.1-1.

Forecast is carried out using both commodity of Sihanoukville Port and Phnom Penh Port because the hinterlands of each port overlap (all of the nation) and handled cargoes influence each other. The cargo of Phnom Penh Port is deducted to obtain the final result of forecast volume at Sihanoukville Port in the target years. The cargo volume transported by road from / to Thailand or Vietnam is not assumed to shift to sea transportation because the volume at present is quite small. And even if the volume increases in future, the cargo from / to Vietnam will still be carried by road because the roads are being rehabilitated and the distance from the countries to Phnom Penh is not so far to justify sea transportation. As for Thailand, the capacity of land transportation will be increased under the condition of rehabilitation of road or rail and if peace is maintained near the border in Cambodia, though neither land transportation nor sea transportation will dominate. In either case, land transportation greatly depends on the foreign and domestic policy in Cambodia.

Table - 3.2.1-1 Cargo volume by main commodity in both ports

[IMPORT] (Phnom Penh & Sihanoukville) (Unit: Ton)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Cement	9,057	28,096	44,170	26,319	33,877	54,342	17,243	173,044	143,070	185,325	117,630
Fertilizer	25,291	20,788	35,696	65,271	19,989	11,501	2,373	13,532	34,852	28,437	30,053
Machinery	3,657	6,554	7,804	7,925	16,449	20,353	3,338	17,370	2,353	2,587	6,917
Rice	1,524	25,501	24,063	14,646	12,440	21,976	13,094	26,984	29,089	30,489	43,257
Sugar	0	3,013	0	0	1,110	0	2,011	2,027	11,987	28,654	21,067
Steel	0	0	0	0	0	0	0	8,881	2,570	22,711	17,936
Bitumen	0	0	0	0	0	0	0	0	0	10,074	19,987
Wheat	0	0	2,014	2,517	0	100	0	0	1,317	7,700	12,510
Others	78,715	95,723	85,234	100,768	118,095	131,255	95,910	190,124	124,821	134,074	96,506
Container	0	0	510	680	1,200	1,560	2,810	31,275	89,600	126,822	208,961
Fuels	62,207	127,487	123,914	152,479	159,996	211,862	241,712	251,403	344,581	375,246	459,437
TOTAL	180,451	307,162	323,405	370,605	363,156	452,949	378,491	714,640	784,240	952,119	1,034,261

[EXPORT] (Phnom Penh & Sihanoukville) (Unit: Ton)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Wood Product	9,948	6,998	10,422	10,940	28,064	33,328	73,977	73,280	106,585	101,728	154,309
Rubber	17,469	21,373	25,550	28,827	33,835	34,664	26,687	24,685	26,345	50,419	26,029
Agriculture Prod	5,690	7,918	14,234	25,672	45,710	30,053	32,223	10,146	9,052	11,300	2,705
Others	72	1,795	3,885	3,303	30,365	65,333	24,874	15,465	19,494	6,677	10,774
Container	0	0	0	0	0	0	0	212	36,151	12,338	19,804
TOTAL	33,179	38,084	54,091	68,742	137,974	163,378	157,761	123,788	197,627	182,462	213,621

Source: Phnom Penh Port and Sihanoukville Port

3.2.2 Main cargo throughput in Cambodia port

Macro forecast is carried out using historical relation between cargo volume and GDP.

(1) Macro forecast by GDP

As mentioned in the methodology, the forecast of the port traffic is carried out using correlation between the cargo volume and historical indices such as GDP and population. In this report, GDP is adopted as the historical index because a census of population has not been conducted since 1979.

a. Import

The correlation between the cargo volume (sum of Sihanoukville Port and Phnom Penh Port, excluding fuel) and GDP from 1987 to 1995 is expressed in the following equation.

$$\mathbf{Y = 4{,}036.86 \times GDP - 711{,}821.25} \qquad (R=0.966)$$

where, Y: Total import cargo volume (excluding fuel)

GDP: GDP (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

The import cargo volume is estimated in Table - 3.2.2-1

Table - 3.2.2-1 Import volume of cargo by macro forecast

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case		1,249,346	2,080,968	3,296,714	5,085,287
Middle Case	574,824	1,035,891	1,771,848	2,846,013	4,424,010
Low Case		1,011,969	1,571,330	2,329,383	3,361,944

b. Export

Total export cargo volume handled at Sihanoukville Port and Phnom Penh Port is forecasted by its relation with GDP. The correlation between the cargo volume and GDP from 1987 to 1995 is expressed in the following equation.

$$\mathbf{Y = 1{,}240.98 \times GDP - 188{,}180.37} \qquad (R=0.850)$$

where, Y: Total export cargo volume

GDP: GDP (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

The export cargo volume is estimated in Table - 3.2.2-2.

Table - 3.2.2-2 Export volume of cargo by macro forecast

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	213,621	414,704	670,354	1,044,088	1,593,915
Middle Case		349,086	575,327	905,538	1,390,632
Low Case		341,732	513,686	746,720	1,064,141

(2) Micro forecast

a. Fertilizer

The future import volume of fertilizer is assumed based on its consumption volume. Furthermore consumption volume is forcasted by the cultivated area and consumption volume per area in Cambodia. The cultivated area will be forecast by correlation with year. The correlation between the cultivated area and year from 1985 to 1993 is expressed in the following equation.

$$Y = 68.25 \times X - 133,847.54 \qquad (R=0.857)$$

Where, Y: Cultivated area in Cambodia (thousand ha)

X: Year

R: Correlation coefficient

On the other hand, consumption volume per area is forecast using increase rate of Thailand (9.34 % per year) till the volume is less than 54.4 kg/ha (consumption volume in Thailand in 1993). After that point, it is assumed that the volume doubles every ten years (7.18 % per year).

The import volume or consumption volume is estimated in Table - 3.2.2-3.

Table - 3.2.2-3 Import volume of fertilizer

		1994 (actual)	2000	2005	2010	2015
Product Area	(thousand ha)	2,102	2,661	3,002	3,343	3,685
Consumption per Unit Area	(kg/ha)	13.5	20.2	31.6	49.5	71.4
Import Volume (Consumption Volume)	(ton)	28,437	53,881	95,013	165,378	262,959

b. Cement

Correlation between the total cargo volume and the sum of GDP of industrial sector and assistance from foreign countries by a linear regression is shown below.

$$Y = 1,747.14 \times X - 26,489.56 \qquad (R=0.925)$$

where, Y: Total import cargo volume

X: Sum of GDP of industrial sector (1989's constant prices, billion

Riels) in Cambodia and assistance from foreign countries

R: Correlation coefficient

The import volume is estimated in Table - 3.2.2-4.

Table - 3.2.2-4 Import volume of cement

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	117,630	226,007	298,046	402,425	648,725
Middle Case		196,643	259,665	351,077	567,891
Low Case		193,587	236,875	297,925	450,181

c. Rice

The future import / export volume of rice is assumed by the paddy production and consumption in Cambodia. Production is forcasted by the cultivated area and yield per area.

The cultivated area of paddy will be forecast by correlation with year. The correlation between the cultivated area and year from 1980 to 1994 is expressed in the following equation.

$$Y = 34.99 \times X - 67{,}819.11 \qquad (R=0.801)$$

Where, Y: Cultivate area of paddy in Cambodia (thousand ha)

X: Year

R: Correlation coefficient

Paddy yield per area has been decreasing since 1990. But in future, it is estimated that the yield per area will increase because the government should make efforts to increase paddy production. Therefore, yield per area is forecast by the annual increase volume which is calculated by the correlation between the yield per area and year from 1980 to 1990. During this period, yield per area increased, by about 30 kg/ha per annum.

On the other hand, consumption volume in Cambodia will be calculated by future consumption volume per capita and population. Based on the "First Socioeconomic Development Plan 1996 - 2000" (Ministry of Planning), necessary consumption volume per capita of paddy is 265 kg. Hence, future consumption per capita is estimated by the correlation between the consumption per capita and production while the consumption is less than 265 kg.

Import / export volume of rice will be calculated by the lack / surplus of paddy. Loss volume ratio of paddy process to rice is adopted as 45 % which is based on the "First Socioeconomic Development Plan 1996 - 2000 (Ministry of Planning)".

Based on the above, the import / export volume is estimated in Table - 3.2.2-5.

Table - 3.2.2-5 Import / export volume of rice

Item			1994	2000	2005	2010	2015
PADDY	Product Area	(thousand ha)	1,924	2,169	2,344	2,519	2,694
	Yield per Unit Area	(ton/ha)	1.16	1.33	1.47	1.61	1.75
	Production	(thousand ton)	2,223	2,877	3,443	4,058	4,724
	Population	(thousand)	9,870	11,403	12,694	14,763	16,504
	Consumption per person	(kg/person)	247	265	265	265	265
	Consumption Volume	(thousand ton)	2,439	3,027	3,441	3,919	4,381
RICE	Import	(ton)	30,489	141,548	63,676		
	Export	(ton)				6,672	112,998

d. Sugar

Import volume of sugar will be forecast by correlation with GDP of industrial sector. The following formula shows the correlation between sugar and GDP of industrial sector from 1986 to 1993.

$$\mathbf{Y = 919.81 \times X - 33{,}513.24} \qquad (R=0.934)$$

Where, Y: Import volume of sugar (ton)

X: GDP of industrial sector (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

Table - 3.2.2-6 shows projection for the import volume of sugar.

Table - 3.2.2-6 Import volume of sugar

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	21,067	57,604	109,926	192,295	321,963
Middle Case		46,695	92,754	165,262	279,407
Low Case		45,597	82,725	137,279	217,437

e. Wheat

Import volume of wheat will be forecast by correlation with GDP of industrial sector. The following formula shows the correlation between wheat and GDP of industrial sector from 1987 to 1995.

$$\mathbf{Y = 304.84 \times X - 10{,}662.14} \qquad (R=0.762)$$

Where, Y: Import volume of wheat (ton)

X: GDP of industrial sector (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

Table - 3.2.2-7 shows projection for the import volume of wheat.

Table - 3.2.2-7 Import volume of wheat

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	12,510	19,535	36,876	64,174	107,147
Middle Case		15,920	31,185	55,215	93,043
Low Case		15,556	27,861	45,941	72,506

f. Steel

The import volume of steel is forecasted by its correlation with GDP of industrial sector. The correlation between the import volume and GDP of industrial sector is expressed in the following equation.

$$Y = 715.75 \times X - 26{,}070.08 \qquad (R=0.885)$$

Where, Y: Import volume of steel (ton)

X: GDP of industrial sector (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

Table - 3.2.2-8 shows projection for the import volume of steel.

Table - 3.2.2-8 Import volume of steel

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	17,936	44,832	85,547	149,642	250,543
Middle Case		36,344	72,185	128,607	217,428
Low Case		35,489	64,381	106,832	169,207

g. Machinery and equipment

The imported machinery increased till 1990, then decreased under condition of progressing containerization and the change in the political situation. The reason for the decrease in import machinery by the progress of containerization is that some of the machinery and equipment was carried in container. Therefore import volume of machinery and equipment will be forecast by the following formula, which shows the correlation between machinery and whole GDP till 1990.

$$Y = 349.71 \times X - 68{,}113.06 \qquad (R=0.800)$$

Where, Y: Import volume of machinery and equipment (ton)

X: GDP (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

The ratio of machinery to the sum of machinery and equipment is assumed as 15 % in 1995 based on actual data, and will gradually increase till 2015 according to the past trend.

Table - 3.2.2-9 shows projection for the import volume of machinery and equipment.

Table - 3.2.2-9 Import volume of machinery and equipment

(Unit: ton)

	1990 (actual)	2000	2005	2010	2015
High Case	20,353	101,780	173,822	279,141	434,082
Middle Case		83,289	147,044	240,097	376,797
Low Case		81,216	129,673	195,342	284,792

h. Bitumen

The correlation between the import volume of bitumen and GDP of industrial sector is expressed in the following equation.

Y = 510.58 × X − 19,386.42 (R=0.786)

Where, Y: Import volume of bitumen (ton)

X: GDP of industrial sector (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

Table - 3.2.2-10 shows projection for the import volume of bitumen.

Table - 3.2.2-10 Import volume of bitumen

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	19,987	39,471	68,515	114,238	186,216
Middle Case		33,416	58,983	99,232	162,593
Low Case		32,806	53,416	83,699	128,194

i. Fuel

The import volume of fuel is forecasted by its correlation with GDP. The correlation between the import volume and GDP from 1987 to 1994 is expressed in the following equation.

Y = 2,961.73 × X − 530,401.21 (R=0.975)

Where, Y: Import volume of fuel (ton)

X: GDP (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

Table - 3.2.2-11 shows projection for the import volume of fuel.

Table - 3.2.2-11 Import volume of fuel

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	459,437	908,454	1,518,591	2,410,551	3,722,778
Middle Case		751,847	1,291,799	2,079,884	3,237,618
Low Case		734,296	1,144,684	1,700,847	2,458,409

j. Other general cargo for import

Other general cargo for import is defined as cargo of others and container excluding equipment. But, according to the statistics of port, container cargo includes some equipment. Therefore, at first, the sum of cargo machinery (including equipment), others and container is forcasted by the correlation with GDP. The correlation between the cargo volume and GDP from 1987 to 1995 is expressed in the following equation.

$$\mathbf{Y = 2{,}103.91 \times X - 384{,}914.57} \qquad (R=0.938)$$

Where, Y: Import volume of machinery, others and container (ton)

X: GDP (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

The import volume of other general cargo is calculated by deducting the forcasted import volume of machinery from the result of above formula. Table - 3.2.2-12 shows projection for the import volume of other general cargo.

Table - 3.2.2-12 Import volume of other general cargo

		1995 (actual)	2000	2005	2010	2015
Including Machinery and Equipment	High Case	312,384	637,199	1,070,619	1,704,237	2,636,398
	Middle Case		525,951	909,514	1,469,343	2,291,757
	Low Case		513,483	805,009	1,200,088	1,738,233
Excluding Machinery and Equipment	High Case	—	535,418	896,797	1,425,096	2,202,315
	Middle Case		442,662	762,470	1,229,245	1,914,960
	Low Case		432,267	675,335	1,004,745	1,453,442

k. Wood product

The export of logs was banned in 1993. Hence future export of wood product will consist of timber, plywood and other processed wood.

In 1995, more than 90 % of round wood is consumed for fuelwood, charcoal and so on

("Cambodia Business & Investment Handbook 1996" (Ministry of Commerce)). The remainder (about 10 %) is used by industry for timber, plywood and so on. On the other hand, export volumes of round wood and processed wood are 47,135 tons and 107,174 ton respectively in 1995. If the volume lost during processing was included, the total volume would be 200,241 tons (8.7 % of wood product, 88.2 % of industrial round wood).

According to the future plan of wood production and consumption in Cambodia, annual growth rate of round wood is 1.3%. Therefore future export volume is estimated by the correlation between the cargo volume and GDP till the volume is less than the volume of industrial round wood. After that, the growth rate of export volume is assumed in High Case, Middle Case and Low Case as 1.6 %, 1.3 % and 1.0 % respectively.

Incidentally, the fell volume calculated by the export cargo volume in 2015 will be less than ultimate fell volume in Cambodia, estimated by the correlation between the forest area and fell volume in Indonesia, Thailand, Vietnam and Malaysia.

Table - 3.2.2-13 shows projection for the export volume.

Table - 3.2.2-13 Export volume of wood product

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	140,169	172,094	186,310	201,699	218,360
Middle Case		169,569	180,881	192,948	205,820
Low Case		167,072	175,595	184,552	193,966

Note: Loss volume ratio of round wood to wood processing is estimated as 30%

1. Rubber

The future export volume of rubber is assumed by the rubber production and consumption in Cambodia. Production is forcasted by the cultivated area and yield per area.

The cultivated area of rubber will be forecast by correlation with year. The correlation between the cultivated area and year from 1980 to 1992 is expressed in the following equation.

$$Y = 4{,}395.76 \times X - 8{,}699{,}041.31 \qquad (R=0.986)$$

Where, Y: Cultivated area of rubber in Cambodia (thousand ha)

X: Year

R: Correlation coefficient

Rubber yield per area has not been increased since 1987, but in future it is estimated that the yield per area will increase. Therefore, yield per area is forecast by annual increase volume calculated by the correlation between the yield per area and year from 1981 to 1988. During this period, the yield per area increased by about 40 kg/ha per annum.

On the other hand, share for export will be forecast by correlation with production. The correlation between the export volume and production from 1985 to 1995 is expressed in the following equation.

$$Y = 0.728 \times X - 6{,}214.09 \qquad (R=0.821)$$

Where, Y: Export volume of rubber in Cambodia (ton)

X: Production of rubber in Cambodia (ton)

R: Correlation coefficient

Based on the above, the export volume is estimated as Table - 3.2.2-14.

Table - 3.2.2-14 Export volume of rubber

		1993 (actual)	2000	2005	2010	2015
Product Area	(thousand ha)	61	92	114	136	158
Yield per Unit Area	(ton/ha)	0.36	0.72	0.90	1.09	1.27
Production	(ton)	22,000	66,538	103,292	148,089	200,929
Export	(ton)	26,345	63,211	98,128	140,685	190,882

m. Agriculture product

The future export volume of agriculture product is assumed by the agriculture production and its consumption in Cambodia. The production of agriculture product will be forecast by correlation with year. The correlation between the production and year from 1985 to 1995 is expressed in the following equation.

$$Y = 24.8 \times X - 48{,}759.91 \qquad (R=0.882)$$

Where, Y: Production of agriculture product in Cambodia (ton)

X: Year

R: Correlation coefficient

On the other hand, consumption volume in Cambodia will calculated by future consumption volume per capita and population. Future consumption per capita is estimated by the average from 1987 to 1995, 68 kg / person.

The export volume of agriculture product is calculated by deducting the domestic consumption volume from the production. Table - 3.2.2-15 shows projection for the export volume of agriculture product.

Table - 3.2.2-15 Export volume of agriculture product

		1994 (actual)	2000	2005	2010	2015
Production	(ton)	625,000	826,000	950,000	1,074,000	1,198,000
Population	(thousand)	9,870	11,403	12,964	14,763	6,504
Consumption per person	(kg/person)	64.6	67.8	67.8	67.8	67.8
Consumption Volume	(ton)	687,831	773,242	879,057	1,001,091	1,119,143
Export	(ton)	-	52,777	70,928	72,858	78,771

n. Other general cargo for export

Other general cargo for export is defined as consist of cargo of others and container for export. The correlation between the volume and GDP from 1987 to 1995 is expressed in the following equation.

$$Y = 209.82 \times X - 43{,}003.04 \qquad (R=0.865)$$

Where, Y: Import volume of other general cargo for export (ton)

X: GDP (1989's constant prices, billion Riels) in Cambodia

R: Correlation coefficient

Table - 3.2.2-16 shows projection for the export volume of other general cargo for export.

Table - 3.2.2-16 Export volume of other general cargo

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	30,578	58,931	102,155	165,345	258,308
Middle Case		47,836	86,089	141,920	223,938
Low Case		46,593	75,666	115,067	168,736

(3) Result of cargo throughput in both ports

According to the above method, the import and export volume both at Sihanoukville Port and Phnom Penh Port is estimated and the results are shown in Table - 3.2.2-17. Total import and export cargo volumes estimated by the micro method are compared with results of the macro method.

Comparing the results of the micro forecast with macro forecast, we observe disparities of 78 - 94 % in the High Case, 80 - 100 % in the Middle Case and 83 - 101 % in Low Case. It is considered that these difference are mainly due to the low growth rate of export wood product

mainly. This is because export volume of wood product will be increased as the GDP constantly in the macro method, against the ban of round wood export, future forestry and wood product plan in Cambodia which are considered in the micro method. Hence, the cargo volumes handled at the port Sihanoukville Port for the target years will be forecast as those obtained by the micro forecast method.

Table - 3.2.2-17 Summary of forecasted cargo volume in Cambodia

(HIGH CASE)

		2000	2005	2010	2015
IMPORT	Fertilizer	53,881	95,013	165,378	262,959
	Cement	226,007	298,046	402,425	648,725
	Rice	141,548	63,676	0	0
	Sugar	57,604	109,926	192,295	321,963
	Wheat	19,535	36,876	64,174	107,147
	Bitumen	39,471	68,515	114,238	186,216
	Steel	44,832	85,547	149,642	250,543
	Machinery and Equipment	101,780	173,822	279,141	434,082
	Other General Cargo	535,418	896,797	1,425,096	2,202,315
	Total	1,220,077	1,828,219	2,792,389	4,413,950
	Macro Forecast	1,249,346	2,080,968	3,296,714	5,085,287
EXPORT	Rice	0	0	6,672	112,998
	Rubber	63,211	98,128	140,685	190,882
	Wood Production	172,094	186,310	201,699	218,360
	Agriculture Product	52,777	70,928	72,858	78,771
	Other General Cargo	58,931	102,155	165,345	258,308
	Total	347,013	457,521	587,259	859,320
	Macro Forecast	414,704	670,354	1,044,088	1,593,915
	TOTAL	1,567,091	2,285,740	3,379,648	5,273,270
	Macro Forecast	1,664,051	2,751,322	4,340,802	6,679,202

(MIDDLE CASE)

		2000	2005	2010	2015
IMPORT	Fertilizer	53,881	95,013	165,378	262,959
	Cement	196,643	259,665	351,077	567,891
	Rice	141,548	63,676	0	0
	Sugar	46,695	92,754	165,262	279,407
	Wheat	15,920	31,185	55,215	93,043
	Bitumen	33,416	58,983	99,232	162,593
	Steel	36,344	72,185	128,607	217,428
	Machinery and Equipment	83,289	147,044	240,097	376,797
	Other General Cargo	442,662	762,470	1,229,245	1,914,960
	Total	1,050,399	1,582,974	2,434,113	3,875,078
	Macro Forecast	1,035,891	1,771,848	2,846,013	4,424,010
EXPORT	Rice	0	0	6,672	112,998
	Rubber	63,211	98,128	140,685	190,882
	Wood Production	169,569	180,881	192,948	205,820
	Agriculture Product	52,777	70,928	72,858	78,771
	Other General Cargo	47,836	86,089	141,920	223,938
	Total	333,393	436,025	555,082	812,410
	Macro Forecast	349,086	575,327	905,538	1,390,632
	TOTAL	1,383,792	2,018,999	2,989,196	4,687,488
	Macro Forecast	1,384,976	2,347,175	3,751,551	5,814,642

(LOW CASE)

		2000	2005	2010	2015
IMPORT	Fertilizer	53,881	95,013	165,378	262,959
	Cement	193,587	236,875	297,925	450,181
	Rice	141,548	63,676	0	0
	Sugar	45,597	82,725	137,279	217,437
	Wheat	15,556	27,861	45,941	72,506
	Bitumen	32,806	53,416	83,699	128,194
	Steel	35,489	64,381	106,832	169,207
	Machinery and Equipment	81,216	129,673	195,342	284,792
	Other General Cargo	432,267	675,335	1,004,745	1,453,442
	Total	1,031,948	1,428,956	2,037,141	3,038,717
	Macro Forecast	1,011,969	1,571,330	2,329,383	3,361,944
EXPORT	Rice	0	0	6,672	112,998
	Rubber	63,211	98,128	140,685	190,882
	Wood Production	167,072	175,595	184,552	193,966
	Agriculture Product	52,777	70,928	72,858	78,771
	Other General Cargo	46,593	75,666	115,067	168,736
	Total	329,654	420,317	519,834	745,354
	Macro Forecast	341,732	513,686	746,720	1,064,141
	TOTAL	1,361,601	1,849,273	2,556,975	3,784,071
	Macro Forecast	1,353,701	2,085,016	3,076,103	4,426,085

3.2.3 Cargo volume at Sihanoukville Port

Cargo volume at Sihanoukville Port is estimated by the total cargo volume in Cambodia, share of cargo volume at Sihanoukville Port and containerization rate in Cambodia. Flow chart of the process to calculate cargo volume at Sihnoukville Port is shown in Fig. - 3.2.3-1.

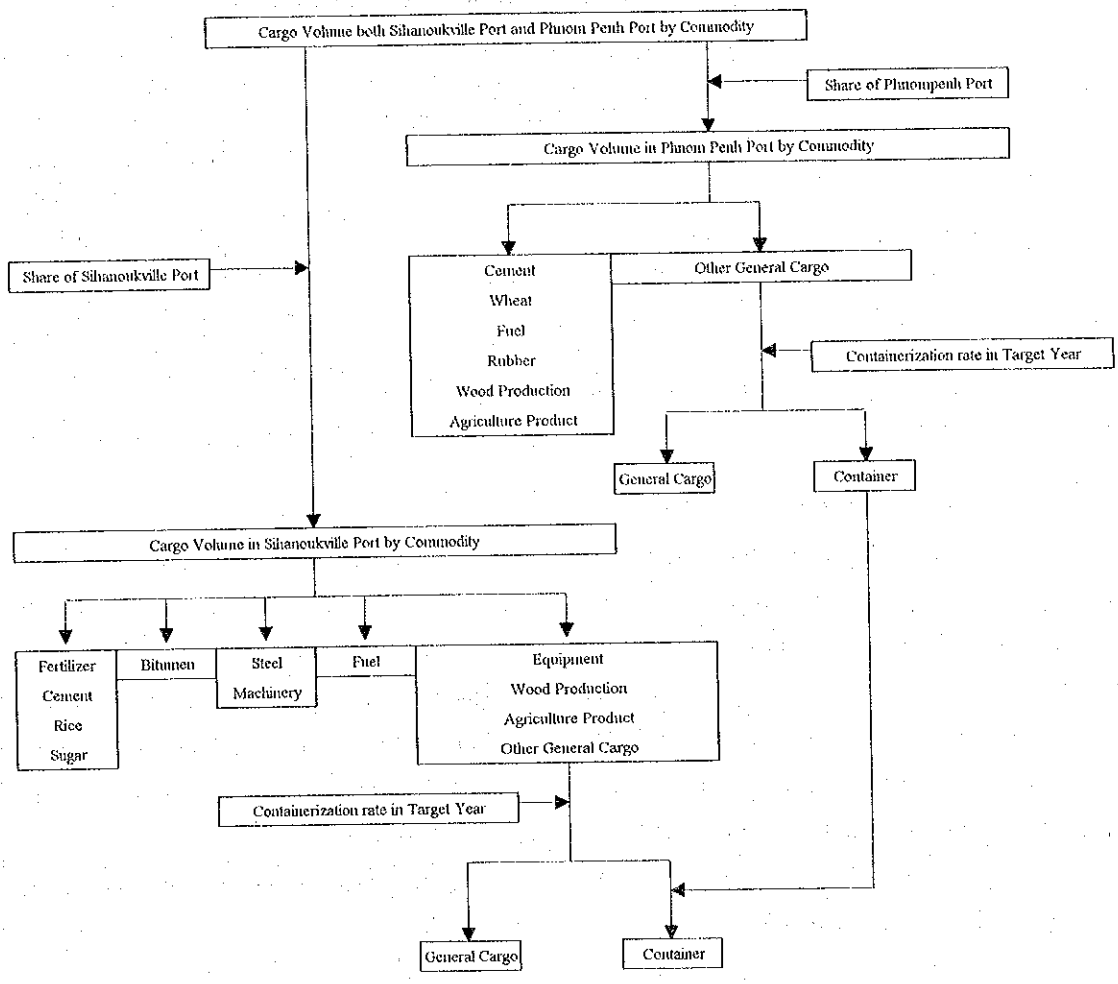


Fig. - 3.2.3-1 Flow chart for forecast cargo volume at Sihanoukville Port

(1) Share of cargo volume at Sihanoukville Port

The share at Sihanoukville Port by commodities is assumed according to the past trend.

The shares of imported fertilizer, rice, sugar, bitumen, steel and machinery have been increasing the in recent years, and the trend will continue in future. Imports of cement and export of other general cargo and agriculture product have decreased since 1993, but the consolidation of Sihanoukville Port and the introduction of large ships will put the brakes on this trend. By the past trend, it is assumed that wheat and rubber will be exported from Phnom Penh Port. The share of cargo volume by commodity at Sihanoukville Port is summarized in Table - 3.2.3-1.

In import fuel, the share of imported volume at Sihanoukville port has been increasing since 1992. Taking into consideration the increase of import fuel, the introduction of large size oil tanker in future, the share of Sihanoukville Port as the sole sea port in Cambodia will increase sharply. Hence, the share is estimated by the logistic curve based on past trend.

Table - 3.2.3-1 Share of cargo at Sihanoukville Port

		1990	1991	1992	1993	1994	1995	2000	2005	2010	2015
IMPORT	Fertilizer	99.5%	85.9%	40.6%	68.6%	100.0%	99.2%	100.0%	100.0%	100.0%	100.0%
	Cement	85.7%	82.4%	48.5%	96.0%	82.9%	79.4%	80.0%	80.0%	80.0%	80.0%
	Rice	21.3%	0.0%	22.1%	35.9%	61.9%	84.8%	100.0%	100.0%	-	-
	Sugar	-	100.0%	0.0%	35.8%	60.8%	94.5%	100.0%	100.0%	100.0%	100.0%
	Wheat	100.0%	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Bitumen	-	-	-	-	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Steel	-	-	83.8%	100.0%	71.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Machinery and Equipment	100.0%	93.8%	73.1%	96.1%	100.0%	94.4%	100.0%	100.0%	100.0%	100.0%
	Other General Cargo	74.7%	23.5%	38.7%	55.2%	61.9%	84.4%	90.0%	90.0%	90.0%	90.0%
	Fuel	8.4%	0.5%	2.0%	6.7%	11.1%	15.7%	31.5%	44.7%	55.4%	64.1%
EXPORT	Rice	-	-	-	-	-	-	-	-	100.0%	100.0%
	Rubber	20.0%	4.6%	0.4%	1.9%	6.1%	0.9%	0.0%	0.0%	0.0%	0.0%
	Wood Production	100.0%	100.0%	87.3%	98.3%	94.6%	97.6%	90.0%	90.0%	90.0%	90.0%
	Agriculture Product	4.5%	15.1%	0.6%	0.0%	0.0%	0.0%	26.0%	26.0%	26.0%	26.0%
	Other General Cargo	5.3%	3.6%	6.5%	97.5%	80.6%	65.3%	60.0%	60.0%	60.0%	60.0%

(2) Containerization rate in Cambodia

The containerization rate is the percentage of the volume of containerized cargo to the containerizable cargo. Generally, containerization rate is calculated in each port because each port has its own hinterland. In Cambodia, however, hinterlands of Sihanoukville Port and Phnom Penh Port overlap to a large extent. Furthermore, the share of cargo volume at Sihanoukville Port has been increasing with the process of containerization. This means that the containerization rate will influence the share of cargo volume in each port. Hence, containerization is correlated to the total cargo volume at Sihanoukville Port and Phnom Penh Port.

The containerization rate in the target year is forecast by using the logistic curve expressed as the following formula.

$$P = P_M / \{ 1 + C^{(t - t_0)} \}$$

where, P : Containerization rate in t year (%)

P_M: Ultimate containerization rate (90 % in import and 80 % in import)

C: Parameter prescribed for change rate of curve
(0.423 in import and 0.481 in import)

t: Year

t_0: Year in which containerization rate reached half of P_M
(1994.0 in import and 1996.3 in import)

Table - 3.2.3-2 shows past containerization rate and Table - 3.2.3-3 shows the future containerization rate which is calculated by above method.

Table - 3.2.3-2 Trend of containerization in Cambodia

(IMPORT) (Unit: Ton)

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Machinery and Equipment	7,804	7,925	16,449	20,353	3,338	17,370	2,353	2,587	6,917
Special Goods	8,338	4,692	14,105	4,638	846	0	0	0	0
Fibro	0	0	10,267	2,049	0	0	0	564	0
Cotton Wool	502	996	997	992	0	0	0	0	0
Sea Fish	0	0	0	0	0	0	0	0	0
Cigarettes	0	0	0	0	0	2,452	8,753	13,137	0
Others	76,394	95,080	92,255	123,576	95,064	187,102	116,068	120,373	96,506
Container	510	680	1,200	1,560	2,810	31,275	89,600	126,822	208,961
Containerizable Cargo	93,548	109,373	135,273	153,168	102,058	238,199	216,774	263,483	312,384
Share of Container	0.55%	0.62%	0.89%	1.02%	2.75%	13.13%	41.33%	48.13%	66.89%

(EXPORT)

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Lumber	0	0	0	4,336	4,574	9,617	97,655	67,515	90,714
Ply Wood	0	0	0	0	0	0	0	6,630	16,460
Machinery UN	0	0	0	0	0	0	5,070	205	0
Others	1,867	2,357	7,538	11,719	16,635	8,548	4,608	3,999	10,610
Container	0	0	0	0	0	212	36,151	12,338	19,804
Containerizable Cargo	1,867	2,357	7,538	16,055	21,209	18,377	143,484	90,687	137,588
Share of Container	0.00%	0.00%	0.00%	0.00%	0.00%	1.15%	25.20%	13.61%	14.39%

Source: Phnom Penh Port and Sihanoukville Port

Table - 3.2.3-3 Containerization rate in future

	1995 (actual)	2000	2005	2010	2015
Import	66.9%	89.5%	90.0%	90.0%	90.0%
Export	14.4%	75.1%	79.9%	80.0%	80.0%

(3) Cargo volume by commodity / package type at Sihanoukville Port

a. Excluding fuel

Estimated cargo volume in each commodity at Sihanoukville Port is classified into packing type, bagged cargo (solid bulk), bitumen (liquid bulk), general cargo and container. Table - 3.2.3-4 and Fig. - 3.2.3-2 shows the result of forecast.

In container cargo, TEU and number of container is estimated under the following conditions.

i) Cargo volume per TEU is assumed 10.0 tons in import and 8.0 tons in export based on the actual data

ii) Share of 20 foot and 40 foot is estimated as follows based on actual data in Cambodia and data of foreign countries

		1995	2000	2005	2010	2015
Import	20 foot	80%	77%	75%	70%	70%
	40 foot	20%	23%	25%	30%	30%
Export	20 foot	67%	63%	60%	54%	54%
	40 foot	33%	37%	40%	46%	46%

iii) The number of empty container, only in export, is estimated by disparity of import and export

Table - 3.2.3-5 summarize the TEU and number of container.

Table - 3.2.3-4(a) Cargo volume by commodity / package type at Sihanoukville Port

HIGH CASE (UNIT: Ton)

		2000	2005	2010	2015
IMPORT	Bagged Cargo	433,839	507,052	679,613	1,103,902
	Fertilizer	53,881	95,013	165,378	262,959
	Cement	180,806	238,437	321,940	518,980
	Rice	141,548	63,676	0	0
	Sugar	57,604	109,926	192,295	321,963
	Bitumen	39,471	68,515	114,238	186,216
	General Cargo	126,618	233,110	408,291	687,497
	Machinery	22,767	54,891	113,860	217,041
	Steel	44,832	85,547	149,642	250,543
	Equipment	8,314	11,902	16,528	21,704
	Other General Cargo	50,705	80,769	128,260	198,208
	Container	549,779	914,083	1,431,338	2,177,421
	Equipment	70,699	107,029	148,752	195,337
	Other General Cargo	431,171	726,348	1,154,327	1,783,876
	from Phnompenh Port	47,908	80,705	128,259	198,208
	Sub Total	1,149,707	1,722,760	2,633,479	4,155,035
EXPORT	Bagged Cargo (Rice)	0	0	6,672	112,998
	Wood Product	38,571	33,761	36,312	39,305
	General Cargo	12,226	16,058	23,638	35,097
	Agriculture Product	3,420	3,716	3,793	4,100
	Other General Cargo	8,805	12,341	19,845	30,997
	Container	183,807	245,126	308,790	397,733
	Wood Product	116,313	133,917	145,217	157,219
	Agriculture Product	10,314	14,742	15,168	16,400
	Other General Cargo	26,553	48,952	79,362	123,988
	from Phnompenh Port	30,626	47,514	69,043	100,127
	Sub Total	234,604	294,945	375,412	585,134
TOTAL		1,384,311	2,017,704	3,008,891	4,740,169

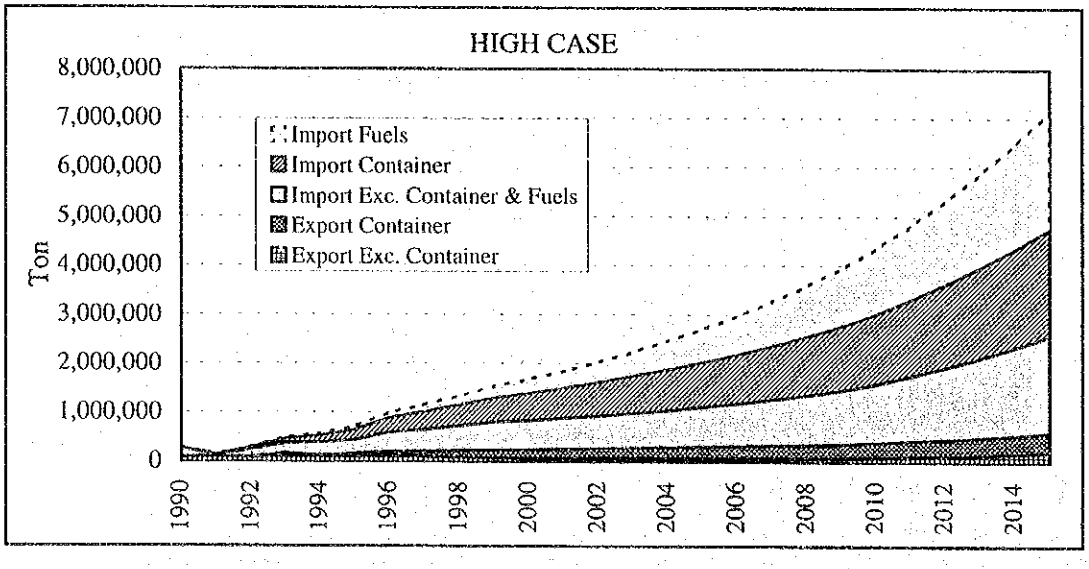


Fig. - 3.2.3-2 (a) Forecasted cargo volume at Sihanoukville Port

Table - 3.2.3-4 (b) Cargo volume by commodity / package type at Sihanoukville Port

MIDDLE CASE (UNIT: Ton)

		2000	2005	2010	2015
IMPORT	Bagged Cargo	399,439	459,175	611,502	996,679
	Fertilizer	53,881	95,013	165,378	262,959
	Cement	157,315	207,732	280,862	454,313
	Rice	141,548	63,676	0	0
	Sugar	46,695	92,754	165,262	279,407
	Bitumen	33,416	58,983	99,232	162,593
	General Cargo	103,699	197,359	351,391	597,013
	Machinery	18,630	46,435	97,934	188,398
	Steel	36,344	72,185	128,607	217,428
	Equipment	6,804	10,068	14,216	18,840
	Other General Cargo	41,921	68,671	110,633	172,346
	Container	453,938	776,709	1,234,266	1,893,022
	Equipment	57,855	90,541	127,946	169,559
	Other General Cargo	356,475	617,552	995,688	1,551,117
	from Phnompenh Port	39,608	68,617	110,632	172,346
	Sub Total	990,492	1,492,226	2,296,391	3,649,307
EXPORT	Bagged Cargo (Rice)	0	0	6,672	112,998
	Wood Product	38,005	32,778	34,737	37,048
	General Cargo	10,568	14,117	20,826	30,973
	Agriculture Product	3,420	3,716	3,793	4,100
	Other General Cargo	7,148	10,400	17,033	26,873
	Container	173,578	227,958	283,050	360,205
	Wood Product	114,606	130,015	138,916	148,190
	Agriculture Product	10,314	14,742	15,168	16,400
	Other General Cargo	21,554	41,253	68,118	107,490
	from Phnompenh Port	27,103	41,948	60,847	88,126
	Sub Total	222,152	274,852	345,285	541,224
TOTAL		1,212,644	1,767,079	2,641,676	4,190,531

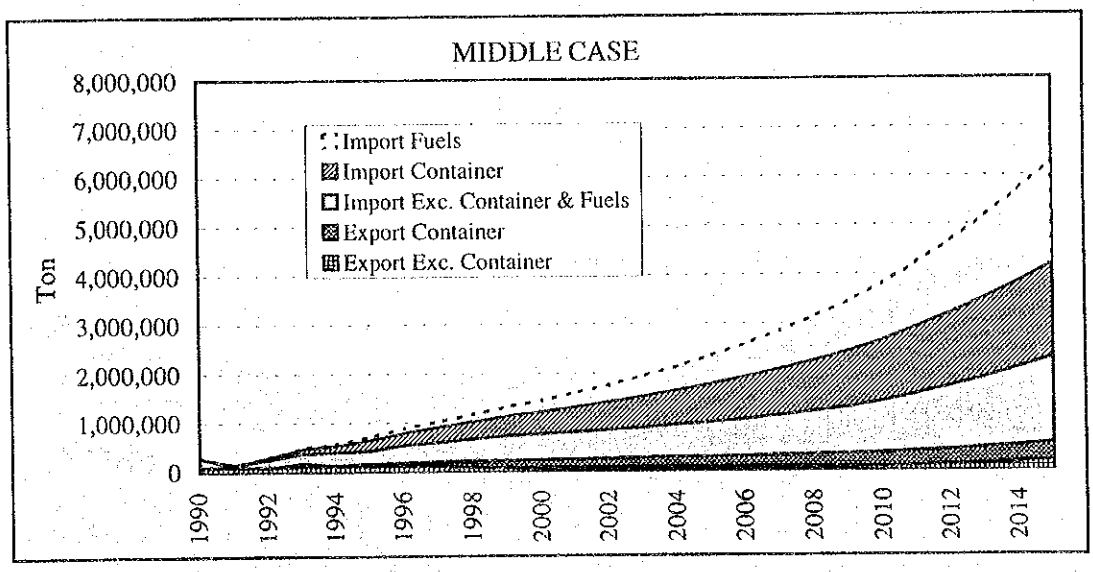


Fig. - 3.2.3-2(b) Forecasted cargo volume at Sihanoukville Port

Table - 3.2.3-4(c) Cargo volume by commodity / package type at Sihanoukville Port

LOW CASE (UNIT: Ton)

		2000	2005	2010	2015
IMPORT	Bagged Cargo	395,896	430,914	540,997	840,541
	Fertilizer	53,881	95,013	165,378	262,959
	Cement	154,870	189,500	238,340	360,145
	Rice	141,548	63,676	0	0
	Sugar	45,597	82,725	137,279	217,437
	Bitumen	32,806	53,416	83,699	128,194
	General Cargo	101,227	175,033	288,505	456,652
	Machinery	18,167	40,949	79,679	142,396
	Steel	35,489	64,381	106,832	169,207
	Equipment	6,634	8,879	11,566	14,240
	Other General Cargo	40,936	60,824	90,428	130,810
	Container	443,197	687,599	1,008,367	1,436,254
	Equipment	56,415	79,845	104,097	128,156
	Other General Cargo	348,103	546,978	813,843	1,177,288
	from Phnompenh Port	38,678	60,775	90,427	130,810
Sub Total		973,126	1,346,962	1,921,568	2,861,641
EXPORT	Bagged Cargo (Rice)	0	0	6,672	112,998
	Wood Product	37,446	31,820	33,225	34,914
	General Cargo	10,382	12,858	17,603	24,348
	Agriculture Product	3,420	3,716	3,793	4,100
	Other General Cargo	6,962	9,141	13,810	20,248
	Container	170,770	215,413	254,853	306,560
	Wood Product	112,919	126,216	132,872	139,655
	Agriculture Product	10,314	14,742	15,168	16,400
	Other General Cargo	20,994	36,259	55,230	80,993
	from Phnompenh Port	26,542	38,196	51,583	69,513
Sub Total		218,598	260,090	312,353	478,821
TOTAL		1,191,724	1,607,052	2,233,921	3,340,462

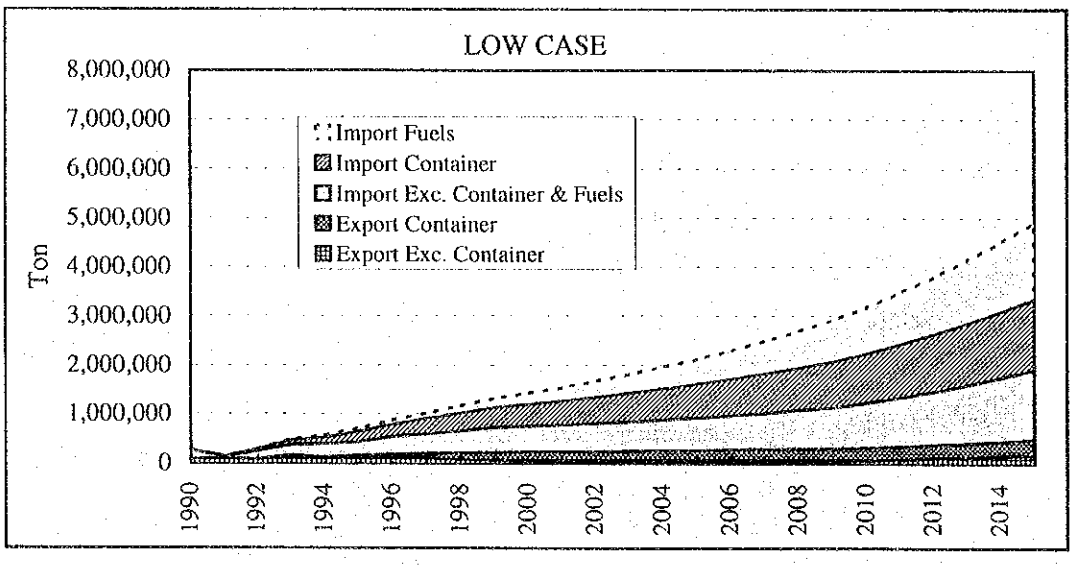


Fig. - 3.2.3-2 (c) Forecasted cargo volume at Sihanoukville Port

Table - 3.2.3-5 TEU and number of container

(Unit: TEU)

			2000	2005	2010	2015
HIGH CASE	Import	Loaded	54,978	91,408	143,134	217,742
	Export	Loaded	22,976	30,641	38,599	49,717
		Empty	32,002	60,768	104,535	168,025
	TOTAL		109,956	182,817	286,268	435,484
MIDDLE CASE	Import	Loaded	45,394	77,671	123,427	189,302
	Export	Loaded	21,697	28,495	35,381	45,026
		Empty	23,696	49,176	88,045	144,277
	TOTAL		90,788	155,342	246,853	378,604
LOW CASE	Import	Loaded	44,320	68,760	100,837	143,625
	Export	Loaded	21,346	26,927	31,857	38,320
		Empty	22,973	41,833	68,980	105,305
	TOTAL		88,639	137,520	201,673	287,251

(Unit: Number)

			2000	2005	2010	2015
HIGH CASE	Import	Loaded	44,697	73,127	110,103	167,494
	Export	Loaded	16,771	21,886	26,438	34,053
		Empty	27,927	51,240	83,665	133,441
	TOTAL		89,395	146,253	220,206	334,988
MIDDLE CASE	Import	Loaded	36,906	62,137	94,944	145,617
	Export	Loaded	15,837	20,353	24,234	30,839
		Empty	21,068	41,783	70,710	114,778
	TOTAL		73,811	124,273	189,887	291,234
LOW CASE	Import	Loaded	36,032	55,008	77,567	110,481
	Export	Loaded	17,355	21,541	24,505	29,477
		Empty	18,678	33,467	53,062	81,004
	TOTAL		72,065	110,016	155,133	220,962

According to the result of the forecast, the export volume will be quite low compared to that of import. With the rapid development of new industry expected in future, new commodities will be exported and the export volume will greatly increase. In this forecast, however, this possibility is not taken into account. In case that the export cargo volume increases, these industrial commodities will be handled by container which are forecasted as exported empty container in this study. TEU and number of export empty container has enough capacity to handle this cargo volume, hence the port facilities and equipment used in this forecast will be able to handle the increase of export cargo volume.

b. Fuel

Import fuel at Sihanoukville Port is calculated by the total volume of fuel in Cambodia and the share at Sihanoukville Port. Table - 3.2.3-6 shows the result of estimation.

Table - 3.2.3-6 Import volume of fuel at Sihanoukville Port

(Unit: ton)

	1995 (actual)	2000	2005	2010	2015
High Case	72,243	285,872	679,324	1,336,212	2,384,772
Middle Case		236,591	577,871	1,152,917	2,073,983
Low Case		231,068	512,061	942,810	1,574,831

4. Formulation of the development strategy of cargo transportation

4.1 The role of Sihanoukville Port and its dry port in the international and domestic trade

(1) Sihanoukville Port

Being the only deep sea port of Cambodia, Sihanoukville Port is given the role as the gateway of the whole country together with Phnom Penh Port. Since, situated on the bank of Mekong River, being a river port, the latter burdens itself with some geographical and operational restrictions, the role of the former in the economic development of the country is expected to become more important.

As the statistics show, the cargo volume handled at Sihanoukville has been rapidly increasing for the past few years, while that at the other is stagnant if not decreasing. In 1995, Sihanoukville Port handled 73% of General cargoes, 99.9% of container cargoes and 16% of oli.57% (see Table - 4.1.1-1). Thus, Sihanoukville Port can be called to be the container handling port, while Phnom Penh Port to be of oil handling port.

Table - 4.1.1-1 Cargo volume Share of Sihanoukville Port (1995)

	Import	Export	Total
General Cargo	74.7%	68.9%	72.7%
Container	99.9%	99.9%	99.8%
Oil	15.7%	-	15.7%
All Commodity	53.6%	71.8%	56.7%

Source: Cargo statistics from Phnom Penh and Sihanoukville Port

It should be noted that, with the on-going rehabilitation and expansion project, Phnom Penh Port will increase cargo handling capacity up to the level of 620,000 tons (except oil) which is almost comparative amount that is presently handled at Sihanoukville Port , and that the latter will burden the role of the gateway of the whole Cambodia in the coming years. It should also be noted that, with the expansion plans proposed by oil companies for the oil terminal at Sihanoukville, the port is also expected to increase the share of oil handling volume.

The major commodities expected to be handled at these two ports are:

1) Phnom Penh Port

Import; Oil, Construction materials(Cement), Rice, Wheat, other consumable

Export; wood product, rubber, agricultural products, and

2) Sihanoukville Port

Import; Construction Materials(Cement), Fertilizer, Machinery, Rice, Sugar, other consumable(container), oil, bitumen

Export; wood product, others(container)

The statistics also show that Singapore and Thailand are the major origins of import cargoes, and that Thailand, China, Malaysia and Singapore are the major destinations of export cargoes. With respect to the container cargoes, Singapore is the largest origin and destination. Some portion of import containers are originated from Thailand, and Malaysia and Thailand are other major destination(see Table - 4.1.1-2). These tendencies is expected to remain unchanged in the coming decades.

Table - 4.1.1-2 Share of the origins and destinations of the cargoes

	Import		Export	
	All cargo types	Containers	All cargo types	Containers
Singapore	44%	86%	14%	49%
Thailand	24%	14%	42%	15%
Australia	15%	-	-	-
China	5%	-	26%	-
Malaysia	2%	-	4%	34%
Share by 5 countries	90%	100%	86%	98%

(2) Dry Port

The construction of the dry port in Phnom Penh, which is intended to take a role of inland cargo terminal of Sihanoukville Port with the connection road No. 4. When it starts operation, the containerization of conventional cargoes will be accelerated.

4.2 Assumption and conditions introduced

4.2.1 Dimensions of calling ships

(1) Analysis of ship size

a. Container carriers

There are 292 full container carriers are presently operated in the sea routes within Far East region. The sizes of these container ships vary over the range between 1,800 and 30,500 DWT with the average 12,400 DWT. The relationship between the size and the year built of these container carriers is shown in Fig. - 4.2.1-1. With few exception, they were built between 1970 and 1994. This shows that the life of container carriers are 25 years. It is observed that the new construction of container carriers having DWT between 5,000 ton and 15,000 tons had been increased over the period from 1970 through 1985. However It is also observed in the figure that the size of those built in recent years, i.e., 1990 or later, are fall on two categories: either between 4,000 and 10,000 or between 12,000 and 25,000. This indicates that, though the size of container carriers tends to increase in general, there are new construction of container carriers with smaller size, and that, in the feeder routes, container carriers having DWT less that 10,000 will be operated in the coming decades.

Of the above mentioned 292 full container carriers, 57 ships are plying in the sea routes either between Singapore and Thailand or Thailand and other ports in Far East such as Japan, Korea, Taiwan, and etc. Figure - 4.2.1-2 is drawn to exhibit the relationship between DWT and the year built of the 47 container carriers which are presently plying in the sea routes between Thailand and other Far East countries. It is obviously seen in the figure that the majority of them have DWTs in the range between 10,000 and 15,000.

On the basis of above analysis, it can be assumed that, in the year 2015, the sizes of the container carriers which are calling Sihanoukville Port are of the classes of 7,000 tons (Singapore feeder) and 16,000 tons (Sihanoukville-Thailand-Malaysia-other Far East Ports rout).

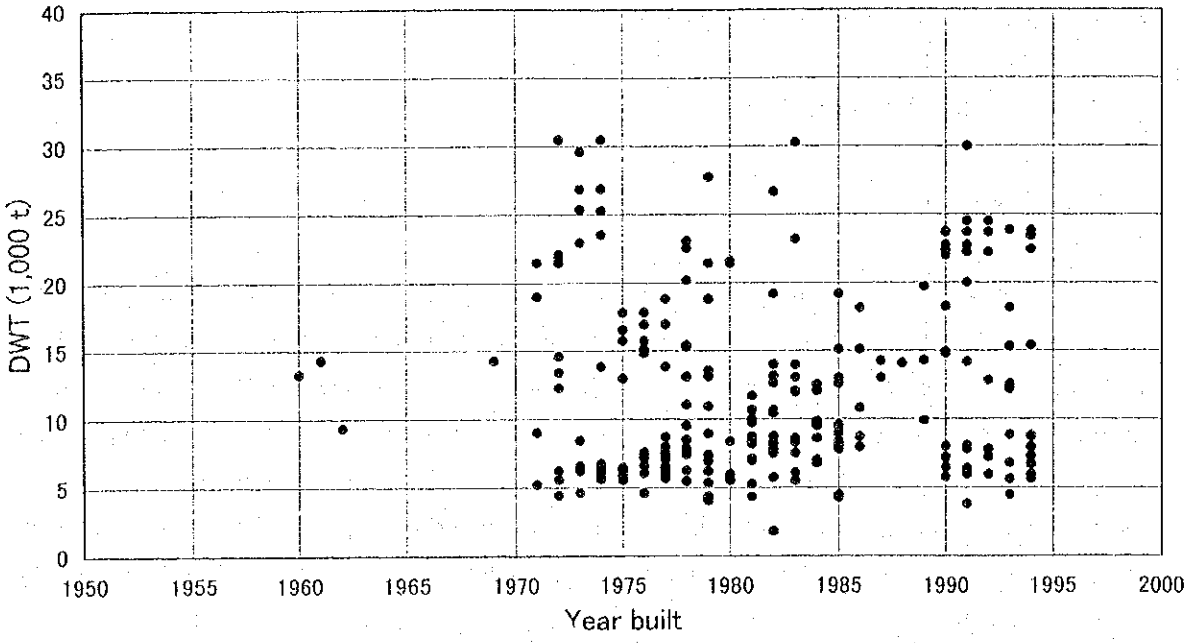


Fig. - 4.2.1-1 Correlation between DWT and Year built
(Full container ships employed in sea routes in Far East)

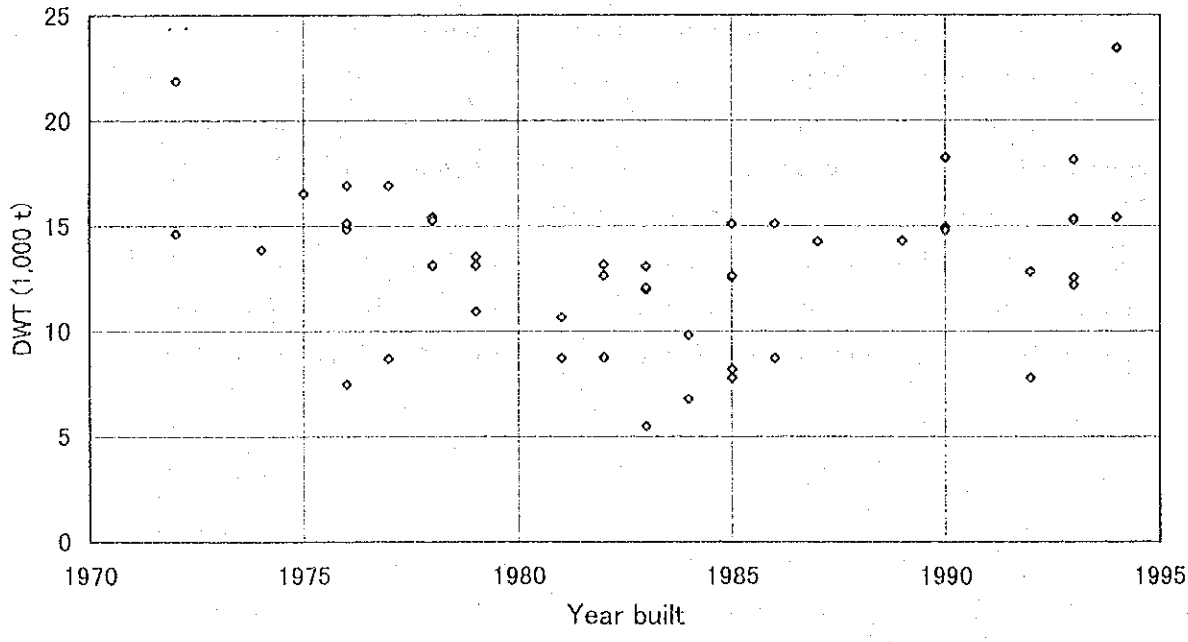


Fig. - 4.2.1-2 Correlation between DWT and Year built
(Full container ships employed between Thailand and other ports in Far East)

b. Bulk carriers

According to the cargo volume forecast, the volume of cement and fertilizer handled at Sihanoukville Port are expected to reach substantial amounts: 454,000 and 263,000 tons, respectively, for Middle case forecast. It seems to be more realistic to assume these two commodities will be brought in the shape of dry bulk rather than bagged form as presently observed at the port. Therefore, in the long-term plan, these two commodities are assumed to be bulk cargoes. present form bags. Considering the origin of these commodity and the average size of cement carriers, the ship size are chosen to be 7,000 DWT.

c. Bitumen

Bitumen has been mainly brought to Sihanoukville in tankers, though some portion was brought in drums in 1995. In the future, it is expected that bitumen will be carried by tankers as observed at present, and that larger tankers will be employed.

d. Rice

In 1995, rice was imported from Bangkok, China and Taiwan in general cargo ships having DWTs 2,000 to 9,000 and from Australia and U.S.A. in sugar in ships with 13,000 to 17,000 DWT. In the scenario employed in the cargo forecast, the domestic production will be increased to exceed the amount of domestic consumption. Thus, it is expected that import of rice from U.S.A. or Australia in large ships will diminish and ships of the class 7,000 DWTs will be employed for the export of rice.

With respect to sugar, ships having 5,000 DWT will be employed, because sugar is brought from Bangkok which is in short distance from Sihanoukville Port.

e. General cargoes

Ship size to be employed for the transportation of other general cargoes is assumed to be 5,00 to 7,000DWT.

(2) Size of calling ships

On the basis of the statistics of calling ships at present and the projection in the future, the design ship sizes to be used for the Master Plan are chosen as shown in Table - 4.2.1-1 with the consideration of such tendency that the ship size will increase in the future.

Table - 4.2.1-1 Ship sizes used for layout plan of berthing facilities

Type of cargoes	Ship Size (DWT)					
	1995		2000	2005	2015	
	Average	Maximum	Average	Average	Average	Maximum
(1) Bagged Cargo						
a. Fertilizer	6,000	10,000	5,000	7,000	7,000	7,000
b. Cement	3,000	5,000	7,000	10,000	7,000	7.000
c. Rice	2,000	17,000	7,000	5,000	7,000	7,000
d. Sugar	2,000	2,700	5,000	5,000	5,000	7,000
(2) Bitumen	2,000	5,000	3,000	5,000	5,000	7,000
(3) General Cargo	2,000	8,000				
a. Machinery			3,000	7,000	7,000	10,000
b. Steel Product			5,000	5,000	7,000	10,000
c. Wood Product			5,000	5,000	5,000	10,000
d. General Cargo			3,000	5,000	7,000	10,000
(4) Container	1,200	4,300	4,000	5,000	7,000	16,000

With the average ship sizes assumed as listed in Table - 4.2.1-1, the number of calling ships are estimated. The results are summarized in Table - 4.2.1-2.

In the year 2015, it is very probable that cement and fertilizer will be brought in the form of bulk rather than bag form, because their import volumes are quite large. Thus, in Table - 4.2.1-1, that the size of the ships carrying cement is smaller in the year 2015 than in 2005.

The dimensions of these ships are given as shown in Table - 4.2.1-3 for various sizes. In the columns on the right in the Table, the frequency of ship calls expected in respective years, i.e., 1996-2000, 2005-2010, and 2015 and over, are exhibited with the marks, ◎, ○, △, where ◎ denotes that the sizes of the ships calling most frequently, ○ denotes sizes of those ship that make few calls in a year, and △ denotes the size of the ships which may call on occasionally.

4.2.2 Approach channels to the port

In the master planning, there are two alternative routes of approach channel are taken into consideration. One is the existing South Channel, which, with a depth of water -7.5m or deeper, is presently used for the access channel to the Old Jetty for larger ships. The other is called the North Channel which serves as the access to New Port for smaller ships, because, at present, the water depth at the mouth of the breakwaters is as deep as -7.5 meters.

The future expansion of the port requires dredging of an approach channel up to New Port area where the proposed site of future expansion of berthing facilities is located.

In the Long-term Plan, the cost of the dredging are estimated for both two alternative routes. It is said that the sea bed of the South Channel is hard rock which makes dredging difficult and more costly. The surveys conducted during the first stage of the study, however, did

Table - 4.2.1-2 Calculation of number of calling ships

Long-term (2015)	High			Middle			Low		
Commodity	Cargo Vol. ton	Ave. Load DWT x 0.8	Ship Calls	Cargo Vol. ton	Ave. Load DWT x 0.8	Ship Calls	Cargo Vol. ton	Ave. Load DWT x 0.8	Ship Calls
(1) Bagged Cargo	1,217,000			1,109,400			953,500		
a. Fertilizer	263,000	5,600	47.0	263,000	5,600	47.0	263,000	5,600	47.0
b. Cement	519,000	5,600	92.7	454,000	5,600	81.1	360,100	5,600	64.3
c. Rice	113,000	5,600	20.2	113,000	5,600	20.2	113,000	5,600	20.2
d. Sugar	322,000	4,000	80.5	279,400	4,000	69.9	217,400	4,000	54.4
(2) Bitumen	186,200	4,000	46.6	162,600	4,000	40.7	128,200	4,000	32.1
(3) General Cargo	761,800			665,000			515,800		
a. Machinery	217,000	5,600	38.8	188,400	5,600	33.6	142,400	5,600	25.4
b. Steel Product	250,500	5,600	44.7	217,400	5,600	38.8	169,200	5,600	30.2
c. Wood Prod.	39,300	4,000	9.8	37,000	4,000	9.3	34,900	4,000	8.7
d. General Cargo	255,000	5,600	45.5	222,200	5,600	39.7	169,300	5,600	30.2
G.C.(Import)	219,900			191,200			145,000		
G.C. (Export)	35,100			31,000			24,300		
G. Cargo Total	2,165,000		425.7	1,937,000		380.1	1,597,500		312.4
(4) Container TEU	435,400	600	725.7	378,600	600	631.0	287,200	600	478.7
Total Cargo ton	4,739,700		1151.4	4,190,000		1011.1	3,340,100		791.1

Short-term (2005)	High			Middle			Low		
Commodity	Cargo Vol. ton	Ave. Load DWT x 0.8	Ship Calls	Cargo Vol. ton	Ave. Load DWT x 0.8	Ship Calls	Cargo Vol. ton	Ave. Load DWT x 0.8	Ship Calls
(1) Bagged Cargo	507,000			459,200			430,900		
a. Fertilizer	95,000	5,600	17.0	95,000	5,600	17.0	95,000	5,600	17.0
b. Cement	238,400	8,000	29.8	207,700	8,000	26.0	189,500	8,000	23.7
c. Rice	63,700	4,000	15.9	63,700	4,000	15.9	63,700	4,000	15.9
d. Sugar	109,900	4,000	27.5	92,800	4,000	23.2	82,700	4,000	20.7
(2) Bitumen	68,500	4,000	17.1	59,000	4,000	14.8	53,400	4,000	13.4
(3) General Cargo	283,000			244,217			219,720		
a. Machinery	54,900	5,600	9.80	46,400	5,600	8.3	40,900	5,600	7.3
b. Steel Product	85,500	4,000	21.4	72,200	4,000	18.1	64,400	4,000	16.1
c. Lumber	33,800	4,000	8.5	32,800	4,000	8.2	31,820	4,000	8.0
d. General Cargo	108,800	4,000	27.2	92,817	4,000	23.2	82,600	4,000	20.7
G.C.(Import)	92,700			78,700			69,700		
G.C. (Export)	16,100			14,117			12,900		
G. Cargo Total	858,500		174.12	762,417		154.5	704,020		142.61
(4) Container (TEU)	182,820	400	457.05	155,340	400.0	388.4	137,520	400	343.8
Total Cargo ton	2,017,700		631.17			542.9	1,607,020		486.41

Urgent(2000)	Middle		
Commodity	Cargo Vol. ton	Ave. Load DWT x 0.8	Ship Calls
(1) Bagged Cargo	399,400		
a. Fertilizer	53,900	4,000	13.475
b. Cement	157,300	5,600	28.089
c. Rice	141,500	5,600	25.268
d. Sugar	46,700	4,000	11.675
(2) Bitumen	32,800	2,400	13.667
(3) General Cargo	152,200		
a. Machinery	18,600	2,400	7.75
b. Steel Product	36,300	4,000	9.075
c. Wood Product	38,000	4,000	9.5
d. General Cargo	59,300	2,400	24.708
G.C.(Import)	48,700		
G.C. (Export)	10,600		
G. Cargo Total	584,400		143.21
(4) Container			
Import (ton)	453,900		
(TEU)	90,780	200	453.9
Export (ton)	173,600		
Total Cargo ton	1,211,900		597.11

Table - 4.2.1-3 Size of calling vessels

Ship size DWT	Type	Ship dimension (m)			Berth (m)		calling vessel size		
		LOA	Beam	Draft	Length	Depth	'96-2000	2005-'10	2015 -
1,000	General Cargo	70	9.5	4.2	80	5.0	○	○	△
3,000	General Cargo Container	86 83*	13.2	5.9	100	6.5	◎	○	○
4,000	General Cargo Container	95 96*	14.4	6.4	110	7.0	◎	◎	○
5,000	General Cargo	103	15.4	6.8	120	7.5	◎	◎	◎
7,000	General Cargo Container (400-500 TEU)	129 120	17.6 20.0	7.5 6.4	150	8.5	○	◎	◎
10,000	General Cargo	144	19.4	8.2	165	9.0	△	○	◎
16,000	Container (600-700 TEU)	180	26.0	9.3	210	10.5		△	○
20,000	General Cargo Dry Bulk	177 171	23.4 23.8	10.0 9.8	200 195	11.0 11.0			○
24,000	Container (800-1,500 TEU)	200 - 215	30.0	10.5	230-245	11.5			△

Ship size DWT	Type	Ship dimension			Berth		calling vessel size		
		LOA	Beam	Draft	Length	Depth	'96-2000	2005-'10	2015 -
1,000	Oil Tanker	57	9.4	4.2	70	5.0			
3,000	Oil Tanker	85	12.8	5.9	100	6.5	◎	○	
4,000	Oil Tanker	88*	13.7**	6.4**	105	7.0	○	◎	○
5,000	Oil Tanker	102	14.7	6.9	120	7.5		◎	◎
10,000	Oil Tanker	139	19.0	8.1	160	9.0		△	◎
15,000	Oil Tanker	157	21.7	9.0	180	10.0			○
20,000	Oil Tanker	171	23.8	9.8	200	11.0			△

*Note: * from the List of calling vessels to Sihanoukville Port, ** the Study Team's guess, others are from Standard Manual*

not observe the exposure of rocks along the route. In the Interim Report, therefore, the comparison of the dredging costs will made on only the dredging volumes between the two routes. Of these two routes, the one which requires less cost for dredging shall be recommended.

During the second phase of the survey, the bed material of both routes shall be identified through boring, and the costs of the dredging shall be refined on the basis of the results of the survey in the Draft Final Report.

4.2.3 Criteria for the productivity of berth, yard, shed and freight stations

On the basis of the cargo handling productivity presently observed in the operation of Sihanoukville Port and other relevant information, the criteria of the cargo handling productivity is determined for respective commodity and at various stages of the port expansion plan. The results are summarized in Table - 4.2.3-1.

Table - 4.2.3-1 Criteria for cargo handling productivity

Commodity	Handling Productivity (ton/day/berth)			
	1995	2000	2005	2015
(1) Bagged Cargo				
a. Fertilizer	434	434	651	1,613
b. Cement	276	651	651	2,880
c. Rice	372	651	434	1,296
d. Sugar	288	434	434	864
(2) Bitumen	1,056	1,620	1,620	10,800
(3) General Cargo				
a. Machinery		700	1,029	1,670
b. Steel Product	480	686	686	1,728
c. Wood Prod.	348	609	609	1,152
d. General Cargo	156	364	504	756
(4) Container (TEU/Day/Berth)	280	280	800	998.4

The criteria shown in Table - 4.2.3-1 is used for the determination of number of berths in the plan. With respect to the requirement of the land area for the yards, the sheds and the container freight stations are discussed in 5.3.5.

4.3 Cargo handling capacity of the existing port facilities

4.3.1 Present capacity of Sihanoukville Port

In order to determine the required scale of plan for future cargo traffic, it is necessary to determine the present cargo-handling capacity of the port. Port capacity is generally calculated in terms of the volume of cargo.

Since port capacity varies according to the type of the cargo, size of lot, size of the berth, method of loading and unloading, etc., it is often represented simply as the volume of cargo handled at the port.

The present capacity of Sihanoukville is estimated by analyzing the relationship between the volume of cargo handled at each berth, in terms of general cargoes and containers.

(1) General cargoes

a. Cargo handling capacity at berths

Some of the data related to the handling of general cargoes is as shown below.

i)	Average loading/unloading capacity :	20.0	tons/hour
ii)	Average working hours per day:	12.5	hours
iii)	Average mooring days per ship:	3.1	days
iv)	Number of berths for general cargo:	6	berths
v)	Working days per year:	320	days

These are used to estimate the annual port capacity for handling general cargo. The number of ships which can moor at the general cargo berths per year is obtained from c, d and e above. This figure is about 619. The actual number of general cargo ships entering the port in 1995 was 353. This indicated a berth occupancy ratio of 57%.

The annual cargo-handling capacity is estimated at 480 thousand tons. This is obtained from the daily cargo handling volume of 250 tons calculated from a and b above. The volume of general cargo handled at Sihanoukville Port in 1995 was 410 thousand tons. This shows that the port of Shihanoukville is being operated slightly below full capacity according to the berth data analysis.

b. Capacity of cargo storage facilities

The present transit shed measures 31,000 m2. Since data on the cargo handling capacity of Sihanoukville Port from the view point of storage space is not available, we substitute the actual values for the port of Yokohama in Japan, where transit shed capacity is estimated at 0.55 t/m2, assuming 1.0 times a month cargo turnover rate. The capacity of cargo storage facilities is

estimated at 670 thousand tons. In view of the present handling volume of 95 thousand tons, the transit sheds still have sufficient capacities.

(2) Containers

a. Container handling capacity at berth

Some of the data related to the handling of containers is as shown below.

i)	Average loading/unloading capacity :	19.0	TEU/hour
ii)	Average working hours per day:	11.4	hours
iii)	Average mooring days per ship:	1.0	days
iv)	Number of berths for general cargo:	1	berths
v)	Working days per year:	320	days

These are used to estimate the annual port capacity for handling container cargo. The number of ships which can moor at the container berth per year is obtained from c, d and e above. This figure is about 320. The actual number of container ships entering the port in 1995 was 176. This indicated a berth occupancy ratio of 55%.

The annual container-handling capacity is estimated at 69 thousand TEU. This is obtained from the daily container handling volume of 216 TEU calculated from a, and b above. The volume of container handled at Sihanoukville Port in 1995 was 40 thousand TEU. This shows that port of Shihanoukville is being operated below full capacity according to the berth data analysis.

The number of containers handled per year is calculated according to the following assumptions.

The maximum number which can be stored is 700 judging from the amount of yard area. With an average of 1.5 layers for storage, and three times a month rate of turnover, the annual number handled will be 37,800 TEU. This shows that Sihanoukville Port is being operated at full capacity.

Generally, the capacity of the container handling facilities is determined by the number of containers stored, however, the area has not been completely paved, therefore, a new container yard of 2.3 ha is under construction at present.

4.3.2 Improvement plan for urgent stage

(1) Present problems

The port still has a sufficient cargo handling capacity as mentioned above. However, the problem areas in the existing handling system are identified as follows;

a. Management of equipment and operators

Reflecting the insufficient number of cargo handling equipment, the distribution of cargo handling equipment is changed according to the number of discharging/loading vessels; this hinders the same vessel from achieving same productivity of cargo handling cotinuouly.

b. Management of handling operation

Damage to the cargoes seems to be caused by improper handling during discharging and/or storing operation rather than by marine damage during sea transportation. This is a result of the lack of adequate cargo handling tool, such as slings, spreaders, and attachment for forklifts, and also improper use of forklifts taking into consideration the types of cargoes. In addition, the condition of open storage yard is also a contributing factor.

c. Operation of container yard

The container yard is allocated around warehouse Nos. I and II and behind warehouse No. III Consequently, tractors are obliged to slip through narrow and winding passages and carry containers a long distance between ship and container yard. And the tractors for discharging/loading and delivery/receiving cross each other. This situation makes container transport inefficient and dangerous.

As regards stacking containers, at present all empty containers are stacked in only two tiers due to the insufficient stability of land because it is not paved completely. This limits the storage capacity of the container yard.

Concerning the dwelling time of containers, the import containers dwell longer than export containers. In particular the dwelling time of empty containers is longer than that of full load containers. This makes the congestion of the container yard much worse.

d. Parking lot

There is no specially designated parking lot for trailers. The trailers are however parked in groups in open spaces.

(2) Improvement plan

As above mentioned, it is necessary to improve the existing cargo handling system in the urgent stage. The necessary items to be improved are summarized as follows:

i) Procurement of cargo handling equipment
ii) Improvement of road
iii) Construction of open yard for container
iv) Construction of parking lot

The required cargo handling equipment and scale of road, open yard and parking lot is shown in Table - 4.3.2-1.

Table - 4.3.2-1 Required cargo handling equipment and facilities in the urgent stage

		Capacity	Unit	Quantity	
Cargo handling equipment					
1	Conveyor with rollers		Set	3	for bagged cargo handling
2	Forklift	3 ton	Nos	2	for bagged cargo handling
	Forklift	15 ton	Nos	1	for heavy cargo handling
3	Tractor(yard)		Nos	6	for container handling
4	Trailor (yard)		Nos	10	for container handling
5	Top Lifter	40 ton	Nos	2	for container handling
Civil works					
1	Road		m^2	5,600	
1	Open yard		m^2	3,800	
2	Parking lot		m^2	1,200	

4.3.3 Improvement plan in future

(1) Cargo handling system

Generally, there is a traditional cargo handling system at every port. Cargo handling systems are also diversified, according to packing style, handling volume and nature of cargo, and type, kind and size of carrying vessel and method of storage in port and the type, size and capacity of the cargo handling equipment and facilities such as cranes, forklifts, etc.

According to the demand forecast for the target year of 2015, the future cargo handling system in Sihanoukville Port is proposed with regard to the following vessel types, considering the present cargo handling system and cargo flow within the port.

General cargo vessel	- Laden with various kinds of cargoes
	- Laden with one kind of commodity
	- Rice (bagged)
	- Sugar (bagged)
	- Wood products
	- Steel products
Bulk carrier	- Cement
	- Fertilizer
Tanker	- Bitumen
Car carrier	- Machinery (Vehicles)
Container vessel	

a. General Cargo Vessel

The unloading and loading of cargoes from/to vessels in the port are generally carried out using the following two types of equipment.

- Ship's Crane/Gear
- Mobile Crane

The packaging of general cargoes is tending conspicuously towards unitization, such as palletization and containerization, enlargement, and the unit weight per package is becoming heavier. Nevertheless it is difficult to select the most advisable equipment for general cargo vessels because besides the unitized cargoes, various kinds, types and sizes of general cargoes are co-stowed in the vessel's hold. Following these trends, the lifting capacity of ship's cranes/gear has become larger and the number of vessels having cranes with lifting capacities between 10-15 ton is increasing in the world's maritime fleets. Heavy cargoes exceeding this range are generally handled by means of mobile cranes.

1) General cargo vessel laden with various kinds of cargoes

At present, loading onto trucks is carried out simultaneously with unloading from the vessel in the port. Although the cargo is only handled once in the port, the overall cargo handling rate is low because the landing of cargoes by cranes onto trucks/cars is very difficult due to the small working area of each truck, and the throughput of cargo is affected by the marshaling of the trucks and turnaround at apron. It is advised that this method be only adopted for the handling of particular cargoes, such as dangerous cargo, frozen cargo, perishable cargo and heavy cargo, taking the nature of cargo into consideration.

In order to achieve smooth unloading and loading from/into vessels, the proper type and capacity of handling tools, such as sling, spreader, etc., and forklifts should be chosen and separately used per kind, type and weight of cargoes.

2) General cargo vessel laden with one kind of commodity

i) Rice and sugar (bagged)

At present, almost all bagged cargoes such as rice and sugar are directly delivered from the port by trucks as they are. Given the nature of such cargo, this handling system is considered to be unavoidable. In order to raise the cargo handling rate, the handling system for bagged cargoes needs some reformation throughout the port, e.g. introduction of palletization and/or provision of storage facilities within the port.

ii) Wood products

Wood products are usually bundled in cubes fit for forklift handling as the handling

throughout the port is mainly carried out by forklifts. This cargo is kept in the transit sheds and open yards of the port in accordance with the nature and packing of the cargo, and requires the transit shed and open yards for smooth handling and storage.

iii) Steel products

There are many kinds of steel products and many types of packaging for international trade. These cargoes, except for high quality goods, are kept in open yards in the port, and require a wide apron and wide open yards for smooth handling and storage given the type of cargo packaging. In addition, the handling of these goods is very difficult because they are lengthy and/or heavy and in order to ensure quick handling and prevent damage at all stages of port traffic, it is necessary that the equipment and handling tools are properly chosen and used.

The handling equipment such as forklifts, mobile cranes, etc., will be arranged step-by-step along with increase of handling volume of cargo in the future.

3) Utilization of transit shed and open yard

At present, in Sihanoukville Port, almost all of the unloaded cargoes are directly delivered to consignee and only valuable and perishable cargoes are stored in the transit sheds in the port, therefore, the transit sheds are almost vacant. In order to ensure the effective use of the transit sheds and open yards, it is necessary to examine the storage of cargoes in the transit sheds depending on the nature and kind of cargo, and also to designate the utilization of the transit sheds and the open yards per kind of cargo. Also, in order to ensure the effective use of the transit sheds and the open yards, the cargo should be stacked in tiers when possible with proper and sufficient wooden dunnage, and the stacking of cargo should be done in a block per kind and lot of cargo with proper clearance between piles thereby facilitating cargo handling at the time of delivery.

4) Delivery of cargo to hinterland

Delivery of the cargoes is immediately carried out using proper handling equipment such as forklifts and/or mobile crane, taking storage capacity into consideration.

b. Bulk carrier

According to the demand forecast for the year 2015, a special berth for the handling of break bulk is to be planned for the target year 2015.

1) Cement

Cement unloading from vessels is carried out by a pneumatic unloader and cement is

directly put in silos through conveyer systems, and then evacuated from silos into trucks for transportation to hinterland.

2) Fertilizer

Fertilizer is unloaded by ship cargo gears and/or mobile cranes with grab buckets to the movable hoppers, and directly landed on to trucks and forwarded to hinterland.

c. Tanker (Bitumen)

At present, bitumen is unloaded at berth Nos. 5 and 6 with the existing shore pipe lines running to storage tanks in the port area by private companies. However, it is proposed that bitumen is handled at the special berth with break bulk. The handling facility such as pipe line and tanks is to be planned by private companies because the fluctuating unloading rate is probably determined by the shore tank capacity, vessel's pump capacity or lack of cargo heating.

d. Car carrier (Machinery)

The machinery (vehicles) is carried by the car carriers. The unloading from vessels is carried out by driving the vehicle through the vessel's ramp way, and transferring between the storage area to the vessel is accomplished by the same means.

e. Container vessel

The container handling system for the target year 2015 is considered in the following chapter.

(2) Cargo handling capacity

a. Assumption of cargo handling productivity by commodities

According to proposed cargo handling system, it is necessary to estimate the cargo handling productivity by commodities. Therefore, the cargo handling productivity by commodities per hour per gang is calculated using the following formula.

i) General cargoes (by ship gear)

1.5 ton x 20 cycle/hour x 0.7 (efficiency) = 21 ton/hour/gang

ii) Rice and sugar (bagged, by ship gear)

1.5 ton x 20 cycle/hour x 0.8 (efficiency) = 24 ton/hour/gang

iii) Wood products (by ship gear)

2.0 ton x 20 cycle/hour x 0.8 (efficiency) = 32 ton/hour/gang

iv) Steel products (by ship' gear or mobile crane)

3.0 ton x 20 cycle/hour x 0.8 (efficiency) = 48 ton/hour/gang

v) Machinery (by driving)

1.45 ton (1 unit) x 20 cycle/hour x 0.8 (efficiency) = 23.2 ton/hour/gamg

vi) Cement (by pneumatic unloader)

200 ton/hour x 1 unit x 0.8 (efficiency) = 160 ton/hour/unit

vii) Fertilizer (by grab bucket and movable hopper)

2.8 ton x 20 cycle/hour x 0.8 (efficiency) = 44.8 ton/hour/gang

viii) Bitumen (by ship' pump)

500 ton/hour x 0.9 (efficiency) = 450 ton/hour

ix) Container (by gantry crane)

24 cycle/hour x 0.8 (efficiency) = 19.2 box/hour/gang