4.1.4 Effective utilization of railways

(1) Possibility of modal shift

As the result of the interview survey to a railway operator TRR (Toll Royal Railway), they declined to disclose confidential business information on the freight transportation quantity and associated costs. Their current freight cost is understood to be only estimated under the several assumptions. As mentioned in section 2.7.2, the cost comparison between the rail and road is noted in below. According to this, the rail freight cost is more than the road freight by the cost of transportation from the factories in Phnom Penh to Samrong ICD (Inland Container Depot). In actual fact, the cost of railway transportation is depended on the volume and characteristic of the freight goods.

Table 4.1-13 Comparison of Freight Cost between Railway and Trailer

【Truck/Trailer Transportation: Export】

Cost Item	Cost (USD)	
	20 ton	40 ton
Lift on empty container and carry to factory	15 – 20	15 – 20
Trucking fee (factory-Sihanoukville Port)	170 – 220	190 – 300
Toll	14.42	18.82
Export custom clearance	190 – 250	220 – 280
Camcontrol (0.1% of value), minimum USD 10	10 – 40	10 – 40
Terminal handling charge (Sihanoukville Port)	90	120
Lift on/off charge (Sihanoukville Port)	24	19
【Total】	513.42 – 658.42	592.82 – 797.82

【Railway Transportation: Export】

Cost Item	Cost (USD)	
	20 ton	40 ton
Lift on empty container and carry to factory	15 – 20	15 – 20
Trucking fee (factory-Samrong Station)	80 – 110	100 – 120
Lift on/off charge (Samrong Station)	24	19
Railway Fee	107	205
Export custom clearance	190 – 250	220 – 280
Camcontrol (0.1% of value), minimum USD 10	10 – 40	10 – 40
Terminal handling charge (Sihanoukville Port)	90	120
Lift on/off charge (Sihanoukville Port)	24	19
【Total】	540.00 – 665.00	708.00 – 858.00

【Truck/Trailer Transportation: Import】

Cost Item	Cost (USD)	
	20 ton	40 ton
Terminal handling charge (Sihanoukville Port)	90	120
Lift on/off charge (Sihanoukville Port)	70	107
Scan fee	25	40
Import custom clearance	150 – 200	180 – 250
Camcontrol (0.1% of value), minimum USD 10	10 – 40	10 – 40
Trucking fee (Sihanoukville Port-factory)	230 – 280	270 – 300
Toll	14.42	18.82
【Totall】	589.42 – 719.42	745.82 – 875.82

【Railway Transportation: Import】

Cost Item	Cost (USD)	
	20 ton	40 ton
Terminal handling charge (Sihanoukville Port)	90	120
Lift on/off charge (Sihanoukville Port)	70	107
Scan fee	25	40
Import custom clearance	150 – 200	180 – 250
Camcontrol (0.1% of value), minimum USD 10	10 – 40	10 – 40
Railway Fee	107	205
Lift on/off charge (Samrong Station)	24	19
Trucking fee (factory-Samrong Station)	80 – 110	100 – 120
【Totall】	556.00 – 666.00	781.00 – 901.00

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The Yusen Logistics and Easter Worldwide Logistics freight forwarders were interviewed on the possibility of rail freight use between the Phnom Penh and the port of Sihanoukville. The Yusen Logistics responded the use of rail freight which had been negotiated with TRR in the earlier stage was postponed by reasoning the fact that the completion of South line rehabilitation was delayed to January 2013. The Eastern Worldwide Logistic responded by raising below 3 points before taking any further actions.

a) Railway freight operation

The procedures and method of scanning the containers, how are the containers handed over to consignee after arriving in PP, who prepares the truck to deliver containers to consignee, etc.

b) Operation cost

Whether on road freight transport is truly low cost or not?

c) Lead Time

On average how long does it take to use rail service once obtained the Customs clearance at the port?

It was found that, although there were some expressions of interest on the rail transport services,

the interviewed forwards had no detailed plans or postponed, because of the incomplete railway infrastructures and unclear of rail services. The rail freight transport will become as one of freight transportation mode, if the advantages of rail freight service are discussed properly, it is acknowledged what kinds of freight items are suitable for the service and forwarders'agreed services are provided.

In regards to the Soma Group who has plans construct the rice mill and associated warehouses within the port yard, is planning to facilitate the rice stockpile area along the rail lines and transport to the port. In this plan, the conversion from on road transport to railway is planned, once the rehabilitation on the south line is completed.

(2) Business model of the railway utilization

Based on the current road transport conditions, the user merits of rail transport service should be realized before utilizing the railway services. The change in mode of freight transportation from on road to rail is gaining momentums as the "modal shifts" in many countries including Japan. The modal shift (can be) is defined as changing mode of fright transportations from roads to railways and/or by sea, which are the means of mass freight transportation with reduced environmental burdens. Although these days, the modal shifts are intended as measures against the global warming, energy saving, traffic congestion relieves, and reduced road accidents, etc, but the modal shift cannot be easily recommended as a matter of fact because of the challenges in utilizing the rail service exist.

While the case of modal shifts may be different in Cambodia, there are common challenges in shifting the main freight transportation mode. The shift towards the rail transport services in Cambodia is investigated, based on the results of questionnaires on the modal shifts challenges conducted to 63 Japanese logistics firms in 2011. In below, the results of questionnaire are noted.

Table 4.1-14 Challenges using Railway Service for Freight Transportation

Challenges in utilizing the Rail Service	Consignees which ansered the questionnare	
	The number of	%
It is difficult to be suitable for transporting lot (5 ton or 10 ton).	17	27.0%
Quality Control for accidents, temperature control, and so on is low level.	6	9.5%
It takes a time to transport freights between terminals.	6	9.5%
Rail transport service is not on time.	8	12.7%
It is difficult to meet a increase and/or decrease of freight volume.	28	44.4%
Support service for accidents is not provided satisfactly.	12	19.0%
It is difficult to receive accurate location information of freights transported by railway.	6	9.5%
It is difficult to secure transportation capacity in accordance with transportation schedule.	12	19.0%
The transportation costs are more expensive than the road transport service's.	25	39.7%
Railway operator does not provide customers with sales activities frequently.	4	6.3%
Customer service is not provided satisfactly.	1	1.6%
One-way transportation is issued frequently.	5	7.9%
Information of railway transport service is not provided sufficiently.	2	3.2%
It is not able to transport large-size container.	6	9.5%
Others	9	14.3%

Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan

From the above results, the problems in the framework of the rail freight transport such as lead time, cost, schedule, securing the alternatives, and services were pointed out. The following attentions are required in the case of Cambodia,

- Although the freight cost competiveness of the railway over road is, in general, when less

than 500km, the distance between PP and SHV is 230km.

- The planned number of train operation is one per day (from the TRR interview)

To promote the rail modal shift in Cambodia, below points are noted in consideration of the challenges in shifting the main freight transportation mode mentioned above.

- To operate uniform freight services among the rail operator and forwarders cooperatively,
- To operate on punctual schedules, and provid the customers with accurate location information of freight container transported by railway
- To operate free storage service of containers
- Provision of alternative transport modes in case of disruption (in cooperation with forwarders)
- To transport in accordance with the planned schedule, even though the only small amount of freight is required to be transported.
- To provide incentives for customers with regular freight volumes

The advantage of rail service is that it can provide large freight volume at once on time. However, when the small and frequent freight volumes are required to be transported, the road transportation is advantageous from the points of transport time and cost. Hence, tfreight characteristics such as cargo volume, size, and weight are needed to consider promoting a utilization of railway transportation.

(1) Container Operation at PAS Railway Terminal

A railway terminal (RT) for handling seaborne containers at Sihanoukville Port will be constructed on PAS' property as an On-Dock RT. The terminal will be operated by TOLL, a railway company in Australia, in a concession agreement with Cambodian National Railway.

It is unknown how TOLL operates the RT at present. However, as shown in the Figure, TOLL (and PAS) reserves certain space there for stacking containers at both sides of two (2) 500 meters long rail-trucks. Therefore, TOLL and PAS should store rail switching containers, inbound (import) and outbound (export), there before moving them to PAS CY or loading onto rail-cars.

Most of the leading ports in the world encourage CT operators at their ports to build on-dock RTs on their premises to make their ports and CTs more competitive whenever the situations allow. Some of these ports used to build off-dock RTs at inland locations separate from the ports as common-use RTs. However, it is now commonly recognized that on-dock RTs are more cost competiveness and involve less switching-time. CT operators with on-dock RTs can move export containers immediately once the trains arrive from the rail-cars to the marshaling yards in their CY; then, import ones from their stacking yards in the CY to the rail-cars in the RTs promptly and directly.

However, in the case of PAS RT, TOLL and PAS should store export containers carried by rail-cars in the rail stacking yards at once, and move them to marshaling yards in PAS CY later. Then, import ones discharged from ships should be stored in the rail yards once before mounting them onto the rail-cars as shown in Figure 4.1-49.

- There are various demerits for PAS when TOLL (and PAS) operates the RT by **"Off-Dock" operating system**, storing train-switching containers in the RT once before moving them to PAS CY or apron for loading onto ships or onto rail cars.
- First, it takes longer hours for marshaling export containers from railing than trucking, because they are once stored in the stacking yards in the RT before shifting to the PAS CY. This means once a train is delayed beyond than CY cut-off time for a ship, not only the ships loading planning works, but also the loading operation itself will be delayed which affects the sailing schedule.
- For avoiding such risks, if TOLL agrees with PAS to use the rail yards as a part of (export

containers') marshaling yards of PAS, PAS has to divide the yards in many lots for storing the containers by vessels, destinations, sizes, heights, weights and so on. However, the volume by lots would be small since the trains are small, wasting a significant amount of space.

- Moreover, reach stackers should be the main CHE at the RT. Accordingly, these reach stackers, moving containers (export) from rail-cars to the marshaling yards in the RT, have to move back and forth and round each time with certain distance when stacking the containers; and this would adversely affect both operational efficiency and safety.
- If PAS relaxes a standard of the marshaling yards in the RT, for minimizing the wasting of the space and frequent movements of the reach stackers in the yard; PAS has to store containers together with different characters at many yard-bays in the RT. That surely kills PAS' ships stevedoring efficiencies by shifting such containers from one bay to another.
- Furthermore, TOLL and PAS have to separate the rail yards in several blocks for operating rail cars and ships at the same time safely. Reach stackers alone can work at the area in between rail-trucks and the stacking yards for moving containers to from rail cars from to marshaling yards or stacking yards in the RT. Other reach stackers and trucks working in between ships (and or CY) work at other areas behind the stacking yards as shown in the figure.
- PAS will be wasting some 4.8 hectares (88m x 550m) of valuable property in the Port for such inadequate operations when adopting/allowing such "Off-Dock" operating system.
- Accordingly, required reach stackers to operate the RT should be 4 units as minimum once rail-cars and ships operations are conducted together.
- Moreover, PAS and shipping lines have to live with inefficient ship operations due to the additional moves of CHE and trucks in between marshaling yards in both terminals (CT and RT) even if ship planners prepare adequate ships working plans.
- There is no significant problem for PAS when handling import containers at the RT, just hauling the containers into the RT. However, TOLL should have the same kind of problems as PAS when handling the export ones at PAS CT when mounting them onto the rail cars.

On the other hand, at **most On-Dock RT**s, CT operators manage and operate the RTs as a part of their CTs, moving train-related containers in between the terminals without storing them in the RTs at all. Accordingly, export containers carried by rail cars are mounted onto trucks belonging to the operators for moving them to marshaling yards in the CY directly. Thus, the space of such RTs is limited as shown in Figure 4.1-50.

- Marshaling yards for export containers are constrained by vessel, destination, size (20', 40' and 45'), height (8'-6" and 9-6") and weight (light, medium and heavy) in basic for ensuring ships safety (keeping enough GM and so on) and economy (utilizing the ships space maximum).
- The biggest benefit of On-Dock rail terminals for CT operators is to move rail containers directly from rail cars in the RT to marshaling yards in their CY for stacking them orderly.
- This is the way to save money and time in handling rail-related containers for the operators, just the same as stacking export containers in marshaling yards in their CY hauled by external truckers through their CY-gates.
- At a normal on-dock RT, railed-containers are dismounted from rail cars in one-end to another by rail-tracks speedily, mounting them onto internal-trucks by reach stackers in the discharging operation in general. These railed-containers are usually stowed on the cars without any orders; thus, internal-trucks with the containers toward to the CY randomly following to marshaling orders by a shotgun method.
- Accordingly, such CT operators do not need to prepare many reach stackers in their RT. In the case of PAS RT, 2 units are enough, because its discharging operation (lift-off from rail cars or trucks) is equal to loading operation (lift-on to trucks or rail cars).
- Moreover, such CT operators can expect 20 lifts/hour/unit or more of train productivity when they order enough trucks (3-4 units per reach stacker, in the case of PAS, due to longer distance in between the terminals), due to the limited moves, just back and forth, of

reach stackers in the operations.

- On the other hand, such CT operators have to prepare multiple RTGs in their CY for stacking such railed export containers, mounted on train disorderly, orderly following to the marshaling yard by vessels, just the same as containers carried by external truckers.
- However, such CT operators can prepare one (1) marshaling yard only by vessel-voyage in their CY; which surely helps them to achieve higher productivities on ships operations.
- Furthermore, such CT operators can calculate traveling time of the railed containers in between the terminals easily for planning efficient operation at low cost.
- Required space for an ideal On-Dock RT for PAS in the Port is some 1.6 hectors (52 m x 300 m) as shown in Figure 4.1-50 because there is no container stacking area.

Switching Method of Import Containers from CT to RT:

In most cases, rail switching import containers are stored in CY once, after being discharged from various ships by trains when the operator has on-dock RT within their premises. Such operators prepare "train marshaling yards" in their CY near the RT by trains (by date, numbers planned to operate) for conducting train-loading operation sufficient and smooth.

- Train loading (import containers) operation is also worked out orderly based on marshaling yard system just the same as the ships' at on-dock RT in the world.
- However, train marshaling yards are not necessary to be as strict as those for ships in general, especially in the case of PAS RT because there is no need to stow laden containers in double-deck on the rail cars.
- Thus, it is enough to segregate the containers by train-numbers (or dates to operate), destination (may be Phnom Penh only), status (laden or empty) and size (20', 40' and 45').
- It may not be necessary to segregate them by height or weight because there are no tunnels in between Sihanoukville and Phnom Penh.
- Loading operation of trains is just to stack containers on rail-cars one by one from end-cars to another, stowing laden containers in bottom; then, empty ones on top in case required.
- Accordingly, the operation is very simple and productivity will become 20 lifts/hour per reach stacker once CT operator sets the marshaling yards properly in their CY near the RT, and order enough trucks. (2-3 units of trucks per reach stacker should be enough at PAS RT.)

In the case of PAS RT, under TOLL (and PAS) system, the operations are complex and as result productivity will be very low. Accordingly, PAS should realize the various demerits of such operations and operate the RT as an On-dock RT based on the standards described above.

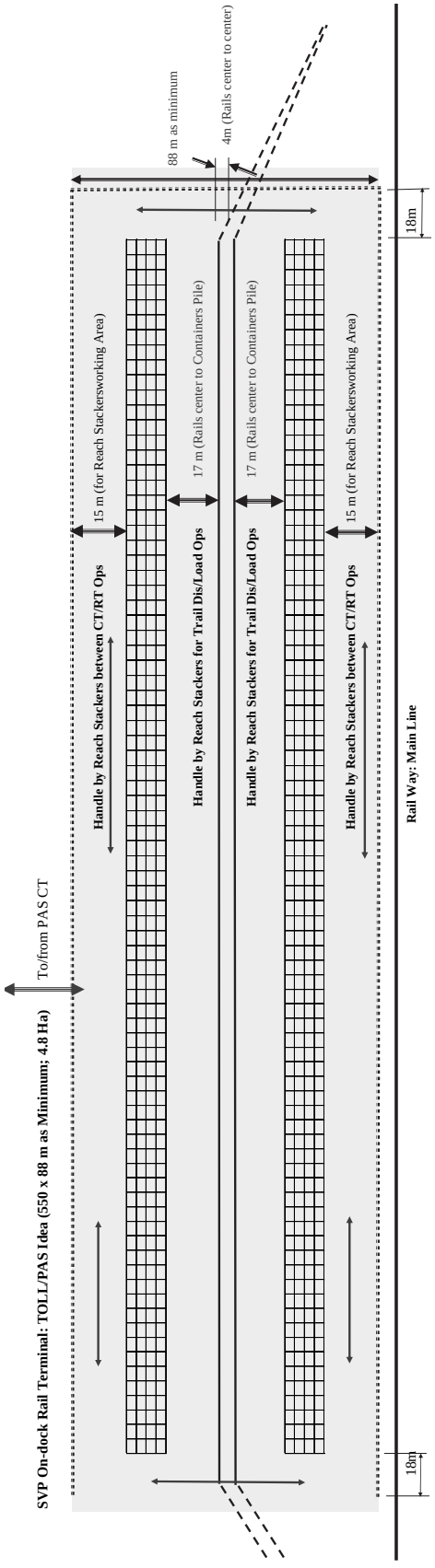
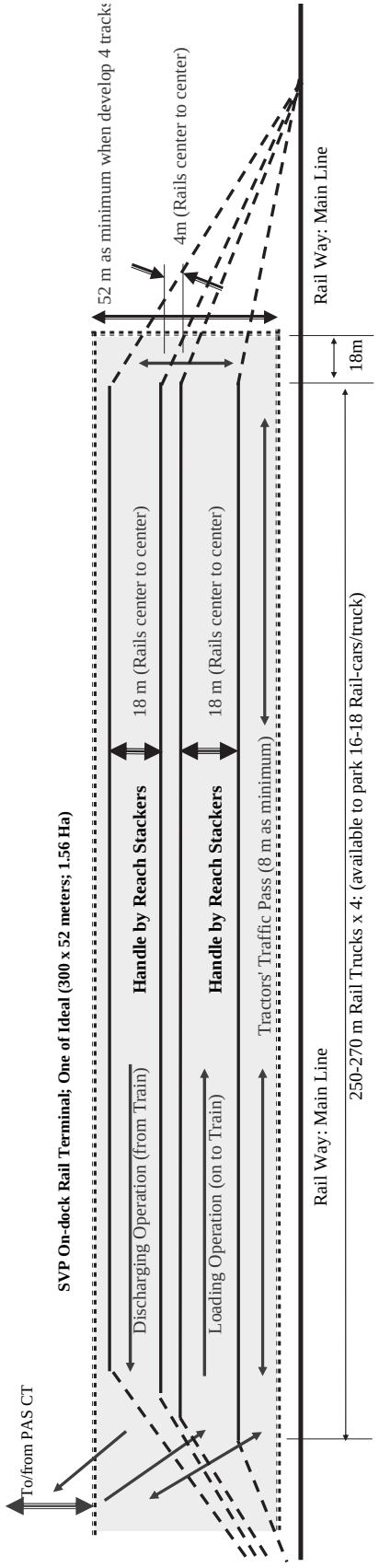


Figure 4.1-49 PAS Rail Yard by TOLL/PAS Idea- Final Idea



PAS Rail Yard; If developed by a Normal Sense

4.1.5 Collaboration between the port and SEZs

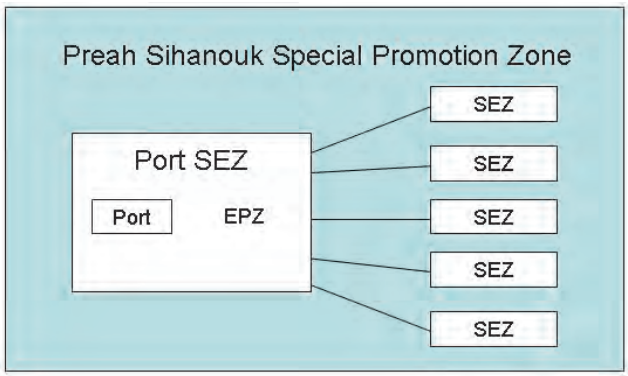
As discussed in the previous section, industrial development in littoral provinces is one of the most important roles of PAS. For this reason, collaboration between the port and SEZs which leads to industrial development is crucial.

As discussed in Chapter 2, it is necessary to materialize the concept of SPZ which was proposed in "The Study on Regional Development for the Phnom Penh - Sihanoukville Growth Corridor" conducted by JICA in order to accelerate industrial development in Preah Sihanouk and to make it lead the country's economic development as "the head of dragon". The area of the Sihanoukville SPZ shall be basically the entire administrative area of Preah Sihanouk Province, excluding the area of two national parks and the designated forest management and water conservation area as proposed by the said study.

The configuration of Preah Sihanouk SPZ shall be as described below:

- In the territory of SPZ, even in the place outside SEZs, all incentives for SEZ investors except those concerning customs procedures shall be furnished to the investors who do business equivalent to those of eligible investors in SEZ.
- SEZs shall be strategically located in Preah Sihanouk SPZ so as to be able to benefit from their synergy effect. Considering geographical characteristics of Preah Sihanouk SPZ where Sihanoukville Port exists and access control to outer region is easy because there are limited number of access roads connecting outer region, incentives on custom procedures shall be furnished to investors in all SEZs within SPZ, even though a SEZ is located 20 km or more away from an official border, in addition to the general incentives for SEZ investors. These measures will ensure that SEZ developers won't plan non-viable ports in their perimeters, and contribute to the harmonized growth of Cambodian port sector.
- Sihanoukville Port shall be an important component of Sihanoukville Port SEZ. The area of the existing Port SEZ shall be expanded to include all areas of the port. The barrier between the port and other part of Port SEZ shall be as low as possible. The only required barrier would be one to secure access control to an international port as prescribed by the ISPS code. The expanded Port SEZ including port shall be a single bonded area. All customs barriers shall be removed basically between the port and other areas in Port SEZ. The cargo movement between the two areas shall be regarded as movement inside a bonded area. X-ray inspection of containers to/from the Port SEZ shall be exempted for the same reason.
- All areas of Port SEZ shall be an EPZ basically. For investors of EPZ in Port SEZ, if their business is regarded as an important industry from the national point of view, such as non-traditional industry which has never located in the country, incentives concerning port service such as free transportation between the port and the factory and priority handling of containers shall be furnished.

Figure 4.1-50 and Table 4.1-15 illustrate the scheme for SPZ described above.



Prepared by Project Team

Figure 4.1-50 Configuration of Preah Sihanouk SPZ

Table 4.1-15 Proposed incentives for investors in SPZ

	Preah Sihanouk SPZ			Outside SPZ	
	Port SEZ	Other SEZs including those located further than 20 km from official border	Outside SEZ	SEZs located within 20 km from official border	Other SEZs
General incentives for SEZs	✦	✦	✦	✦	✦
Incentives on customs procedures	✦	✦		✦	
Incentives on port service	✦				

Prepared by Project Team

4.1.6 Port promotion

In this sub section, the Project Team makes a suggestion on the practical measures to improve the promotional activities of Sihanoukville Port.

(1) Basic framework for the marketing strategy

1) 4Ps for marketing

In the contemporary theories of marketing, "promotion" is given status as a part of total marketing strategy. From this viewpoint, the Project Team hereby recognizes "promotion" as a process to be included in the total marketing strategy.

According to the definition approved by The American Marketing Association in 2007, "marketing" is "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large". As per this definition, it can be said that "marketing" needs to be sought by any public institutes like PAS, as well as private firms to optimize the value for the public and various stake holders.

To ensure that the considerations and arguments hereinafter on the marketing cover every aspect and avoid any overlaps, the Project Team applies a definitive framework broadly used by the marketing consultants in the world. "The 4Ps of marketing" is a well-known framework from service provider's viewpoint. 4Cs model would be another common framework to give customer's perspective. Each element of 4Ps and 4Cs correspond each other as indicated below.

Supplier's viewpoint		Customer's viewpoint
Product	⇔	Customer value
Price	⇔	Customer cost
Place	⇔	Convenience
Promotion	⇔	Communication

In this subsection, consideration is made along with 4Ps model to avoid complication, while it might be important to retain customer's viewpoint also, to make fair decisions.

2) Product

Among 4Ps, product is probably the most crucial as it is epitome of any marketing decisions. Unlike manufactures or retailers, the primal product provided by PAS is, an intangible service of port operations.

Though the service of PAS is physically provided just at Sihanoukville Port, and fortunately, PAS has a core competence on its position within the nation; the sole international deep sea port in Cambodia. However, it would be important for PAS to have a perspective that the market to provide its service is virtually the global market. Even such privileged position of PAS could be threatened by the global trend, unless PAS continuously tries to make its service meet the global market's needs .

a) Quality of services

The services to be provided by PAS should primarily meet the port users' needs through maintaining the quality of services at satisfactory level. It is noteworthy that most of the users of PAS, such as shipping lines, exporters/importers, freight forwarders are engaged in the global-scale business and have a broad outlook to compare the service quality of PAS with other ports' in the world. Therefore it is essential for PAS to be conscious of whether its service is globally standardized.

① Operational efficiency

The primal criterion for evaluating the quality of intangible service is efficiency; i.e. operational efficiency in case of PAS. As stated in the previous section of 4.1, operational efficiency of a port is clearly measurable and objectively comparable to other ports', which sometimes allow port users the option to go for other more efficient ports.

Built in the global supply chain system, most of the users of PAS are always required by the system integrator to perform their role in the limited time frame. Failure in which will cause a loss to the entire system, and soon such user may be penalized by the market, being diminished their competitiveness in the market. If the users should recognize PAS as a bottleneck in their performing areas, they will avoid using PAS and look for other better choices.

What PAS is required to do is to have a market-oriented viewpoint and support the users to keep competitive position in the global market (namely, "customer value" in 4Cs), which will in return enhance PAS's competitiveness, too.

② Customers' satisfaction

Apart from the operational efficiency, there are a lot of areas in the service quality that cannot be clearly measured but surely evaluated by the users. As the port operation is not only composed of cargo handlings but also including various transactions which are done directly with the users, such as gate works, documentation, billing, claim handling, responding to inquiries, meeting with users etc. As the aggregate of those day-to-day transactions have an influence on the users' impression on PAS in the long term, PAS needs to maintain the quality of those works at a satisfactory level from users' viewpoint.

Practically, customers' satisfaction in those transactions, when evaluated as much numerically as possible, could be inversely proportional to the waiting time of users from the inquiry to the receipt of result. As a matter of course, quality of the result will also be crucial. To maintain the level of users' satisfaction, PAS will be required to establish a refined delegation of authority so that a clerical staff can confidently give a quality solution to the user in a short time. The management themselves will be required to have a sense of time which needs to reach down to the clerical level. Every management and staff should have a sense of ownership, ethics, self-accountability and professionalism that is acceptable to global users from trans-cultural viewpoint. Unnecessary transactions or procedures involving the users need to be eliminated in light of the globally prevailing standard. As a public service provider, any discriminatory treatment among users must be eliminated.

b) Warranty

In general, warranty is a system where a provider bears an obligation to the customer for the quality of products. The merit of warranty is that the provider's brand value and credibility in the market is enhanced by fulfilling it. In view of current business trend at major ports in the world, following issues would be worth considering as a possible service lineup of PAS in future, while those require a high level challenges in operational efficiency.

① Berthing windows

A berthing window is fixed at the time of inducement of a shipping line. Once it is "committed" to the shipping line, the terminal needs to bear responsibility to finish the loading/discharging works within that period of time. Nowadays major container carriers require strict management of berth windows to be done by the terminal operators. In case of some cruise ship operators, they require the commitments on berthing windows 1 or 2 year in advance of the callings.

② Stevedoring performance

A terminal operator makes commitment on the certain level of productivity with penalty scheme to be paid by the operator in case of failure. Nowadays such style of contract is becoming common in Asia between mega container carriers and major terminal operators. This issue is closely related to the berthing windows.

3) Price

The price is very important as it is a determinant of the service provider's turnover and profit. In addition, pricing is quite sensitive and difficult because it must reflect the correlation of supply and demand. The customers, since the price is the cost for them, would carefully refer to the prices of other competitors. Therefore the service provider needs to gain a full picture of those circumstances, namely, market trend, competitors' behaviors as well as the financial situation of its own, prior to the pricing.

a) Revenue Management

The definitive theory of pricing, named "revenue management" or "yield management", was firstly invented by the airline industry in US in late 1970's to 1980's when the industry was in a struggle to survive after the enactment of deregulation act. Following the airlines' success, this methodology has been implemented and refined among other industries such as hotel, electric power, telecommunications, railway, bus, cruise lines, television network, restaurant, theater, super market, video rental etc. Nowadays revenue management has become a mainstream business theory and practice in the world.

Revenue management is effective for the industries which have a characteristic profit structure as follows:

- There is a fixed (limited) amount of products available for sale.
- The products sold are perishable (there is a time limit to selling the resources, after which their value becomes NIL).
- High portion of fixed costs
- Low portion of variable costs
- Demand is fluctuated in a day, week or year
- Different customers are willing to pay a different price for using the same products.

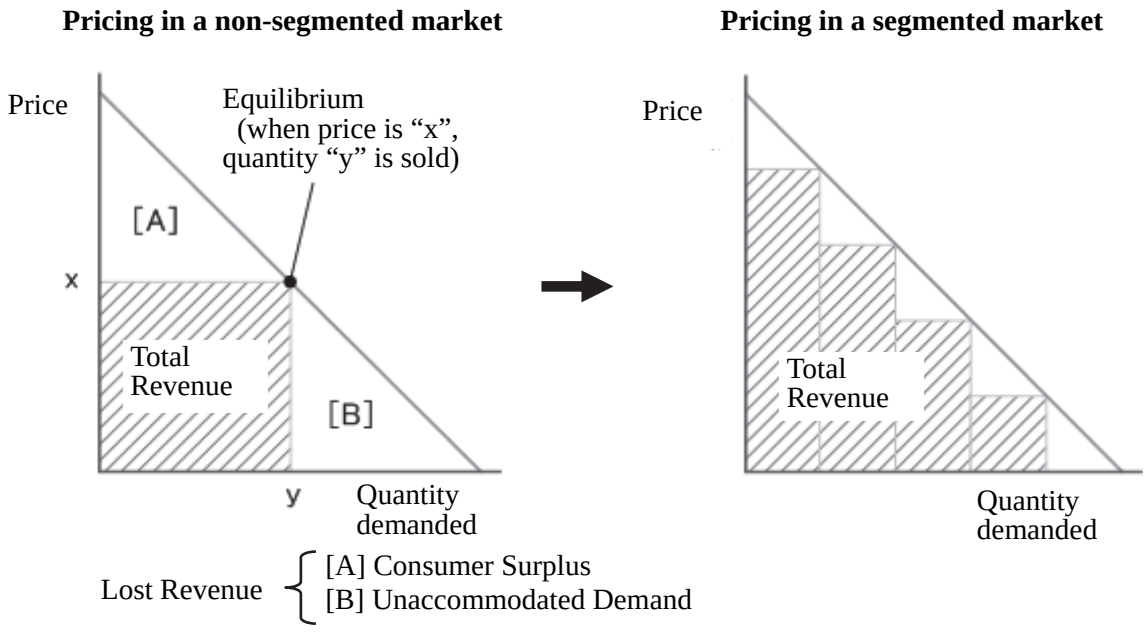
The core concept of this theory is selling the right product to the right customer at the right time for the right price. Pricing strategy is anticipating the value for customers of particular segment and then setting a specific price to capture that value. The price can vary by the customer's willingness of payment. This is not to be confused with price discrimination, as a higher price is put in place not forcefully but because there is a market ready to pay such prices.

Figure 4.1-51 illustrates how revenue management works. The downward-sloping chart is known as "demand curve" in microeconomics, showing the number of units of a certain product which are sold at a certain price.

The left chart shows the revenue generated if a provider were to charge a single price to every customer with non-segmented marketing. The shaded quadrilateral area under the demand curve shows the total revenue of the provider. Area [A] above the shaded quadrilateral named as "consumer surplus" is the revenue that is considered to be "lost" due to customers getting a "good deal." They would have paid more, but are happy that they were able to pay less. Concurrently, the area [B] to the right of the shaded quadrilateral is also revenue lost because customers didn't actually buy the products as the price was higher than a point where they could make a purchase. Consequently, it would be optimal for the provider to charge every customer the price he is actually willing to pay.

The right chart shows what would happen to revenue if a provider were able to segment the market, and provide 4 different price-points. If that attempt is successful, the revenue of the provider could be the shaded stair-like area under the curve, which is significantly greater than that with a single price.

The segmentation could be done by time of use. One of significant effects that revenue management can bring to the provider is to shift demand from the peak to the off-peak period, and also generate higher overall profit. The effective tactic is to charge higher price during peak period and a lower price during off-peak periods, this tactic result in shifting demand from peak to off-peak period.



Prepared by Project Team

Figure 4.1-51 Conceptual illustration of Revenue Management

b) Revenue management applicable to PAS

It is observed that the container terminal business of PAS shares the same characteristic features as those of airlines, hotels etc. on the ground as follows:

- The berthing windows which can accommodate the vessels are limited in a week.
- The berthing windows which were not used cannot be sold in a later time.
- High portion of fixed costs such as capital cost for the facilities, salary for permanent employees.
- Vessel callings are concentrated in the weekends, while very little on week days.
- Shipping lines are accustomed to the discriminating port charge, as it is common at other ports in the world.

The observation above implies that the theory of revenue management could be effective to PAS. It would be the key issues for PAS from the revenue management perspective to segment the users first, and then apply different tariff rates to the users of different segments. The suggestions in general would be as follows:

i) To differentiate the tariff rate for off-peak berth windows from that for weekend berth windows.
ii) To differentiate the tariff rate for the containers coming in the off-peak time from that for peak time.
iii) To differentiate the tariff rate for the volume exceeding certain level from that for less volume (i.e. volume incentives)

Measures stated in i) and ii) would be useful to alleviate the congestion both of berthing windows and yard operations at the peak period. Volume incentives stated in iii) above should be implemented carefully so as to secure existing revenue and then encourage the users to bring additional volume.

It would be important for PAS to obtain a mandate from MEF so that it can set the tariff rates freely within certain price range. The tariff rates introduced as above need to be reviewed regularly to reflect the latest market trend.

4) Place

Place is where the product is provided. It should be convenient for the users to access. In case of retailing industry, it means physical distribution or sales channel. In case of PAS, its service is intangible and cannot be packaged nor physically sent to any different places.

However, it would be important for PAS to have an extended arm to capture any potential users. The extension in this meaning could be as follows:

i) Dry ports in Phnom Penh
ii) Warehouse in its SEZ or other private warehouses
iii) SEZs of its own or others around Sihanoukville

i) and ii) shall function as an off-dock facility for FCL and LCL respectively. If an information link is established with those facilities, PAS will be able to provide a seamless service from the proximity of cargo sources down to Sihanoukville Port, without forcing the users to submit duplicate cargo information at the off and on docks.

SEZs can also be an extension of PAS, if any special preference is arranged with them on institutional base. Facilitation of the port entry procedures might be the key issue. Customs office should be involved in this case.

Place for PAS, in a broad sense, is not only the matter of geographical location, but also the matter of time. Opening hours of the gate and yard operations should be considered as an opportunity or a tool to capture the potential users. Therefore opening hours needs to be determined primarily from the viewpoint of customers' convenience.

5) Promotion

Products or services will not sell unless people are told about them. Promotion represents various methods of communication that a provider may use to give information to different parties about the product. Promotion comprises elements such as: advertising, public relations, personal selling and sales promotion.

a) Promotional strategy

Strategy of promotion can be classified broadly into 2 categories; "push" strategy and "pull" strategy.

"Push" strategy makes use of a provider's sales force directly to capture the customers' demand for a product. It includes trade show promotions to encourage retailer demand, or direct selling to customers in showrooms or face to face. Sales activity is exercised just at the point of purchase. Wholesalers are sometimes utilized as a leverage by giving an incentive to them.

"Pull" strategy is one that requires high spending on advertising, mass media promotion, or word-of-mouth referrals through internet to build up consumer demand for a product. It is used in demand-driven market. If the strategy is successful, consumers will ask their retailers for the product, the retailers will ask the wholesalers, and the wholesalers will ask the providers.

Many providers use a combination of both push and pull strategies. Portion of each type of strategy will depend on factors such as type of product, target customer, competition and. budget of the provider.

b) Target market of PAS

Target market is a group of customers that the provider decides to aim its marketing efforts and resources. Target market needs to be determined first to concentrate the provider's resources and bring maximum output with minimum amount of resources.

Target market of PAS is distinguished between two main categories; shipping lines and cargoes. Shipping lines could be divided into main lines and feeders, and cargoes could be rephrased as exporters and importers.

c) Promotional strategy applicable to PAS

The combination of both push and pull strategies is considered to be suitable to PAS. For shipping lines, limited in number of customers, face to face sales would bring maximum effect. In this sense, push strategy seems more workable for shipping lines. However, to deal with the shipping lines' global mobility, pull strategy through internet would also take effect. For cargoes, having large number of customers in Cambodia, pull strategy through mass media and internet would be essential, while direct sales promotion to the industrial associations would also be important. The details of the strategy will be stated in the next sub sections.

(2) Basic policy for attracting shipping lines

In this sub section, the Project Team makes a suggestion on the promotional strategy for shipping lines toward the year of 2020.

1) Target market

As stated in 2.6.1-(6), there is a possibility in future that more intra-Asia and feeder vessels with a larger size will call at Sihanoukville Port combined with Laem Chabang Port on the route, while there will be little chance that the large trunk line vessels will call at Sinhanoukville Port and it will become a transshipment hub in place of Cai Mep Port. Based on this projection, the Project Team suggests PAS to aim target market as below:

a) Main lines:

Intra-Asia trade lanes shall be the primal target market. If there is a service with the wayports in the range of Bangkok/Laem Chabang-Cai Mep-China/Taiwan/Korea/Japan, Sihanoukville will have a chance to be added to the ports of call.

It is recommended for PAS marketing staffs to make a data base of potential shipping lines and update it regularly. The shipping lines currently calling at Bangkok, Laem Chabang, Cai Mep and Ho Chi Minh on the intra-Asia services must have a potential. Table 2.6-5 to 2.6-17 in Chapter 2 indicate those potential shipping lines and the services thereof. Following is an extract on the name of lines.

(Global lines)
- The New World Alliance members : MOL, Hyundai, APL
- Grand Alliance members : NYK, OOCL, Hapag Lloyd, MISC
- CKYH Green Alliance members : COSCO, K Line, Yang Ming, Hanjin
- Global line's affiliated : MCC Transport for Maersk Line, CNC Line for CMA CGM etc.
- Independent : Evergreen Line, Wan Hai, China Shipping, Emirates Shipping Line etc.

(Intra-Asia specialized)
- Korea based : Korea Marine Transport, Heung-A Shipping, STX Pan Ocean, Sinokor Merchant Marine, Namsung Shipping, Yanghai Shipping
- Taiwan based : TS Line
- Hong Kong based : Gold Star Line
- Thai based : Regional Container Line, Siam Paetra
- China based : SITC Shipping, Grand China Shipping

b) Feeder lines:

The target market of feeders shall be the lines connecting with transship hubs such as Singapore for westbound, and Cai Mep, Chinese major ports, Hong Kong, Kaohsiung, Busan for eastbound. Feeder lines are composed of common feeder lines and main lines' own companies. It is noteworthy that main lines must be the virtual players behind any common feeder lines, as they are the users of common feeder lines, exercising an influence on the feeder lines' vessel deployment plans.

Some of the intra-Asia main lines listed in a) have feeder services also. Some global lines deploy their own fleets into their dedicated feeder services. Intra-Asia specialists have short-distance

feeder services, too. Following is the name of common feeder lines which are specialized in feeder service only.

- Singapore based : Advance Container Lines, Pendulum Express Lines
- Indonesia based : Samudera Shipping
- Malaysia based : Hub Shipping
- Vietnam based : Vinalines, Bien Dong Shipping, Gematrans
- China based : Hainan P O Shipping

2) Push strategy

Push strategy of PAS represents direct approach (may be rephrased as "canvassing") toward the shipping lines. It includes sales visits or communications with the lines' offices at different hierarchy level. In case of global lines, hierarchy would be as below. (This is to indicate a general view. Organization and delegation of authority may differ by line)

i) Country manager (Phnom Penh) :
This duty position may have a responsibility for day-to-day sales and cost control within Cambodia. In case of major shipping lines, he may be a managing director of a locally incorporated company.

ii) Indochina regional GM (Bangkok, etc.)
He may be responsible for marketing strategy and cost control in the broader area of Indochina. He may also claim iii) for an additional vessel calling at Indochinese ports to accommodate the cargoes obtained under his command.

iii) Asia regional director (Hong Kong, Singapore, etc.)
He may be responsible for overall vessel deployment in Asia region, exercising decisive power to place an intra-Asia vessel to Sihanoukville Port.

iv) Director of liner division (head quarter in various countries)
He may be responsible for the global vessel deployment.

When PAS makes any proposal to a shipping line, it is important to choose appropriate level of counterpart who is authorized to make a final decision on the issue as indicated above. Day-to-day operational issues could be negotiated with i). If a local consensus needs to be built on the additional vessel callings, i) and ii) could be the counterparts. However, decisive negotiation of which should be done with the level of iii) and above only, as the vessel deployment requires substantial management resources of the shipping line. In this sense, top sales by PAS management toward this level may bring the good result in most cases.

As the first contact with the level iii) directors, it must be effective to attend a meeting of shipping lines' associations to make a presentation in the presence of multiple shipping lines' representatives. Hong Kong Liner Shipping Association, Hong Kong Shipowners Association and Singapore Shipping Association etc. are available for contact.

When contacting global lines, PAS is recommended to obtain information not only on intra-Asia trade but also the other trades such as North America and Europe, as the cargoes to/from those area are supposed to be carried primarily by feeder vessels. This could also be a part of canvassing activities for cargo inducement.

In case of common feeder lines, the country managers at Phnom Penh and the head quarters may be able to cover all issues.

3) Pull strategy

Pull strategy of PAS consists of the activities through various media, such as public relations, advertisement, publishing, web-based publishing etc.

a) Public relations

Public relations (PR) is mostly recommended among the activities of pull strategy, as it can be exercised with less amount of budget compared with advertising, and can build credibility of PAS assured by the mass media.

i) Press releasing

Press releasing is a positive action to distribute information to the mass media for the purpose of generating their interest and motivating them to write up articles in favor of PAS. Information for the press release could be any topics of public interest or news items on whatever recently happened to PAS, such as the start of early gate opening, tariff review, service improvement or even organization change. The media for press releases could be newspapers, TV channels, business magazines, industry journals The more frequent and broader distribution is made, the more interest from the press is generated. Every release should be made both in Khmer and English, so that it can attract the interest of overseas media.

ii) Inducement of media coverage

In addition to press releasing, it is recommended for PAS to make positive approach to the press to induce the media coverage. Sometimes press people could be invited to Sihanoukville to provide them information on the real scene including photos or video recordings. This attempt would be successful especially when PAS achieved any epoch-making events such as completion of a new facility, introduction of the single window system that may be universally appreciated by the public. To make this realized, it is essential for PAS marketing staffs to make daily effort to build good relationship with the press people.

iii) Announcements through web site

Whenever a press release is distributed by PAS, the announcement of the same content needs to be up-loaded on PAS web site both in Khmer and English without fail, as the press may try to gather side information related to the release through internet. Other contents on the web site need to be updated regularly for that purpose.

Another significant merit of press releasing is that PAS employees can internally share the positive impression on PAS among themselves, which will strengthen the unity of employees. In that sense, the announcements through the web site is recommended.

iv) Publishing

Publishing involves issuing of annual reports, brochures, directories, or handouts which PAS may distribute time to time. Some contents of those publications could be shared with the web site to save overall budget for public relations. Also latest topics would rather be shifted to the web site than inserted to the brochures, since such perishable contents are suited to the media that allows audience's quick access.

b) Advertising

Advertising may be effective in the sense that PAS could make an appeal to the public only on the features favorable to itself. Advertising can be done whenever PAS may desire. Since advertisement costs a lot, it needs to be placed to the right media at the right time. Advertising media suitable to PAS would be as follows.

- Shipping industry journals
- Business magazines
- Newspapers

Effectiveness of the advertisement shall be maximized when it is placed together with a special feature article written by the media themselves such as "rapid industrial development in Cambodian coastal area", "emerging Cambodian economy", "booming Greater Mekong Subregion" and so on, as those unique articles may be desired by those audiences who have a spirit of enterprise. It would be

important for PAS marketing staffs to build a good relationship with editors and ad sales section of those media on a daily basis in order not to miss the opportunities of special feature articles.

4) Shipping line's criteria to determine an extra calling

It is important for PAS to know what the shipping lines' logic is, when they study for an extra calling.

When a shipping line determines to deploy vessels at a port as an extra calling, they usually compare the costs and revenue relevant to the extra calling. If the revenue amount per call exceeds the costs amount per call, the shipping line will decide to place the vessel to that port. The cost to be considered will be "port charges" payable to the port of extra calling, and "deviation cost" for detouring a vessel away from the original navigation route and make her stay at the port. The revenue is actually the net profit to be gained from ocean freight for export/import cargoes which is expected to be captured additionally at the port of extra calling.

Assuming that an extra calling is envisaged at Sihanoukville Port, following simulation might be made by the shipping line:

a) Costs

Port charges

Average size of the vessels is assumed as follows, which is close to the average vessel size currently calling at Laem Chabang Port:

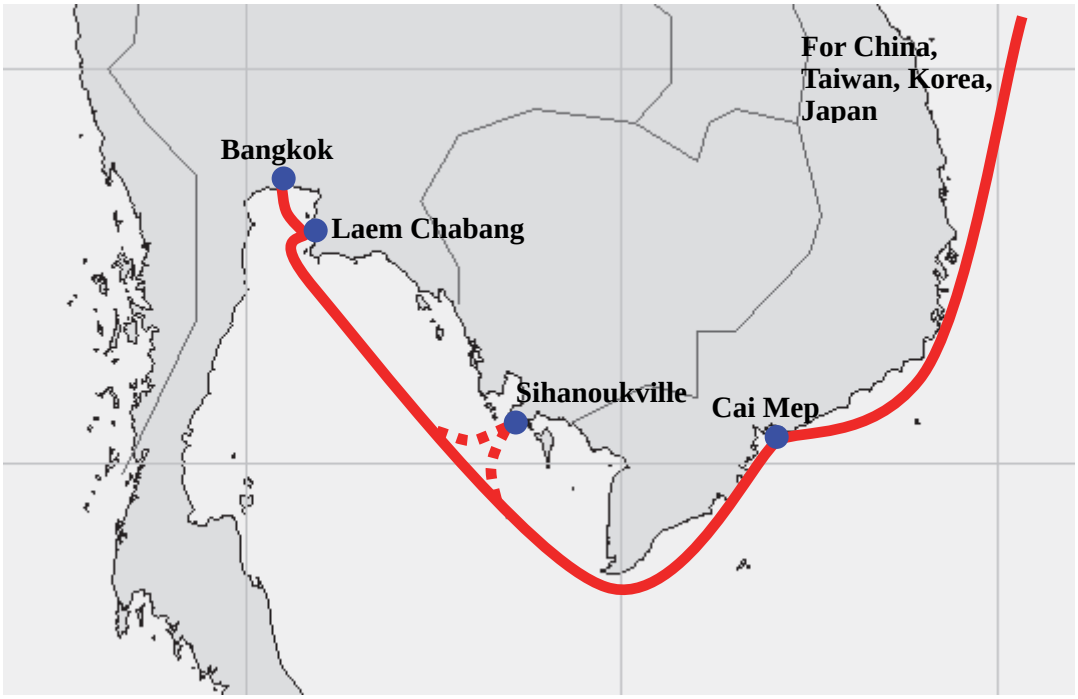
Capacity	: 2,468 TEUs
DWT	: 34,122
GT	: 25,300

When the existing port tariff is applied to the above, total amount of port charges per call at Sihanoukville Port is calculated as US$ 24,680 ---------- ①

	(USD)
Tonnage due	6,325
Berth due	5,819
Channel due	9,450
Pilotage	1,518
Towage	886
Mooring/unmooring	482
Port clearance in/out	200
Total	24,680

Deviation cost

Deviation cost may be varied subject to the intention of the shipping line by which trade lane to cover Sihanoukville Port. The most probable trade lane is considered as intra-Asia, connecting Laem Chabang-Cai Mep-China/Taiwan/Korea/Japan, adding an extra call between Laem Chabang and Cai Mep. Figure 4.1-52 maps the routing of possible extra calling.



Prepared by Project Team

Figure 4.1-52 Image of possible extra calling at Sihanoukville

The distances for navigation based on the great circle routing are as follows:

Laem Chabang → Cai Mep	575 nautical miles ----------	②
Laem Chabang → Sihanoukville	236	
Sihanoukville → Cai Mep	356	
Total	592 nautical miles ----------	③

Deviation is given as ③－② ＝ 19 nautical miles

When the vessel sails at the speed of 19 knots/hour, the steaming time required for deviation is given as:

19 nautical miles÷19knots/hr÷24hrs＝0.042 days

Time of vessel's stay on berth is assumed as 1.5 days.

Items and calculations of deviation costs are as below. Charterage for overall deviated days and diesel oil cost for power generation during stay days have a significant portion in the total costs.

Charterage: US$ 16,000/day×(0.042+1.5)days	＝ US$ 24,672	
Fuel oil: 97.6mt/day×0.042days×US$ 730/mt	＝ US$ 2,992	
Diesel oil: 12mt/day×1.5days×US$ 980/mt	＝ US$ 17,640	
Container capital cost per diem:		
US$2.0/TEU/day×2,468TEUs×(0.042+1.5)days	＝ US$ 7,611	
Total	＝ US$ 52,915----------	④

Total cost for the extra calling is given as:

①＋④＝ US$ 77,595---------- ⑤

b) Revenue

Ocean freight rate

Currently the prevailing base freight rates in intra-Asia trade are as follows:

(Exports)		
Shanghai	: US$ 400/TEU	Average freight rate: US$483
Tokyo	: US$ 550/TEU	
(Imports)		
Shanghai	: US$ 500/TEU	

To make the calculation simple, the "terminal handling charge" paid by the shipper/consignee in addition to the base freight is excluded from the calculation, since it is considered to offset the shipping line's stevedoring cost which is also excluded from the amount of costs above.

When net profit after administration cost is assumed as 40%, the net profit to be gained from the base freight is given as

US$483×40%＝US$ 193----------⑥

c) Marginal TEU required for an extra calling

Marginal cargo volume required to cover the additional costs is given in TEU by dividing the total amount of extra costs with the net profit per TEU.

⑤ / ⑥＝US$ 77,595÷US$ 193/TEU＝402 TEUs ---------- ⑦

Consequently, if 402 TEUs of additional cargoes can be secured in total of export and import, a shipping line may determine an extra call at Sihanoukville Port with a 2,500 TEU type vessel deployed on intra-Asia trade lane.

What is derived from this simulation is that the marginal TEU could be lowered if the amount of costs was reduced. Reduction of costs could be realized by a price cut of port charges, or shortening of the vessel's stay days. If the port charges was cut at 30% and the stay days was shortened from 1.5 days to 1.0 day, the marginal TEU could be lowered from 402 TEUs to 279 TEUs as calculated below:

Port Charges	US$ 17,276
Deviation costs	US$ 36,567
Total	US$ 53,843

Marginal TEU : US$ 53,843÷US$ 193/TEU＝279 TEUs

The result of calculation above implies that, as long as the cargo generation from the hinterland is not so sufficient, it would be a very effective measure for vessel inducement of PAS to make a compromise in reducing the tariff rates of port charges, otherwise to improve the stevedoring efficiency to shorten the vessel's stay.

(3) Basic policy for attracting cargoes

As stated in (2), inducement of vessels may be fruitless without generation of cargoes. In that sense, inducement of cargoes must be a primal activity for a port in order to build the prosperity of its own.

1) Target market

Target market of cargoes represents the industries that may generate export and import cargoes. Target market could be identified not only in domestic industries but also overseas industries. For export cargoes as an example, if overseas buyers have a strong power to choose the shipping route and the port of loading, as common in the garment exports under FOB term, those overseas buyers could be the target.

2) Push strategy

Push strategy for cargoes involves direct approach tward following institutes. It would be effective to attend the meeting of a chamber of commerce to make a presentation in the presence of multiple members..

a) Domestic industries

i) Cambodia Chamber of Commerce
ii) Industry-wise associations (such as Garment Manufacturers Association in Cambodia)
iii) Local chambers of commerce (Phnom Penh Chamber of Commerce, Kampong Speu Chamber of Commerce, Kandal Chamber of Commerce, Kampong Cham Chamber of Commerce, Battambang Chamber of Commerce etc.)
iv) Individual companies

b) Overseas industries

i) Overseas chambers of commerce (offices abroad)
ii) Overseas chambers of commerce (offices in Cambodia, such as Japanese Business Association of Cambodia, Cambodian American Chamber of Commerce, British Business Association, French-Cambodian Chamber of Commerce, Taiwan Commercial Association in Cambodia, The Korean Chamber of Commerce in Cambodia, Chinese Chamber of Commerce in Cambodia)
iii) Industry-wise associations abroad

3) Pull strategy

Portfolio of pull strategy could be same as those for shipping lines. Optimum mix of public relations and advertisement is recommended.

4.2. Managerial and Financial Strategy

4.2.1 Financial status of PAS

The balance sheet, statement of income and statement of cash flow have been prepared by PAS for several years. The format of the statements was revised in 2010. Therefore, items of the financial statements are different from ones before 2009, but the financial statements of 2009 were prepared in both new and old formats for comparison.

The summary of the balance sheet, statements of income and cash flow are summarized as shown in Tables 4.2-1, 4.2-2 and 4.2-3 respectively. The amount of fixed assets was USD 129 million at the end of 2010, in which the amount of land assets was a large portion; USD 81 million. The amount of current assets is USD 16.8 million, of which the pre-paid state dividend is USD 7 million. The total of assets of PAS amounted to USD 146 million at the end of December 2010.

The amount of capital reached USD 110 million due to investment in terminals and the purchase of equipment. Long-term liabilities are USD 28 million, of which long-term loan amounts to USD 25.8 million. However, the long-term loan only includes the loan coded CP-P3 (Yen loan entitled Urgent Rehabilitation), and does not include other loans which are booked in a separate account. The total amount of yen loan may amount to 8.8 billion yen (USD 115 million at an exchange rate of 77 yen/USD) at the end of 2010.

Revenues from port services were USD 26 million in 2010, a 17% increase from the previous year. Operating expenses were USD 14.8 million and other expenses were USD 6.7 million. The latter expenses are for administrative activities and construction materials. Total expenses were USD 21.5 million in 2010.

Income before interest and tax amounted to USD 5.2 million and net income after tax was USD 2.4 million in 2010. Revenues and expenditures from 2005 to 2009 are shown in Table 4.2-4, which was prepared in the old format of financial statements. Sales of PAS increased from 2005 to 2008, and experienced a decrease in 2009 due to the world economic recession. However, sales recovered in 2010 to the level of 2008. Net income after tax reached USD 2.56 million in 2007, but decreased to USD 1.54 million in 2008 and recovered to USD 2.39 million in 2010.

The statement of cash flow indicates that repayment of debts was USD 0.96 million in 2009 and cash at the end of 2009 was USD 5.5 million. Repayments of debts will increase considerably in the next several years and be a burden on PAS's financial management.

(1) Financial performance

Financial performance of an enterprise is often checked by ROA (Return on assets) and ROE (Return on equity). ROA is a ratio of the net profit and total assets of a commercial enterprise and indicates performance of the total assets. Total assets used for ROA are an average of the assets at the beginning and the end of a certain year. ROE is a ratio of net profit and the capital of a commercial enterprise. The capital used for ROE is also an average of the capital at the beginning and the end of a certain year.

ROA of PAS's business activities is estimated at 1.64% in 2010 and ROE is at 2.16%.

(Riel)

Year 2010	31 Dec. 2010	01 Jan. 2010
Total assets	596,618,247,069	598,364,898,075
Return on assets (ROA)	1.64%	-
Capital	451,943,610,641	452,048,601,881
Return on equity (ROE)	2.16%	-

Source: Calculation by Project Team based on PAS's financial report

An ordinary private commercial company usually expects 5%-10% of ROA as financial

performance of their business activities. Since PAS is a state owned company and has rather large assets, ROA is lower than the expected level of a commercial company.

(2) Comparison with PPAP's financial performance

Financial statements of PPAP are shown in Table 4.2-5 (Balance Sheet) and Table 4.2-6 (Statement of Income) as a comparison with PAS. Operating revenues in 2010 amount to USD 6.4 million, which was one forth of that of PAS. Net profit of PPAP was USD 1.2 million in 2010, which was a half of PAS's net profit.

Total assets of PPAP were USD 27 million at the end of 2010, which is 19% of the total assets of PAS. Consequently, performance of the assets was higher than that of PAS.

ROA of PPAP's business activities is estimated at 4.56% in 2010, which seems to be at an acceptable level of commercial enterprise.

(Riel)

Year 2010	31-Dec-10	31-Dec-09
Total Assets	110,686,553,620	105,829,957,951
Return on assets (ROA)	4.56%	-
Capital	105,594,961,859	103,730,072,490
Return on equity (ROE)	4.71%	-

Source: Calculation by Project Team based on PPAP's financial report

(3) Comparison with PAT (Thailand)'s financial performance

The Port Authority of Thailand (PAT) operates the ports of Bangkok, Laem Chabang and three other local policy ports. Major revenues are generated from stevedoring services at Bangkok Port and operational concession fees at Laem Chabang Port. Bangkok Port has an area of 376 ha, where ship handling and cargo handling services are provided by PAT. Laem Chabang Port has an area of more than 1,000 ha, where PAT provide ship handling services but cargo handling services are rendered by private operators. PAT's revenues at Laem Chabang Port are ship handling fees and concession fees collected from private terminal operators. Revenues and expenses at the other three local ports are considerably smaller in terms of the financial management of PAT.

The total number of staff members of PAT was 3,117 in the year 2011, in which the headquarters had a staff of 704, Bangkok port 2,224, Laem Chabang Port 178, and the three local ports had 11 staff members.

The balance sheet of PAT is summarized in Table 4.2-7 and the statement of income is shown in Table 4.2-8. Revenues of PAT in 2010 amounted to USD 338 million. PAT indicates that revenues from the Bangkok Port have the biggest portion followed by incomes from Laem Chabang Port, but this portion will change in the future.

Performance of PAT's business activities is very satisfactory as shown in ROA, i.e. 11.25% in a year from October 2009 through September 2010. However, fixed assets of PAT are calculated based on the book value of their land premises, which are assessed at 369 million baht as of 30 September, 2010, but may have a current value of 500-1000 times. Since Bangkok port has an area of 378 ha and Laem Chabang port has more than 1,000 ha, the current value of land assets may be 200- 400 billion Baht. If the land assets have a value of 200 billion Baht, ROA may be 1.3% instead of 11.25%.

(USD)

Fiscal Year 2010	30-Sep-2010	30-Sep-2009
Total Assets	831,795,279	780,759,609
Return on Assets (ROA)	11.25%	-
Capital	230,146,052	230,146,052
Return on Equity (ROE)	39.40%	-

Source: Calculation by Project Team based on PAT's financial report

ROA is an indicator to show the performance of business assets and not always suitable for public entities which own large infrastructure for the national economy. PAT is a state owned enterprise like PAS, so that it may be accepted that their ROA remains at a lower level than ordinary private companies.

(4) Net profit margin

Net profit margin is a ratio of net profit to operating income of a commercial enterprise, which indicates profitability of the commercial enterprise. Net profit margin of PAS, PPAP and PAT are 9.0%, 18.7% and 31.1% respectively. Net profit margin of PAS remains at a low level compared with PPAP and PAT.

(USD)

(in 2010)	Net Profit	Sales	Ratio
PAS	2,389,381	26,570,044	9.0%
PPAP	1,205,341	6,439,282	18.7%
PAT(Thailand)	90,668,177*	291,585,276	31.1%** (21.8%)

Source: Calculation by Study Team based on PAS, PPAP, PAT financial reports

Note

*: PAT is a state agency and exempt from income tax. If PAT pays the ordinary corporate tax of Thailand, i.e. 30%, the "Net Profit" reported as USD 90.66 million shall be reduced to USD 63.5 million. Since 65% of the "Net profit" is transferred to the Ministry of Finance. Real net profit may be deemed as USD 31.7 million.

**: If PAT pays ordinary corporate tax, "Ratio" is estimated at about 21.8%. As 65% of net profit is transferred to the government, real "Ratio" may be 10.9%.

Sales per container volume handled are calculated as follows. Sales per TEU are USD 119.2 at PAS and USD 103.4 at PPAP. As the sales include revenue from general cargo handling, PAS's "Sales per TEU" is a little higher than that of PPAP. There may be no significant difference in "Sales per TEU" at PAS and PPAP. More than 80% of sales is generated from container related business at PAS.

Net profit per TEU is estimated at about USD 10.7 at Sihanoukville port and USD 19.4 at Phnom Penh port. These figures do not represent the exact amount of "Net profit per TEU" as some part of the profit is generated from general cargo handling. Taking this into account, PAS's "Net profit per TEU" may be 20% less than the USD 10.7, which may be caused by higher "Other expenses" and "Interest on loans" at PAS.

Sales and net profit per container TEU

(in 2010)	Net Profit/TEU* (USD)	Sales/TEU* (USD)	Container handled (TEU)
PAS	10.7	119.2	222,928
PPAP	19.4	103.4	62,256

Source: Calculation by Project Team based on PAS and PPAP financial reports

Note

*: "Net Profit" and "Sales" include those from general cargo operation. "Net Profit per TEU" and "Sales per TEU" in the above table do not show exact figure, but most of sales are generated from container related business at PAS and PPAP.

Table 4.2-1 Balance Sheet (PAS)

Balance sheet (PAS)

Assets	2010	2009	2010	2009
	31 Dec. 2010	01 Jan. 2010	31 Dec. 2010	01 Jan. 2010
	Riel	**Riel**	**USD**	**USD**
Fixed Assets				
Land	333,606,939,922	330,516,046,648	81,486,795	80,731,814
Buildings	130,795,627,684	135,060,147,220	31,948,126	32,989,777
Investing properties	992,394,904	1,063,026,649	242,402	259,655
Other intangible assets	43,602,314,727	43,294,121,006	10,650,297	10,575,017
Tangible assets in progress	17,923,007,999	18,670,597,969	4,377,872	4,560,478
Tangible assets to be written off		160,468,197		39,196
Computer software	16,063,125	32,126,250	3,924	7,847
Non-operating tangible assets	842,555,966	842,555,966	205,803	205,803
Total Fixed Assets	**527,778,904,327**	**529,639,089,904**	**128,915,218**	**129,369,587**
Current Assets				
Inventories	6,461,810,057	5,288,167,045	1,578,361	1,291,687
Advanced and prepayments on account	9,620,000	13,420,000	2,350	3,278
Trade receivables	9,805,389,120	7,191,375,360	2,395,063	1,756,565
Bad debts		105,647,427		25,805
Advanced and on-account payments to employees	23,660,000	21,593,500	5,779	5,274
Pre-paid dividend to state	29,580,149,342	32,775,567,280	7,225,244	8,005,757
Other miscellaneous transactions with public authorities and international bodies	126,000,000		30,777	
Other sundry debtors	480,273,800	631,843,800	117,312	154,334
Banks	21,609,755,234	21,986,961,610	5,278,396	5,370,533
Cash	742,685,189	711,232,149	181,408	173,725
Total Current Assets	**68,839,342,742**	**68,725,808,171**	**16,814,690**	**16,786,959**
Total Assets	**596,618,247,069**	**598,364,898,075**	**145,729,909**	**146,156,546**

Source: Summarized by Project Team based on PAS's financial report   Exchange rate: 4,094 Riel/USD

Capital and Liabilities	2010	2009	2010	2009
	31 Dec. 2010	01 Jan. 2010	31 Dec. 2010	01 Jan. 2010
	Riel	**Riel**	**USD**	**USD**
Capital				
Capital	451,943,610,641	452,048,601,881	110,391,698	110,417,343
General Reserves	2,958,228,362	2,614,905,501	722,577	638,717
Retained Earnings				
Profit in the period (p.a)	9,782,124,384	6,002,689,780	2,389,381	1,466,216
Total Capital	**464,683,963,388**	**460,666,197,162**	**113,503,655**	**112,522,276**
Liabilities				
Long-term liabilities				
Other grants	2,099,239,526	2,099,239,526	512,760	512,760
Deferred tax on non-current assets	4,090,840,572	2,566,164,445	999,228	626,811
Borrowings from banks and others	105,464,037,163	123,522,736,995	25,760,634	30,171,650
Deposits received	585,985,000	458,720,000	143,133	112,047
Past service liability (Pension)	4,348,143,818	4,283,554,951	1,062,077	1,046,301
Total long-term liabilities	**116,588,246,079**	**132,930,415,917**	**28,477,832**	**32,469,569**
Short-term liabilities				
Trade payable for goods and services	566,968,734	599,966,870	138,488	146,548
Other state taxes	2,902,130,223	2,140,025,794	708,874	522,722
Accrued interest	1,773,153,716	1,862,409,771	433,110	454,912
Short-term borrowings	9,207,907,340		2,249,122	
Other short term liabilities	895,877,590	165,882,562	218,827	40,518
Total short-term liabilities	**15,346,037,602**	**4,768,284,996**	**3,748,421**	**1,164,701**
Total capital and liabilities	**596,618,247,069**	**598,364,898,075**	**145,729,909**	**146,156,546**

Source: Summarized by Project Team based on PAS's financial report

Exchange rate: 4,094 Riel/USD

Table 4.2-2 Statement of Income (PAS)

(Riel)

	2010	2009 Restatement
I. Revenues		
Services	107,394,105,276	91,672,436,958
Miscellaneous services	1,383,653,231	1,178,454,649
Interest gains	246,013,507	147,696,397
Exchange gains	248,344,480	456,035,873
Exceptional incomes		163,718,455
Total revenues	**109,272,116,494**	**93,618,342,332**
II-1 Operating expenses		
Combustible expense for operation	10,912,764,048	7,587,041,980
Motor oil expense for operation	1,072,391,350	1,033,821,412
Supplies for workshop and other spare-part expenses	3,988,431,864	3,099,673,577
Spare-part expense	3,612,967,164	4,473,564,108
Tyre expense	2,089,400,971	1,052,134,275
Salaries	22,960,633,427	17,863,811,796
Bonus	26,000,000	646,820,000
Depreciation on tangible assets	15,755,679,936	16,350,986,293
Depreciation on intangible assets	16,063,125	
Total Operating Expenses	**60,434,331,885**	**52,107,853,441**
II-2 Other expenses		
Materials for repair and maintenance expense	7,191,954,603	2,819,660,612
Combustible expense for administration	2,083,411,466	2,113,925,941
Combustible expense for daily maintenance	3,439,576,375	6,309,669,582
Others	14,902,858,412	14,088,345,361
Total Other Expenses	**27,617,800,856**	**25,331,601,495**
II. Total expenses	**88,052,132,741**	**77,439,454,936**
III. Income before interest and tax	**21,219,983,754**	**16,178,887,396**
V. Interest on loans and debts	**8,992,328,275**	**8,033,984,061**
X. Income before tax	**12,227,655,479**	**8,144,903,336**
VI. Income tax	**2,445,531,095**	**2,142,213,556**
XII. Net income	**9,782,124,384**	**6,002,689,780**

Source: Summarized by Project Team based on PAS's financial report

(USD)

	2010	2009 Restatement
I. Revenues		
Services	26,232,073	22,391,900
Miscellaneous services	337,971	287,849
Interest gains	60,091	36,076
Exchange gains	60,661	111,391
Exceptional incomes		39,990
Total revenues	**26,690,795**	**22,867,206**
II-1 Operating expenses		
Combustible expense for operation	2,665,551	1,853,210
Motor oil expense for operation	261,942	252,521
Supplies for workshop and other spare-part expenses	974,214	757,126
Spare-part expense	882,503	1,092,712
Tyre expense	510,357	256,994
Salaries	5,608,362	4,363,413
Bonus	6,351	157,992
Depreciation on tangible assets	3,848,481	3,993,890
Depreciation on intangible assets	3,924	
Total Operating Expenses	**14,761,683**	**12,727,859**
II-2 Other expenses		
Materials for repair and maintenance expense	1,756,706	688,730
Combustible expense for administration	508,894	516,347
Combustible expense for daily maintenance	840,151	1,541,199
Others	3,640,171	3,441,218
Total Other Expenses	**6,745,921**	**6,187,494**
II. Total expenses	**21,507,604**	**18,915,353**
III. Income before interest and tax	**5,183,191**	**3,951,853**
IV. Interest on loans and debts	**2,196,465**	**1,962,380**
V. Income before tax	**2,986,726**	**1,989,473**
VI. Income tax	**597,345**	**523,257**
XII. Net income	**2,389,381**	**1,466,216**

Source: Summarized by Project Team based on PAS's financial report
Exchange rate: 4,094 Riel/USD on 21 Oct. 2011

Table 4.2-3 Statement of Cash Flow (PAS)

Ended 31 Dec 2009

	(Riel)	(USD)
Incomes before tax	10,711,067,781	2,616,284
Interest expenses	8,033,984,061	1,962,380
Minimum tax	29,929,480	7,311
Loss on sales of fixed assets	16,103,714	3,933
Depreciation	16,350,986,293	3,993,890
Incomes before changes in assets	**35,142,071,328**	**8,583,799**
Changes in assets	(185,000,707)	(45,188)
Cash from Operating Activities	34,957,070,622	8,538,610
Interests paid	6,171,574,290	1,507,468
Tax paid	1,425,498,147	348,192
Net cash from operating activities	**27,359,998,185**	**6,682,950**
Cash for investment activities	**(19,147,543,259)**	**(4,676,977)**
Repayment to loans	**(3,924,877,761)**	**(958,690)**
Cash increase in the period	4,287,577,164	1,047,283
Cash balance in the beginning of 2009	18,410,616,594	4,496,975
Cash at the end of 2009	**22,698,193,759**	**5,544,258**

Source: Summarized by Project Team based on PAS's financial report
Exchange rate: 4,094 Riel/USD on 21 Oct. 2011

Table 4.2-4 Revenues and Expenses (2005-2009, Old format)

Revenues and Expenses (2005-2009, Old format)

(Riel)

Description	2009	2008	2007	2006	2005
I. OPERATING INCOMES					
1. SALES	92,850,891,607	110,106,689,252	100,072,341,113	92,879,783,890	80,416,703,862
2. CAPITALIZED CONSTRUCTION (Hypothetic income)	6,332,026,000	2,310,745,000	1,926,737,450	3,097,155,990	3,477,911,400
3. OTHER OPERATING INCOMES					
4. TRANSFER OF CHARGES	101,611,677				
TOTAL I	**99,284,529,284**	**112,417,434,252**	**101,999,078,563**	**95,976,939,880**	**83,894,615,262**
II. OPERATING EXPENSES					
1. PURCHASES	38,499,787,111	49,095,470,886	35,463,324,133	34,904,003,687	29,264,588,256
2. EXTERNAL SERVICES	1,876,659,034	1,555,838,502	1,369,001,696	1,453,050,013	1,450,677,318
3. OTHER EXTERNAL SERVICES	1,898,913,730	2,196,600,889	2,075,428,036	1,560,944,992	1,204,873,564
4. TAX & SIMILAR SERVICES	35,764,000	48,394,000	48,509,000	48,198,143	48,281,800
5. PERSONNEL EXPENSES	18,172,083,796	22,263,166,300	20,576,074,584	19,185,050,496	18,073,822,227
6. OTHER OPERATING EXPENSES	2,147,302,400	2,377,149,625	2,139,356,440	2,007,762,267	1,847,315,710
7. DECPRECIATION, AMORTIZATION AND PROVISIONS	16,842,658,555	20,879,403,341	22,461,361,492	24,916,751,198	26,925,577,327
8 MINIMUM TAX	29,929,480				
TOTAL II	**79,503,098,106**	**98,416,023,544**	**84,133,055,381**	**84,075,760,795**	**78,815,136,201**
III. NET OPERATING INCOMES I - II	**19,781,431,179**	**14,001,410,708**	**17,866,023,181**	**11,901,179,084**	**5,079,479,061**
IV. FINANCIAL INCOMES	603,732,270	176,613,432	229,145,036	496,616,717	341,251,399
V. FINANCIAL EXPENSES	8,036,184,061	78,098,003	234,973,840	194,335,866	300,000
VI. NET FINANCIAL INCOMES IV - V	**(7,432,451,791)**	**98,515,429**	**(5,828,804)**	**302,280,851**	**340,951,399**
VII. EXCEPTIONAL INCOMES	62,106,778		43,050,196	541,299,999	5,016,000
VIII. EXCEPTIONAL EXPENSES	1,700,018,384	6,213,496,671	4,780,775,349	2,911,558,919	1,062,141,670
IX. NET EXCEPTIONAL INCOMES VII - VIII	**(1,637,911,607)**	**(6,213,496,671)**	**(4,737,725,154)**	**(2,370,258,920)**	**(1,057,125,670)**
X. NET INCOME BEFORE TAX III + VI + IX	**10,711,067,781**	**7,886,429,466**	**13,122,469,224**	**9,833,201,016**	**4,363,304,790**
XI. INCOME TAX	2,142,213,556	1,577,285,893	2,624,493,800	1,966,640,000	872,660,958
XII. NET INCOME AFTER TAX X - XI	**8,568,854,225**	**6,309,143,573**	**10,497,975,424**	**7,866,561,016**	**3,490,643,832**

(USD)

Description	2009	2008	2007	2006	2005
I. OPERATING INCOMES					
1. SALES	22,679,749	26,894,648	24,443,659	22,686,806	19,642,575
2. CAPITALIZED CONSTRUCTION (Hypothetic income)	1,546,660	564,422	470,625	756,511	849,514
3. OTHER OPERATING INCOMES					
4. TRANSFER OF CHARGES	24,820				
TOTAL I	**24,251,228**	**27,459,070**	**24,914,284**	**23,443,317**	**20,492,090**
II. OPERATING EXPENSES					
1. PURCHASES	9,403,954	11,992,054	8,662,268	8,525,648	7,148,165
2. EXTERNAL SERVICES	458,393	380,029	334,392	354,922	354,342
3. OTHER EXTERNAL SERVICES	463,828	536,541	506,944	381,276	294,302
4. TAX & SIMILAR SERVICES	8,736	11,821	11,849	11,773	11,793
5. PERSONNEL EXPENSES	4,438,711	5,437,999	5,025,910	4,686,138	4,414,710
6. OTHER OPERATING EXPENSES	524,500	580,642	522,559	490,416	451,225
7. DECPRECIATION, AMORTIZATION AND PROVISIONS	4,113,986	5,100,001	5,486,410	6,086,163	6,576,839
8 MINIMUM TAX	7,311				
TOTAL II	**19,419,418**	**24,039,087**	**20,550,331**	**20,536,336**	**19,251,377**
III. NET OPERATING INCOMES I - II	**4,831,810**	**3,419,983**	**4,363,953**	**2,906,981**	**1,240,713**
IV. FINANCIAL INCOMES	147,468	43,140	55,971	121,304	83,354
V. FINANCIAL EXPENSES	1,962,917	19,076	57,395	47,468	73
VI. NET FINANCIAL INCOMES IV - V	**(1,815,450)**	**24,063**	**(1,424)**	**73,835**	**83,281**
VII. EXCEPTIONAL INCOMES	15,170		10,515	132,218	1,225
VIII. EXCEPTIONAL EXPENSES	415,246	1,517,708	1,167,752	711,177	259,439
IX. NET EXCEPTIONAL INCOMES VII - VIII	**(400,076)**	**(1,517,708)**	**(1,157,236)**	**(578,959)**	**(258,213)**
X. NET INCOME BEFORE TAX III + VI + IX	**2,616,284**	**1,926,338**	**3,205,293**	**2,401,857**	**1,065,780**
XI. INCOME TAX	523,257	385,268	641,059	480,371	213,156
XII. NET INCOME AFTER TAX X - XI	**2,093,027**	**1,541,071**	**2,564,234**	**1,921,485**	**852,624**

Source: Summarized by Project Team based on PAS's financial report

Exchange rate: 4,094 Riel/USD

Table 4.2-5 Balance Sheet (PPAP)

At 31 December 2010 -2008, (Riel)

	2010	2009	2008
Non-current assets	97,734,451,119	98,051,784,421	94,415,828,669
Current assets	12,952,102,500	7,778,173,530	10,803,586,022
Total Assets	**110,686,553,620**	**105,829,957,951**	**105,219,414,691**
Capital	105,594,961,859	103,730,072,490	103,689,164,027
Total Capital	**105,594,961,859**	**103,730,072,490**	**103,689,164,027**
Non-current liability	1,966,178,610	172,213,910	261,863,125
Current liability	3,125,413,151	1,927,671,551	1,268,387,539
Total Liability	**5,091,591,761**	**2,099,885,461**	**1,530,250,664**
Total Capital & Liabilities	**110,686,553,620**	**105,829,957,951**	**105,219,414,691**

At 31 December 2010 -2008, (USD)

	2010	2009	2008
Non-current assets	23,872,607	23,950,118	23,062,000
Current assets	3,163,679	1,899,896	2,638,883
Total Assets	**27,036,286**	**25,850,014**	**25,700,883**
Capital	25,792,614	25,337,096	25,327,104
Total Capital	**25,792,614**	**25,337,096**	**25,327,104**
Non-current liability	480,259	42,065	63,963
Current liability	763,413	470,853	309,816
Total Liability	**1,243,672**	**512,918**	**373,779**
Total Capital & Liabilities	**27,036,286**	**25,850,014**	**25,700,883**

Source: Summarized by Project Team based on PPAP's financial report
Exchange rate: 4,094 Riel/USD

Table 4.2-6 Statement of Income (PPAP)

(Riel)

	2010	2009	2008
Operating Income	26,362,419,004	20,734,266,008	21,113,765,954
Financial Income	2,868,799	7,522,903	18,997,835
Exceptional & Extraordinary Income	25,385,090	1,386,370,882	1,693,626,102
Total Revenues	**26,390,672,893**	**22,128,159,789**	**22,826,389,891**
Operating Expense	18,146,974,197	16,767,640,828	17,002,416,239
Financial Expense	133,470,075		
Exceptional & Extraordinary Expense	1,941,898,056	1,624,784,356	2,749,684,433
Income Tax Expense	1,233,666,113	747,146,921	614,857,844
Total Expense	**21,456,008,441**	**19,139,572,105**	**20,366,958,516**
Net Profit	**4,934,664,452**	**2,988,587,685**	**2,459,431,376**

(USD)

	2010	2009	2008
Operating Income	6,439,282	5,064,550	5,157,246
Financial Income	701	1,838	4,640
Exceptional & Extraordinary Income	6,201	338,635	413,685
Total Revenues	**6,446,183**	**5,405,022**	**5,575,572**
Operating Expense	4,432,578	4,095,662	4,153,008
Financial Expense	32,601		
Exceptional & Extraordinary Expense	474,328	396,870	671,638
Income Tax Expense	301,335	182,498	150,185
Total Expense	**5,240,842**	**4,675,030**	**4,974,831**
Net Profit	**1,205,341**	**729,992**	**600,740**

Source: Summarized by Project Team based on PPAP's financial report
Exchange rate: 4,094 Riel/USD

Table 4.2-7 Balance Sheet (PAT, Thailand)

(USD)

Assets	**2010**	**2009**
Current Assets		
Cash and cash equivalent	193,962,805	150,704,649
Temporary investment	35,322,927	51,904,993
Accounts receivable - net	11,133,861	11,594,876
Other debtors - net	1,993,436	1,745,032
Inventories	7,030,629	5,556,689
Debtor account (Provident fund)	13,591,690	17,215,127
Other current assets	22,963,318	13,364,646
Total current assets	**286,863,495**	**252,086,012**
Non-current assets		
Property, plant, and equipment - net	510,598,569	479,409,332
Assets under construction and installation	21,263,738	14,895,995
Deferred debit of assets of community project	10,825,879	10,867,815
Intangible assets - net	1,944,041	2,045,773
Deferred debit of contribution to first set capital	0	20,968,885
Other non-current assets	299,558	485,798
Total non current assets	**544,931,784**	**528,673,597**
Total Assets	**831,795,279**	**780,759,609**
Liabilities and Capital	**2010**	**2009**
Current Liabilities		
Trade accounts payable	20,048,423	19,345,066
Creditor (The Revenue Department)	400,632	341,759
Accrued expenses	14,500,106	9,677,993
Accrued remittance	33,322,966	21,289,558
Deposit and guarantee	5,149,065	4,590,748
Refundable deposit	3,302,551	3,416,574
Other current liabilities	19,786,217	19,076,929
Total current liabilities	**96,509,960**	**77,738,627**
Non current liabilities		
Deferred income from donate assets	15,345,905	9,717,103
Provisions	1,148,985	
Provident fund	68,379,722	69,162,390
Accrued saving deposit	17,392,651	17,539,752
Total non current liabilities	**102,267,264**	**96,419,246**
Capital		
Capital	230,146,052	230,146,052
Surplus on revaluation of assets Appropriate earnings	1,581,860	1,581,860
Reserve for expansion and investment	276,286,438	276,286,438
Unappropriated	106,466,396	80,050,077
Insurance fund	18,537,310	18,537,310
Total capital	**633,018,055**	**606,601,736**
Total liabilities and capital	**831,795,279**	**780,759,609**

Source: Summarized by Project Team based on PAT's financial report
Exchange rate: 31.22 Baht/USD

Table 4.2-8 Statement of Income (PAT, Thailand)

(USD)

	2010	2009
Revenues		
Ship handling	41,766,539	37,483,419
Cargo handling	241,518,854	213,196,371
Service	8,299,883	8,173,142
From provident fund	135,531	334,292
From insurance fund	595,952	1,096,462
Interest earned	2,283,458	3,190,296
Gain on sales of fixed assets	727,572	629,939
Other revenues	42,584,425	42,466,511
Total revenues	**337,912,214**	**306,570,432**
Expenses		
Personnel expenses	83,177,771	76,141,599
Repair and maintenance	18,554,958	19,069,251
Fuel and electricity	30,921,614	25,537,580
Depreciation and amortization	43,028,808	39,328,912
Provident fund expenses	62	63
Insurance fund expenses	292,094	428,747
Contribution to provident fund	25,803,825	25,890,313
Contribution to PAT staff's provident fund	2,474,586	2,480,891
Deferred expense on contribution to first set capital	20,968,885	20,968,885
Other expenses	22,021,436	21,333,731
Total expenses	**247,244,037**	**231,179,974**
Income before interest paid	90,668,177	75,390,458
Interest paid		359,747
Net Profit	**90,668,177**	**75,030,711**

Source: Summarized by Project Team based on PAT's financial report
Exchange rate: 31.22 Baht/USD

4.2.2 Port dues and charges

The present tariff on port dues and charges of the port of Sihanoukville is stipulated by "PRAKAS No.053, PR.PWT, dated 17th January 1997". Port dues and charges are basically collected in accordance with this PRAKAS. However, the port is authorized to make one-year contracts with shipping companies and the main part of the container handling tariff is decided by this one-year contract with shipping companies. The tariff of Sihanoukville port revised by the one-year contract charges in 2011 is attached in the Appendix-X.

(1) Comparison of port dues and charges

Supposing a model case, i.e. a container vessel of 10,000 GRT enters and discharges 220 boxes of import containers and loads 200 boxes of export containers, port dues and charges are compared between Sihanoukville Port, Bangkok Port and VICT (Ho Chi Minh). Details of containers are:

Imports: 20'Laden 80 boxes, 40'Laden 120 boxes, 20'Empty 10 boxes, 40'Empty 10 boxes
Exports: 20'Laden 50 boxes, 40'Laden 70 boxes, 20'Empry 30 boxes, 40'Empty 50 boxes

In this model case, port dues and charges of the three ports are estimated as shown in Table 4.2-9 with a summary of estimates as follows.

(USD including VAT)

	Sihanoukville Port	Bangkok Port	VICT (Ho Chi Minh)
Dues and charges for ship entering, mooring and leaving	11,575	6,091	6,972
Charges for container handling (Shipping companies and agents)	40,211	27,822	30,809
Charges for container lift on/off (Shippers and consignees)	22,231	19,834	6,794
Total	74,016 (100%)	53,742 (72.6%)	44, 575 (60.2%)

Source: Estimate by Project Team

Dues and charges for ship entering, mooring and leaving are USD 11,575 at Sihanoukville Port, which is almost double of those of Bangkok Port and VICT (HCM). Charges for container handling are USD 40,211 at Sihanoukville Port, i.e. 45% and 31% higher than those of Bangkok and VICT respectively. Since shipping companies pay these port dues and charges for cargo handling, they may feel that Sihanoukville port dues and charges are 1.5 times of Bangkok and 1.4 times of Ho Chi Minh.

Charges for container lift on and lift off are mainly collected from shippers and consignees, and partly from shipping companies in the case of the export of empty containers. Lift on/lift off charges at Sihanoukville port are slightly higher than those of Bangkok Port, but three times higher than those of VICT (Ho Chi Minh).

Total dues and charges paid at Sihanoukville Port are 37% higher than Bangkok Port and 40% higher than VICT (Ho Chi Minh).

(2) Comparison with private and provincial ports

Private ports and provincial ports, namely Oknha Mong Port, Sre Ambel Port and Tomnop Rolok Port, are used for the import of cement and general goods from Thailand. Port dues and cargo handling charges of such ports are considerably lower than those of Sihanoukville Port. Supposing a case of cement import from Thailand with a 1,500 DWT cement barge, port dues and cargo handling charges are estimated as shown in Table 4.2.10.

Port dues for a 1,500 DWT cement barge are USD 600 and the wharfage of USD 750 is charged at Sihanoukville Port. In addition, consignees have to hire laborers and equipment for stevedoring, which may cost USD 1.500 for handling cement of 1,500 tons. Total cost at Sihanoukville port is estimated at about USD 2,850 for this case.

In the case of Tomnop Rolok port, the cost is estimated at about USD 2,750 including cargo handling by consignees. At the Oknha Mong Port, the cost for this case is about USD 2,040 including port dues and cargo handling charges. The cost at Sre Ambel Port is estimated at about USD 1,500 in the same case.

(USD)

Port	Total cost for cement import of 1,500 tons
Sihanoukville	2,850
Tomnop Rolok	2,750
Oknha Mong	2,040
Sre Ambel	1,500

Source: Estimate by Project Team

Sihanoukville port may not be so competitive with private ports in terms of cost comparison. Moreover, Oknha Mong port and Sre Ambel port have an advantage in their location, which are closer to the destination of cargoes than Sihanoukville port. However, the SHV port may be competitive if

cement were carried in bulk. Total cost at SHV port and Tomnop Rolok port may not have so much difference, but cement cargo owners prefer to use Tomnop Rolok port due to some other reasons.

(3) Income by business activities

Sixty five percent of PAS's revenues are generated by cargo handling services and 25% of the revenues are from port dues and charges for ship entering, mooring and leaving.

(USD)

	Income during Jan.-Nov. 2011 (USD)	Ratio
Cargo handling services	18,268,215	65.4%
Port Dues	6,907,537	24.7%
Warehouse & Storage	783,937	2.8%
Transportation services	11,569	0.04%
VAT 10%	1,945,400	7.0%
Total	27,916,658	100.0%

Source: Calculation by Project Team based on PAS's report

Breakdowns of revenues collected under port dues are not available. However, it is important to know the amount of revenues collected as tonnage dues, channel dues, pilotage fee, tug boat fee, and berth fee separately. It is also important to know revenues of general cargo handling and container handling services. Cost for tug boat services, pilotage, general cargo handling and container handling, and other services shall be assessed in connection with revenues of respective services.

(4) Revision of Tariff

Taking into account competitiveness, efforts shall be made to lower port dues and charges for cargo handling. However, dues and charges shall cover the cost of services as well as the cost of maintenance and facility improvement. It is therefore important to revise tariff structure and rationalize/simplify tariff items. The following revisions are requested by port users:

- Lift on/lift off charges shall be collected separately when actual service is provided.
- Berth fees shall be collected in accordance with actual berthing hours, instead of the number of times
- Minimum quantity of water supply shall be lifted.
- Charges for performance bonus shall be included in charges for Vessel-Yard handling.
- Charges for delivery and receipt of cargoes shall be included in charges for lift on/lift off.
- KAMSAB delivery order shall be included in lift on charges.

Port dues collected as tonnage dues and channel dues are charges for covering the cost of administration, port management, safety inspection and the maintenance of channels and navigational aids. The sum of tonnage dues and channel dues are almost double of those of Bangkok port or VICT (Ho Chi Minh). Berth fees are also almost three times of Bangkok and VICT.

Container handling charges are also higher than the neighboring two country's ports. Container handling bonus and gantry crane charges shall be incorporated into container handling charges or demolished. Container lift on/lift off charges are also important sources of port revenues, which are a little higher than those of Bangkok Port and much higher than those of VICT. PAS collects lift on/lift off charges together when a container leaves the port and checks the payment when an empty container comes back to the port. This billing method makes gate procedures more complicated, and the portion of lift off charge is not refunded to consignees even if empty containers do not come back to the port.

The financial situation of PAS may not allow such a reduction in port dues immediately, however, it is imperative to reduce the tariff rate and make the port competitive. Revision of the tariffs shall be taken into consideration when the volume of cargo increases and total revenues rise

accordingly. It is also an effective means to introduce volume-discount in container handling charges. It's a charging system whereby PAS reduces container handling charges by a certain rate when a shipping company brings more containers than agreed to by annual contract.

Besides revising the tariffs, it will be a good strategy to allow private companies to provide stevedoring services for general cargoes, as they are already approved for stevedoring work for cement import, in order to make the port more competitive.

Table 4.2-9 Comparison of Port Dues and Charges between Sihanoukville, Bangkok and HCM

Dues and Charges for Ship Entering, Mooring, and Leaving

	Sihanoukville	USD	Bangkok [6]	USD	VICT (HCM)	USD
Port Dues (Shipowner, Agent)						
* Tonnage Dues	0.25 /GT	2,500	0.32 /GT [6]	3,200	0.032 /GT/In & Out	640 x
* Channel Dues	0.5*GT-GT^2/200000	4,500			0.100 /GT/In & Out	2,000 x
* Pilotage Fees [2]	0.030 /GT	750	D*(1.2*LOA+2) [7]	896	0.0034~0.0015 /GT/Mile	1,500 [12]
Pilot Boat	-	-	6,200 Baht/Round trip	397	-	-
* Tug boat [2]	190 /Hour	808	0.0128 /GT/Hour	448	800 or 1,400 /Time [10]	1,600
* Port Clearance	100 /Time	100	-	-	100 /Time	100 x
* Berth Fees [1]	0.23 /GT	2,300	0.288 /100GT/Hour	691	0.0031 /GT/Hour [11]	744
* Mooring & Unmooring [2]	50 /Time	125	-	-	40 /Time	80
Hatch Opening Closing	60 /Hatch	360	-	-	28 /Hatch	168
* Fresh Water [3]	1.50 /m^3	75	0.80 /m^3	40	2.5 /m^3	125
Garbage Removal	30 /Time	30	4.81 /Vessel/Day	5	15 /Time	15
Quay Cleaning Charge	-	-	16.0 /Vessel/Day	16	-	-
Sub-Total		11,548	Sub-Total	5,693	Sub-Total	6,972
	VAT	27	VAT	399	VAT	0

Source: Calculation by Study Team based on interviews and tariff
Note:
Entering ship: 10,000 GRT Container Vessel
Tug boat service: 2 hours for entry, 1.5 hours for departure
Pilotage: Weekday entry, weekend departure
Berth occupation: 24 hours

Charges for Cargo Handling (Collected from Shipping Companies and Agents)

	Sihanoukville	USD	Bangkok [6]	USD	VICT (HCM)	USD
Cargo Handling Charges (Shipowner, Agent)						
Container Handling Charges			Container Lifting Charges			
20' Laden	57 /Unit	7,410	32.0 /20' Unit	5,440	61.7 /20' Laden [15]	8,021
20' Empty	30 /Unit	1,200			40.23 /20' Empty [15]	1,609
40' Laden	86 /Unit	16,340	54.5 /40' Unit	13,625	92.09 /40' Laden [15]	17,497
40' Empty	43 /Unit	2,580			59.61 /40' Empty [15]	3,577
Container Handling Bonus [2]	5 /Unit	2,625	-	-	-	-
Gantry Crane Charges			Container Wharfage Charges		Container Lashing & Unlashing	
20' Laden	10 /Unit	1,300	11.9 /20' Laden Import	952	1 /Unit	105
20' Empty	10 /Unit	400	10.9 /20' Empty Import	109	Container Wharfage Charges	
40' Laden	20 /Unit	3,800	20.2 /40' Laden Import	2,424	1.6 /20' Unit	(272) [16]
40' Empty	15 /Unit	900	18.6 /40' Empty Import	186	3.2 /40' Unit	(800) [16]
			11.9 /20' Laden Export	595	4.0 /Over 40' Unit	
			10.9 /20' Empty Export	327		
			20.2 /40' Laden Export	1,414		
			18.6 /40' Empty Export	930		
Sub-Total		36,555		26,002		30,809
	including VAT	40,211	including VAT	27,822	Exempted from VAT	30,809

Source: Calculation by Study Team based on interviews and tariff

Note

Imports: 20'Laden 80 boxes, 40'Laden 120 boxes, 20'Empty 10 boxes, 40'Empty 10 boxes

Exports: 20'Laden 50 boxes, 40'Laden 70 boxes, 20'Empry 30 boxes, 40'Empty 50 boxes

Charges for Container Lift On/Off (Collected from Shippers, Consignees)

	Sihanoukville	USD	Bangkok [6]	USD	VICT (HCM)	USD
(Consignees, Shippers)			(Consignees, Shippers)		(Consignees, Shippers)	
Delivery & Receiving	1.0 /Unit		-	-		
Lift On/Lift Off Charges [4]			Lift On/Lift Off Charges		Lift On/Lift Off Charges	
20' Laden	46 /Unit	6,300	49.6 /20' Laden Lift On Import	3,968	10.9 /20' Laden	1,417
20' Empty	23 /Unit		84.9 /40' Laden Lift On Import	10,188	8.1 /20' Empty	324
40' Laden	62 /Unit	13,910	16.0 /20' Laden Lift Off Export	800	19.3 /40' Laden	3,667
40' Empty	44 /Unit		28.8 /40' Laden Lift Off Export	2,016	12.8 /40' Empty	768
			12.8 /20' Empty Lift Off Export	128	22.8 /Over 40' Laden	-
			21.8 /40' Empty Lift Off Export	1,090	17.6 /Over 40' Empty	-
			12.8 /20' Empty Lift On [8] Import	128		
			21.8 /40' Empty Lift On [8] Export	218		
Container Storage Charges	5 days free		3 days free			
KAMSAB Delivery Order	5 /Document		-	-		
Sub-Total		20,210		18,536		6,176
	including VAT	22,231	including VAT	19,834	including VAT	6,794
Total (including VAT)		74,016		53,747		44,575
				72.6%		60.2%

Note

1) Berth Fees: per time, but better to be charged in line with berth hours
2) Saturday, Sunday Holiday: to be 50% increase. Above estimation based on weekday in and weekend out.
3) Minimum charge is USD 60 /Voyage (inclusive of a case of no fresh water supply)
4) Delivery and receiving charges are only collected from export containers.
5) * items are exempted from VAT
6) Vessels under 750 GT are exempted
7) Pilotage overtime and holiday are double charge
8) This "Lift On Lift Off Charge" is levied on Shipowner or Ship's Agent
9) VAT is not included in dues and charges of Sihanoukville
10) HCM Tug company rates
    LOA 100m-150m: USD 800 /Time
    LOA 151m-200m: USD 1,400 /Time
11) Wharfage at Berth
12) 50 Nortical miles, In & Out
13) x items are charged by VINAMARINE
15) Exemped from VAT
16) Collection of Wharfage is not confirmed May be included in Container Handling

Exchange Rate: 31.22 Baht/USD on 21 December 2011
Exchange Rate: 19,124.3 Dong/USD, Average rate of 2010

Table 4.2-10 Comparison of port dues and handling charges for cement import

Sihanoukville Port **(USD)**

		Special Contract for Cement		Ordinary Tariff	
1	Tonnage Dues			0.25/GT	188
2	Berthage Dues			0.23/GT	173
3	Channel Dues			0.50GT-GT^2/200000	372
4	Pilotage Charges	0.8/GT	600	0.03/GT	23
5	Tug boat charges				
6	Moooring and Unmooring			16/Time	32
12.1	Charges for Clearance			100/Time	100
	Port Dues		600	Port Dues	887
14.4	Stevedoring				
	Wharfage	0.5/ton	750		
	by cargo owner (Est.)		1,500		
	Port Labor Tariff			3.16/ton	4,740
	Total in USD		2,850		

Oknha Mong Port

	Dues and Charges	
Berth Charge	0.12/GT	240
Channel Dues	0.2/GT	
Stevedoring (50kg Bag)	1.2/ton	1,800
Port Dues		240
Total in USD		2,040

Note:
A model case of Cement Barge:
1,500 DWT
(750 GT)

Tomnop Rolok Port

	Lump-sum Tariff	
Tonnage Dues		
Berthage Dues	500	500
Channel Dues		
Moooring and Unmooring		
Truck Entry Charge	10/truck	750
Stevedoring (50kg Bag)		
by cargo owner (Est.)		1,500
Port Dues		500
Total in USD		2,750

Sre Ambel Port

Tonnage Dues		
Berthage Dues	none	0
Channel Dues		
Moooring and Unmooring		
Stevedoring (50kg Bag)	1.0/ton	1,500
Port Dues		0
Total in USD		1,500

Source: Calculation by Project Team based on site survey

4.2.3 Public private partnership in port development and operation

(1) Types of terminal operation

Types of container terminal operators are 1) a private terminal operator who is granted an operation concession from the port authority or who has a lease contract with the port authority, 2) a private terminal operator who builds the container terminal and installs cargo handling equipment, 3) the operation department of the port authority, 4) a state owned enterprise or stock company which is owned by a public corporation, local or central government, 5) a private corporation which is derived from the privatization of the port authority, and other corporate bodies.

As an option of new terminal operation, PAS could lease out a new container terminal to private operators, however, another option for PAS is to operate the container terminal and acquire the know-how of container terminal operation to prepare for the establishment of a terminal operation company.

Careful consideration shall be given to the scheme of container terminal operation from the viewpoint of productivity of container cargo handling, good services to shipping lines and consignees, sufficient revenue to redeem the port investment, and development of its hinterland to contribute to the national economy. Table 4.2-11 shows the types of container terminal operation and responsible entities for the development of port facilities and operation. Advantages and disadvantages of the abovementioned types of terminal operation are shown in Table 4.2-12

Table 4.2-11 Types of terminal operation and development of port facilities

Types of Terminal Operation		Procurement of Equipment, Development of Facilities	Terminal Operator
1	Lease to Terminal Operator	PAS	Lessee
2	Concession to Terminal Company	Concessionaire	Concessionaire
3	Joint Stock Company established by PAS and Private Terminal/Shipping Companies	PAS or Joint Stock Company	Joint Stock Company
4	Department of PAS	PAS	PAS
5	Terminal Company separated from PAS	PAS or Terminal Company	Terminal Company

Source: JICA Study Team

Table 4.2-12 Advantages and disadvantages of terminal operation types

Types of Terminal Operation		Advantages	Disadvantages
1	Lease to Terminal Operator	International container terminal operator will improve the productivity of operation instantly.	International terminal operator acquires a profit, so the income of PAS will be reduced. No Cambodian company is capable of terminal operation. Terminal operation techniques have not been acquired in Cambodia.
2	Concession to Terminal Company	In addition to the above, foreign investment in the development of port facilities and procurement of equipment can be expected.	Besides the above, larger part of port income is transferred to foreign terminal companies.

3	Joint Stock Company established by PAS and Private Terminal/Shipping Companies	PAS can acquire skills and techniques of international terminal operation.	Improvement of container terminal operation may take a certain period of time. Part of the income of PAS is divided and the balance of PAS' account will worsen.
4	Department of PAS	PAS can acquire terminal operation techniques through the actual operation. All port income will remain in the country.	Improvement of container terminal operation may take a certain period of time. Service level of the port may not improve for the time being.
5	Terminal Company separated from PAS	In addition to the above, revenues and expenses of the container terminal are separated and become self supporting. Service level of the container terminal may improve.	Besides the above, part of the income of PAS is divided and the balance of PAS account may worsen.

Source: JICA Study Team

(2) Public private partnership in port development

Private participation in port development has several patterns from a type that 1) the public sector develops minimum facilities such as the navigation channel, basin and breakwaters, and the private sector develops other facilities (Private initiative type); to a type that 2) the public sector develops all infrastructure and large scale equipment such as quay gantry cranes and RTGs, and the private sector prepares small scale equipment such as reach stackers and tractors for operation. Several types between the above type 1) and type 2) are observed in actual cases of private participation in port development.

In the case that the private sector invests in some part or the whole part of port development, the development of an access road, railway, or navigational channel shall be discussed between competent public authorities and the private investor. A Landlord port usually develops the infrastructure of the port and invites private terminal operators to invest in superstructure, such as quay gantry cranes, RTGs, and other cargo handling equipment. Typical cases of PPP in port development and operation are summarized in Table 4.2-13.

Table 4.2-13 Public and private demarcation in developing port facilities

Type / Port Facilities	Private Port	Landlord Port		
		PPP by Public Initiative	PPP in Middle Case	PPP by Private Initiative
Navigational Channel, Basin, Breakwater	Private Investment	Public Investment	Public Investment	Public Investment
Access Road, Bridge, Railway and other transportation means				
Land Reclamation				
Quay, Pier and other mooring facilities			Private Investment	Private Investment
Terminal facilities (Pavement, Buildings)				
Quay gantry cranes, RTGs, Other heavy equipment				
Cargo handling equipment		Private		

Note: PPP (Public Private Partnership)
Source: JICA Study Team

4.2.4 Financial and managerial improvement

PAS's financial performance is assessed using Return on Assets, Net Profit Margin and Net Profit per container as shown in section 4.2.1 of this report. Those indicators imply that PAS's business produces lower profitability compared with PPAP and PAT. It may depend on the fact that consumption of fuel and oil is greater. Non-operating cost reaches 25% and payment of interest reaches 8.2% of the total revenue. Major items of expenses are extracted in Table 4.2-14 Profit Loss Statement (Extract).

Payment of interest on loans will increase every year until 2017 and total repayment of principal will increase until 2020. Net income of PAS will be reduced accordingly. Furthermore, PAS will have to pay dividends to shareholders after the sale of their stocks in June 2012. It is therefore imperative for PAS to increase their sales, improve efficiency of operation, reduce operational costs and the idle labor force, lower non-operational cost and depress payment of interest.

Table 4.2-14 PAS profit loss statement (Extract) 2010

	2010	2009 Restatement
I. Revenues	**26,690,795**	**22,867,206**
II. Total expenses	**21,507,604**	**18,915,353**
II-1 Operating expenses	**14,761,683**	**12,727,859**
Combustible expense for operation	2,665,551	1,853,210
Salaries	5,608,362	4,363,413
Depreciation on tangible assets	3,848,481	3,993,890
Others	2,639,290	2,517,346
II-2 Other expenses	**6,745,921**	**6,187,494**
Materials for repair and maintenance expense	1,756,706	688,730

Combustible expense for administration & maintenance	1,349,044	2,057,547
Other non-operational expenses	3,640,171	3,441,218
III. Income before interest and tax	**5,183,191**	**3,951,853**
IV. Interest on loans and debts	**2,196,465**	**1,962,380**
V. Income before tax	**2,986,726**	**1,989,473**
VI. Income tax	**597,345**	**523,257**
XII. Net income	**2,389,381**	**1,466,216**

Source: PAS Profit Loss Statement (Extract from Table 4.2-4)

(1) Promotion of shipcalls and cargo throughput

In order to increase sales of PAS, it is most important to increase shipcalls and cargo throughput. Necessary measures for port promotion are as follows:

- To improve services to users (see section 4.1 Strategy on Port Service Improvement)
- To revise port tariffs for encouraging the use of Sihanoukville Port (see section 4.2.2 Port dues and charges)
- To compete with Phnom Penh Port (Cai Mep route services)
- To encourage development of SEZ and the establishment of factories around the port

(2) Reduction of operating and non-operating cost

In order to reduce operating cost, it is necessary to reduce the cost for fuel and oil, materials for repair, spare parts, salaries for labor force and other non operating expenses. Reduction of fuel and oil cost is faced with the price escalation of petroleum products but it may be possible to cut fuel consumption by achieving efficient operation of equipment and receiving electric power from the outside.

Main items of non-operating expenditure are materials for construction, fuel for administration and daily maintenance. Non-operating cost is about 30% of the total expenses, which shall be reduced to a much lower level. In particular, fuel for administration and maintenance can be reduced by proper management of port labors and personnel.

(3) Rational number of labor force

An average of USD 5,600 was paid to staff members of PAS in 2010 and a bonus was paid in accordance with net profit ratio against the operating expense. Wages consist of basic salary of each class of worker and additional payment for family, house, food and the like. However, wages are not connected with the performance of each staff member, and therefore do not give them an incentive for performance improvement. It is essential for PAS to adjust the number of port workers to a necessary level and introduce an incentive system in wage payment. Details will be shown in section 4.3.3(2) PAS's organizational reform.

(4) Reduction of interest payment

1) Yen loans and sub-loans from MEF to PAS

PAS is faced with a rapid cost increase of repayment of loans. Payment of interest will be a heavy burden to PAS's financial management. Table 4.2-15 shows the amount of yen loans and their conditions which were already agreed between the governments of Japan and Cambodia. While interest rates of ODA loans are from 0.01% to 1.0%, those of MEF sub-loans to PAS are from 2.5% to 3.85% and MEF collects service charges on sub-loans from 0.1% to 0.15% as shown in the Table.

Table 4.2-15 Yen loans and sub-loans from MEF

	CP-P3 Rehabilitation	CP-P4 Expansion	CP-P6 SEZ (ES)	CP-P8 SEZ (CW)	CP-P10 Multi-Purpose
Contract with MEF					
Currency	Yen	US Dollar	Yen	Yen	Yen
Interest	3.50%	3.70%	3.85%	3.85%	2.50%
Service Chg.	0.10%	0.10%	0.15%	0.15%	0.10%
Total Int.	3.60%	3.80%	4.00%	4.00%	2.60%
Loan agreement (L/A) with Japan					
Currency	Yen	Yen	Yen	Yen	Yen
Date	24-Sep-99	26-Nov-04	20-Mar-06	31-Mar-08	21-Aug-09
L/A (million yen)	4,142	4,313	318	3,651	7,176
Interest	1.00% (0.75%)	0.90%	0.90%	0.01%	0.01%

Note: L/A: Loan Agreement, ES: Engineering Service, CW: Construction Work,
( ): Interest rate for Engineering Service
Source: PAS, JICA Homepage

2) Yen loan repayment plan (Repayment to MEF vs. Repayment to ODA)

The first yen loan project was agreed in September 1999 as CP-P3 and loans were disbursed from 2000 till 2006. Since then, four more yen loan projects were agreed till 2011 as CP-P4, CP-P6, CP-P8 and CP-P10 (see Table 4.2-15). Disbursement of loans for CP-P4 and CP-P6 was already finished and those for CP-P8 will be finished in 2012/2013, and those for CP-P10 will be completed in 2017.

Supposing the disbursement of all abovementioned loans will have been completed, the repayment plan is estimated as shown in Table 4.2-16 Repayment plan of yen loans. The column of "MEF Int. Rate" shows annual repayment of the sum of principal and interest at MEF interest rates. The column of "ODA Int. Rate" shows annual repayment of the sum of principal and interest at Loan Agreement with Japan.

Due to high interest rates of MEF sub-loans to PAS, PAS's annual repayments from 2012 till 2017 are about twice the annual repayments agreed by the Loan Agreement with Japan. Case B of Table 4.2-16 shows annual repayments of a case if the exchange rate of Yen/USD depreciates from 80 yen/USD to 100 yen/USD after 2015.

Table 4.2-16 Repayment plan of yen loans

	CASE A	80 Yen/USD			CASE B	80 Yen/USD (2012-14)	
	Loan from year 2000 to year of completion of Multi-Purpose					100 Yen/USD (2015 -)	
					Loan from year 2000 to yr of completion of Multi-Purpose		
	MEF Int. Rate	ODA Int. Rate	Difference		MEF Int. Rate	ODA Int. Rate	Difference
	USD	USD	USD		USD	USD	USD
2001	48,647	0	48,647		48,647	0	48,647
2002	55,723	0	55,723		55,723	0	55,723
2003	373,470	0	373,470		373,470	0	373,470
2004	722,831	0	722,831		722,831	0	722,831
2005	1,023,226	0	1,023,226		1,023,226	0	1,023,226
2006	1,139,326	0	1,139,326		1,139,326	0	1,139,326
2007	1,447,442	0	1,447,442		1,447,442	0	1,447,442
2008	1,867,798	358,439	1,509,359		1,867,798	358,439	1,509,359
2009	3,102,371	1,352,817	1,749,554		3,102,371	1,352,817	1,749,554
2010	4,951,465	2,416,016	2,535,449		4,951,465	2,416,016	2,535,449
2011	5,853,850	2,766,530	3,087,320		5,853,850	2,766,530	3,087,320
2012	6,125,456	3,198,487	2,926,969		6,125,456	3,198,487	2,926,969
2013	6,947,950	3,174,608	3,773,342		6,947,950	3,174,608	3,773,342
2014	7,913,402	4,347,437	3,565,964		7,913,402	4,347,437	3,565,964
2015	9,440,864	5,513,070	3,927,794		8,371,472	4,410,456	3,961,017
2016	10,323,569	5,628,804	4,694,765		9,239,008	4,503,043	4,735,965
2017	10,359,681	5,582,103	4,777,578		9,293,062	4,465,682	4,827,380
2018	11,513,371	6,855,437	4,657,934		10,202,372	5,485,853	4,716,518
2019	12,535,874	8,042,392	4,493,482		11,253,286	6,681,972	4,571,314
2020	13,526,304	9,229,857	4,296,447		12,272,125	7,878,467	4,393,658
2021	13,251,945	9,183,151	4,068,794		12,026,174	7,841,053	4,185,121
2022	12,977,586	9,137,101	3,840,485		11,780,223	7,804,163	3,976,060
2023	12,703,227	9,091,050	3,612,177		11,534,273	7,767,273	3,767,000
2024	12,428,868	9,045,405	3,383,463		11,288,322	7,730,708	3,557,614
2025	12,154,509	8,998,948	3,155,561		11,042,372	7,693,493	3,348,878
2026	11,880,149	8,952,897	2,927,252		10,796,421	7,656,603	3,139,818
2027	11,605,790	8,906,846	2,698,944		10,550,470	7,619,713	2,930,757
2028	11,331,431	8,860,952	2,470,479		10,304,520	7,582,948	2,721,571
2029	11,057,072	8,814,744	2,242,328		10,058,569	7,545,933	2,512,636
2030	8,623,686	6,618,976	2,004,710		8,085,397	5,789,269	2,296,128
2031	8,426,912	6,594,476	1,832,436		7,901,515	5,769,620	2,131,895
2032	8,230,138	6,570,003	1,660,136		7,717,632	5,749,992	1,967,641
2033	8,033,365	6,545,477	1,487,887		7,533,750	5,730,322	1,803,428
2034	7,836,591	6,520,978	1,315,613		7,349,868	5,710,673	1,639,194
2035	5,796,217	4,105,804	1,690,413		5,322,385	3,778,485	1,543,901
2036	5,588,182	4,023,358	1,564,823		5,143,136	3,712,479	1,430,657
2037	5,383,325	3,941,602	1,441,723		4,966,430	3,647,025	1,319,406
2038	5,261,122	3,940,050	1,321,073		4,855,848	3,645,733	1,210,114
2039	5,138,920	3,938,497	1,200,423		4,745,265	3,644,442	1,100,823
2040	4,863,919	3,780,565	1,083,354		4,512,444	3,518,047	994,396
2041	4,747,357	3,780,188	967,169		4,406,373	3,517,696	888,677
2042	4,630,795	3,779,810	850,985		4,300,303	3,517,344	782,959
2043	4,514,232	3,779,432	734,800		4,194,232	3,516,993	677,240
2044	4,397,670	3,779,054	618,616		4,088,162	3,516,641	571,521
2045	4,281,108	3,778,677	502,431		3,982,092	3,516,290	465,802
2046	4,164,546	3,778,299	386,246		3,876,021	3,515,938	360,083
2047	4,047,983	3,777,921	270,062		3,769,951	3,515,587	254,364
2048	3,275,684	3,121,806	153,877		3,139,290	2,990,646	148,645
2049	2,529,613	2,465,757	63,857		2,529,613	2,465,757	63,857

Note

1) Repayment of CP-P4 to MEF is made in USD, Other repayment is made on Yen basis.
2) In case of ODA Int. Rate, it is assumed that MEF made contract with PAS on Yen basis and ODA interest rate is applied.
3) Investment on "Multi-purpose" is estimated in USD, and loan is assumed to be disbursed based on this estimation. Therefore, the loan on "Multi-purpose" is not affected by USD-Yen exchange rate in the above table.
4) Yen/USD exchange rates from 2000-2011 are actual rates.
5) Case A is estimated assuming an exchange rate of 80 yen/USD
6) Case B is estimated assuming exchange rates of 80 yen/USD (2012-2014) and 100 yen/USD after 2015.

3) Interest during construction

Aiming at releasing PAS from payment of interest during the period of construction, as no income is expected during construction, additional loans of the same amount as the interest are provided to MEF by ODA and the amount is accumulated on the principal of the loan. Despite this fact, MEF collects interest on the loan immediately after disbursement of sub-loans to PAS. PAS pays interest on loans to MEF during the period of construction, but the same amount is accumulated on the principal and PAS has to repay the principal. It causes PAS to pay double interest during the period of construction.

It is difficult to get enough revenue during the period just after completion of construction and opening of facilities. Therefore, a grace period of 10 years is stipulated in the Loan Agreement with Japan and interest during the period of construction is provided by additional loans. Difference of payment of interest is estimated supposing a case that PAS pays interest at rates and conditions of MEF sub-loans and a case that PAS pays interest at rates and conditions of ODA loans, as shown in Table 4.2-17.

Table 4.2-17 Payments of interest (Yen loans vs. MEF sub-loans)

(Interest only, Exchange rate: 80 yen/USD) in USD

Year	Interest of MEF Sub-loans	Interest of ODA loans	Difference
2011	3,552,381	465,062	3,087,320
2012	3,813,631	886,662	2,926,969
2013	4,636,125	862,783	3,773,342
2014	4,676,957	840,056	3,836,900
2015	5,285,439	810,570	4,474,869
2016	6,168,144	767,231	5,400,913
Years after 2017 are omitted			

Source: Estimated by JICA Study Team

(5) Improvement of financial management

In order to make the Sihanoukville Port more competitive, efforts shall be made to reduce port dues and charges. Operational cost shall be reduced by improving efficiency of operation and reforming organization. Financial management shall aim at increasing cargo handling and reducing nonoperational costs.

Payment of interest shall also be reduced. Interest rates of MEF sub-loans shall be reduced to or near the level of ODA. As the minimum request, the interest rates of sub-loans shall be reduced to the level of ODA rates during the grace period. Interest on sub-loans during construction shall not be collected due to the fact that ODA provides the interest during construction.

Taking into account the abovementioned financial issues, PAS shall take the following measures to reduce the financial burden. Special attention shall be paid to the SEZ project and the oil supply base/multi-purpose terminal project so as to not worsen the financial management of PAS.

Item	Measures
Interest rates of sub-loans	Recalling that ODA loans are provided to assist development projects of public infrastructure, which are not profitable but important for national economy, interest rates of sub-loans from MEF to PAS shall be reduced to a level of ODA loans or nearby level.
Interest rates in grace period	At least interest rates of MEF sub-loans shall be reduced to the level of those of ODA loans during a grace period,.
Payment of interests during construction	MEF shall not collect interest during a period of construction due to the fact that the same amount as interest is financed by ODA loan and recipient is released from payment of interest during construction.
SEZ project	F/S of SEZ was undertaken based on an assumption that long-term loan of 0.01% interest were available. However, interest rates of MEF sub-loans to PAS are 3.85% and service charge of 0.15% is added to the interest rate. It is anticipated that PAS will be faced with difficulties after completion of SEZ if interest of 4% is collected immediately after the opening of SEZ. At least, interest rates of MEF shall be reduced to 2% or less. Companies which intend to established factories or other facilities in SEZ will pay land-lease fee of 50 years in advance. This amount shall be used for repayment to MEF and reducing the amount of principal. MEF shall accept early clearance of part of the debt. If MEF refuses early clearance of the long-term loan, PAS shall invest the deposit obtained from land lease fee by its own capacity. If the deposit of land lease fee is not properly managed, PAS's financial situation will be deteriorated.
Oil supply base & Multi-purpose terminal	Oil supply base and multi-purpose terminal project may not be able to cover the cost of investment if the interest rate of MEF sub-loans is 2.5% and service charge of 0.1% is collected, and if increase of port tariff on chip storage and handling are not agreed with chip exporting companies. Since the OSB and multi-purpose terminal project is important for national economy, MEF shall reduce interest rates of sub-loans for this project.

4.3. Organizational Strategy

4.3.1 Pre-capacity assessment

(1) General

1) Outlines

PAS was established as a Public Enterprise with state-owned characteristics under the technical supervision of the Ministry of Public Works and Transport and the financial management of the Ministry of Economy and Finance. PAS's headquarters is located in Sihanoukville City. PAS is an autonomous legal entity in technical, administrative and financial sections.

PAS provides a comprehensive range of services including bringing vessels in and out for offloading and loading and storage and transport of cargo for customers from all social circles. According to the Sihanoukville Autonomous Port Sub-decrees and Statutes, the following are PAS' major duties for business operations and basic services:

- Pilotage, bringing vessels in and out and providing them with supplies
- Conduct cargo handling, offloading, loading and transport
- Maintenance, stock safeguarding, warehouse and yard
- Develop and rehabilitate the PAS's existing infrastructure that are required to be expanded
- Taking responsibility on health care, security and order in its management areas
- Adhere to the basic principles and working procedures in the same functions as the customers
- Commit to manage and organize the operational activities to be effective and progressive

As a public institution, PAS has obtained an extensive authority from the government to carry out major duties in accordance with its objectives.

2) Management

PAS is led by a Board of Directors which consists of one chairman and six members from the ministries concerned shown below. The PAS's Board of Directors was appointed by the Head of the Royal Government of Cambodia.

- Director-General of PAS (Chairman)
- Representative of the MPWT (Member)
- Representative of the Council of Ministers (Member)
- Representative of the MEF (Member)
- Representative of Sihanoukville Authority (Member)
- Representative of the Ministry of Commerce (Member)
- Representative of PAS's employees (Member)

PAS is under the direct management of the Chairman & CEO, and three Deputy Director-Generals as assistants.

3) Organizational chart, management officer and staff

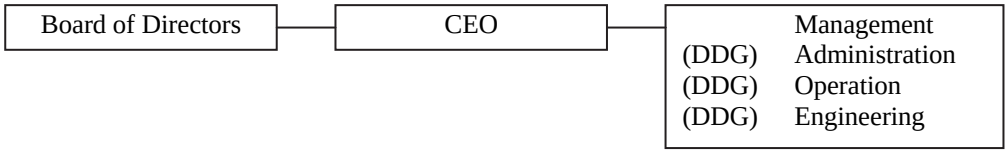
The organizational chart of PAS is shown below. The organization consists of four Divisions with twelve departments arranged under these Divisions. The Management Division is superintended directly by the CEO. Other Divisions are supervised by Deputy Director Generals. The number of employees and workers totaled 1,104 including 40 staff members working for Phnom Penh Dry Port in 2010.

Officials are as follows:

- HE Lou Kim Chhun: Chairman and CEO
- HE Ma Sun Hout : Deputy Director General (Technical & Engineering Division)
- Mr. Pen Sitha : Deputy Director General (Administration Division)

- Mr. Va Sonath : Deputy Director General (Business Division)
- Mr. Chea Sambath : Director of Planning and Statistic Department
- Dr. Chhun Hong : Director of General Cargo Terminal Operation Department
- Mr. Leng Mao : Director of Machinery Transport Department
- Mr. Chea Yuthdyka: Director of Technical Machinery & Construction Department
- Mr. May Marith : Director of Harbor Master Department
- Mr. Nomg Soyeth : Director of Marketing and SEZ Department
- Mr. Nhim Vuth : Director of Admin. & Personnel Department
- Mr. Pen Socheat : Director of Billing Department
- HE Sem Kythay : Director of Financial and Accounting Department
- Mr. Srey Narin : Director of Container Terminal Operation Department
- Mr. Sar Satya : Director of Phnom Penh Dry Port Department

The number of staff by Department and Office as of Sept. 2011 is as follows. Numbers in parenthesis are the total number of staff including Directors and Chiefs. The total number of staff is 1,104, comprising 1,064 PAS employees and 40 who work for Phnom Penh Dry Port.



Organization of PAS

Dept.	Office	No. of staff
MANAGEMENT		
Accounts-Finance Dept. (15)	Accounting Office	5
	Finance Office	7
Planning-Statistic Dept. (10)	Planning and Contract Office	4
	Planning-Communication Office	4
Marketing& SEZ Dept. (21)	APA Affair Office	1
	Customer & Promotion Office	3
	Planning & Marketing Office	4
	Administration & Accounting Office	3
	Logistic Office	3
	Training & Vocational Office	4
Audit Dept. (2)	Audit Office	1
	Implementation & Dispute Settlement Office	0
ADMINISTRATION		
Administration-Human Resource Dept. (191)	Administration Office	88
	Health Office	9
	Protocol & Communication Office	1
	Safety & Labor Office	1
	Human Resources & IT Office	12
	Social Responsibility Office	1
	Security Office	3
	Traffic & Order Office	43
	Safety Office	30
Harbor Master Dept. (85)	Harbor Master Office	20
	Pilot Office	21

	Navigation Means Office	41
OPERATION		
Container Terminal Operation Dept. (273)	Operation Office	196
	Container Terminal Planning Office	40
	Data Office	14
	General Affairs Office	20
Billing Dept. (12)	Exploitation Office	5
	Contract & Price Office	5
Phnom Penh Dry Port (40)	Administration & Finance Office	19
	Exploitation Office	19
General Cargo Operation Dept. (288)	Warehouse Yard-Tally Office	22
	Recapitulation Reports Office	7
	Transport & Cargo Handling Office	93
	Technical Handling Office	163
ENGINEERING		
Technical-Materials Dept. (157)	Construction Office	13
	Technical Office	134
	Architect Office	5
Machinery Dept. (8)	Standard Office	1
	Research Study Office	1
	Statistic & Inspection Office	4
		1,064

Reflecting the basic feature of PAS's activity, the number of staff in port operation sections account for around 850, or 80% of total staff. It is also noted that the number of staff in the administration section is substantially large with around 190 (17%). On the other hand, the number of staff in the business development section for the Planning and Marketing Office, AFA Affairs Office and Customer and Promotion Office is comparatively small with only 8.

A Human Resource Development Office is not found in the organization chart except for the Training and Vocational Office and Human Resource and IT Office. The total number of staff for these two Offices is 15. This may mean that each department is responsible for its own human resource development. Considering that the role and function is quite different for each department, the department trains their staff by themselves. However, it is necessary to train all staff at PAS under the same objective, philosophy, target and common understanding. It is recommended to set up a new training section for all staff at PAS where PAS's management style is to be presented and shared. Examples of the curriculum are as follows:

- Business environment surrounding PAS
- Current situation and how to enhance competitiveness at PAS
- Importance of strengthening the cooperation among departments to enhance competitiveness
- Role of each department toward enhancement of PAS's competitiveness

The Human Resource and IT Office may be responsible for the planning.

According to the Statute of Sihanoukville Autonomous Port, management staff and employees at PAS are divided into the following four frameworks:

- Department framework: Deputy Director-Generals, Directors
- Management framework: Chiefs of offices, chiefs and deputy chiefs of units, chiefs of brigades, sections and cashiers
- Administration framework: Employees working in the offices
- Production framework: Employees working in the operation line (other areas than the above three frameworks)

The criteria for each qualification are made clear and according to the criteria, the level and scale of wages for employees are set. Further, based on the levels, the salary scale is set.

Each officer and employee is required to hold different knowledge and capability as follows:

- Theoretical knowledge and professional techniques
- Knowledge in physical implementation
- Administrative knowledge
- Working organization
- Employee management
- Achievement and working quality
- Activity and faithfulness
- Sanitation-Security
- Strictness and Authority
- Disciplinary Spirit
- Relationship and Unity
- Initiatives in taking corrective actions

PAS's organization is well arranged for a public organization. However, when the organization is evaluated from the viewpoint of a private institution, it has the following issues:

- Lack of aggressiveness in enhancing competitiveness
- Lack of aggressiveness in providing better services to customers
- Lack of aggressiveness in training all staff toward better service to people in Cambodia

4) Financial position

Although PAS is a government organization, as an independent and enterprise organization, it keeps its own independent financial statements. The recent performance of PAS is summarized in the tables below.

Table 4.3-1 Profit & Loss Account

(unit: Million Riel)

FY	2002	2003	2004	2005	2006	2007
Operating Income	77,426 (100)	84,039 (100)	88,485 (100)	83,894 (100)	95,976 (100)	101,999 (100)
Operating Expense	51,552 (67)	58,923 (70)	75,259 (85)	78,815 (94)	84,075 (88)	84,133 (82)
Net Operating Income	25,874 (33)	25,116 (30)	13,225 (15)	5,079 (6)	11,901 (12)	17,866 (18)
Net Income Before Tax	26,202	24,329	13,678	4,363	9,833	13,122
Net Income After Tax	20,961	19,463	10,942	3,490	7,866	10,497

Source: PAS

Table 4.3-2 Balance Sheet

(Unit: Million Riel)

FY	2002	2003	2004	2005	2006	2007
Assets	452,515	467,972	466,341	465,155	467,667	473,523
(Current)	(43,176)	(60,499)	(64,925)	(65,418)	(79,476)	(78,227)
(Fixed)	(409,339)	(407,472)	(402,046)	(399,736)	(388,191)	(395,296)
Liability & Equity	452,515	467,972	466,341	465,155	467,667	473,523
(Current Liability)	(2,421)	(987)	(3,417)	(1,132)	(2,599)	(3,011)
(Provision)	(495)	(499)	(2,050)	(2,792)	(3,493)	(4,256)
(Capital)	(449,599)	(466,486)	(460,872)	(461,231)	(461,574)	(466,255)

Source: PAS

In terms of "Net Income before Tax", PAS records a profit every year; however, it shows a declining trend. "Operating Income" shows an increasing trend almost every year, but due to the large increase in "Operating Expense", especially the increase in "Purchase and Personnel expenses", the "Net Operating Income" shows a declining trend.

Since PAS is a capital-intensive organization, the balance sheet is unique. Capital accounts have a share of 98% and the debt portion is negligibly small. For assets, fixed assets hold around 83% of total assets, while liquid assets account for 17%. There is some room for getting funds for further capital expenditure, but when PAS needs a large amount of capital investment, it has to raise the funds through an increase in capital account or new borrowings from financial institutions.

5) Summary of the pre-capacity assessment of PAS

Areas	Evaluation (Positive)	Evaluation (Negative)
1. Organization (1) Structure	Simple and well organized	The following needs to be improved: - Too many sections. Consolidation will be necessary and possible - Too much horizontal organization
(2) Human resource allocation	Allocation to competitive areas	More human resource allocation to Business development sector
2. Communication	Communication within each Dept. seems good	Communications between departments seems to be insufficient. The same issue is seen in communications between top management and each department.
3. Financial position		Data on financial position are not satisfactory Financial data by main department is necessary The disclosure is not timely
4. Human resource (1) Quality	Seems to be favorable Large potential	Seems to be underutilized
(2) Development	Positive attitude for human resources development by managers Positive attitude for training of subordinates by managers	
5. Business strategy	Some top managers seriously consider	Seems to be unclear Some top managers hold their own strategies, but do not share with other top managers Seems not to be discussed

(2) Port promotion

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	Main issues to be addressed by the port include: - Public relations - Inducement of ships - Inducement of cargoes - Inducement of SEZ tenants
	Related aid activities	There has been no aid activities specific to port promotion
	Issues of the field, indicators	Existing or potential issues: [Public relations] - Press releases - Inducement of media coverage - Advertisements - Web site - Publication of promotional materials [Inducement of ships] - Marketing - Canvassing toward main line shipping companies - Canvassing toward feeder shipping companies [Inducement of cargoes] - Marketing - Canvassing toward domestic industries - Canvassing toward the industries overseas [Inducement of SEZ tenants] - Marketing - Canvassing toward domestic industries - Canvassing toward the industries oversea
Policies and legal system	System of policies and laws, availability of public funds	Not applicable
	Capabilities for drafting financial policies	Not available
Society	Public, society	Not applicable
	Private sector	[Cambodia] - Cambodia Chamber of Commerce - Garment Manufacturers Association in Cambodia (GMAC) [Overseas]

Domain	Item	Assessment
		- Shipping associations in various countries
Organization	Quantitative allocation for and capabilities of human resources	Marketing Department is responsible for port promotion. 6 personnel is currently assigned.
	Finances	Not available
	Physical and intellectual resources (techniques)	[Currently available resources] - Web site of PAS - Publications on regular basis (annual reports, brochures) - Assistance by JICA experts for SEZ promotion [Necessary additional resource] Hard component: - Nothing particular Soft component: - Policy of public relations - Policy of advertisement - Policy of ship inducement - Policy of cargo inducement
	Project process and project implementation capabilities	Most of existing manpower of the Marketing Department seems to be used only for the promotion of SEZ or nominal public relations activities, scarcely for the inducement activities of ships and cargoes.
	Organizational quality	Though the staff members seem to have potential abilities, the knowledge has not been accumulated in the organization.
Education and research status in related sectors	Status of occupational training, higher education, and research activities	Not applicable

(3) Asset management and spatial management

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	According to PAS's balance sheet, total fixed assets of PAS are around 100 million USD. Since PAS is not a port authority, PAS doesn't have power to manage spatial resources of port beyond its property. The total land area is 125 hectares.
	Related aid	There have been no aid activities specific to asset management

Domain	Item	Assessment
	activities	or spatial management of PAS.
	Issues of the field, indicators	Disorderly use of land and basin in the vicinity of the port Unlawful occupation of PAS's land by local residents
Policies and legal system	System of policies and laws, availability of public funds	RGC plans to establish the Port Act which prescribes spatial management of port area.
	Capabilities for drafting financial policies	Not applicable
Society	Public, society	Public awareness on the importance of harmonized spatial utilization of port areas is not sufficient.
	Private sector	Private sector's awareness on the importance of harmonized spatial utilization of port areas is not sufficient.
Organization	Quantitative allocation for and capabilities of human resources	There is no specific department within PAS that is responsible for spatial management of the port area. Administration office which consists of 88 staff members is in charge of the asset management.
	Finances	Not applicable
	Physical and intellectual resources (techniques)	Not applicable
	Project process and project implementation capabilities	Not applicable
	Organizational quality	Not applicable
Education and research status in related sectors	Status of occupational training, higher education, and research activities	Not applicable

(4) Port planning

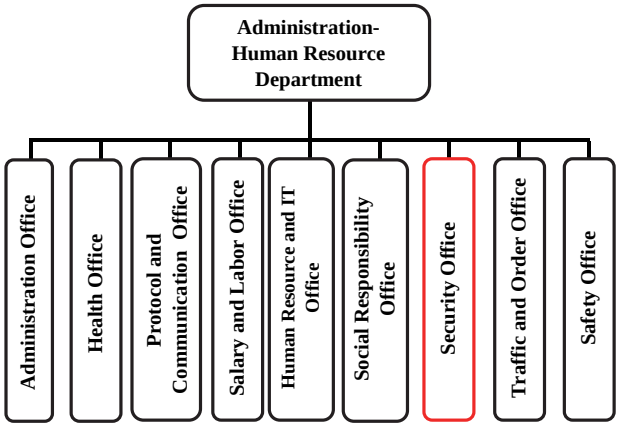
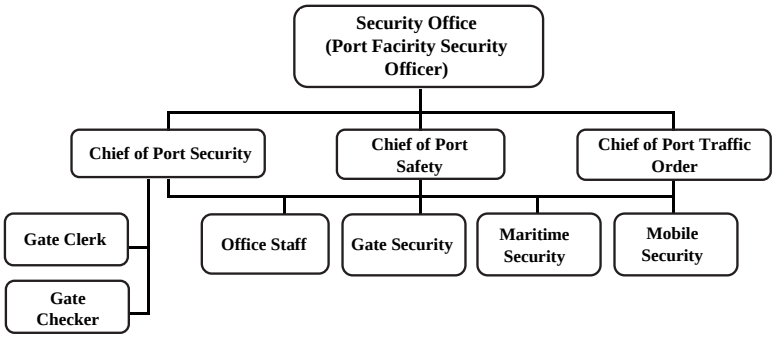
Domain	Item	Assessment
General	Basic information,	The spatial extent of which port planning is under PAS's

Domain	Item	Assessment
(basic) items	characteristics of the field in question	responsibility is not clearly defined.
	Related aid activities	Japan, Singapore and European countries have carried out training for port planning.
	Issues of the field, indicators	The port master plan formulated in 1997 has not been updated to cope with emerging demands such as railway access to the port.
Policies and legal system	System of policies and laws, availability of public funds	RGC plans to establish the Port Act which prescribes function of port plan and procedures for its establishment.
	Capabilities for drafting financial policies	Not applicable
Society	Public, society	Public awareness on the importance of harmonized spatial utilization of port areas based on the port plan is not sufficient.
	Private sector	Private sector's awareness on the importance of harmonized spatial utilization of port areas based on the port plan is not sufficient.
Organization	Quantitative allocation for and capabilities of human resources	There is no specific department within PAS that is responsible for port plan. The main activity of the Planning Department is yearly or shorter-term planning of port management.
	Finances	Not applicable
	Physical and intellectual resources (techniques)	Not applicable
	Project process and project implementation capabilities	Not applicable
	Organizational quality	Not applicable
Education and research status in related sectors	Status of occupational training, higher education, and research activities	Not applicable

(5) Port security

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	PAS applied the ISPS code and port security has been carried out according to the PFSP (Port Facility Security Plan) drawn up mainly by PFSO (Port Facility Security Officer) of the security office. MPWT (Ministry of Public Works and Transport) approved the PFSP of PAS in 2006 and then it came into effect. First edition is planned to be released by 2012. Security office (total staff of 77 persons) has been conducting gate control at four (4) gates as well as port security control as a whole. The various works implemented by several sections are described as follows: Gate clerk, Gate clerk examines the export declaration brought by the driver. If the document is in order, truck goes to the booth where the officers of customs, Camcontrol and immigration police follow the prescribed procedure. After the driver pays container handling charge of PAS, the truck enters the container yard through the gate. Gate clerk inputs the data of container number and related information in a computer at the gate booth. Gate checker, Gate checker inspects external container condition by visual inspection. He enters comments on EIO when damages of container are detected such as tiny holes, dents and so on. Gate security, Gate control at the gate No.1, No.2, No.3 and administration building is conducted by gate security. Office staff, They monitor port activities through a surveillance camera system and identify potential security threats. They are also responsible for ID pass control and implementation of training. Maritime security, They patrol the sea area inner harbor by patrol boat. Mobile security, They patrol the port land area and maintain traffic signs.
	Related aid activities	Japan's grant aid in 2007 was used to set up the port facility security plan, which included the installation of vessel traffic management system (VTMS) and X-ray inspection system, CCTV camera and ID pass control system.
	Issues of the field, indicators	When the ID pass control system was installed at the gate at 2007, PAS issued ID cards to PAS personnel, public officers and agents related to port activities. However, this system was discontinued. CCTV camera system is now being installed. X ray inspection system is now operational following a 2-year period when it was

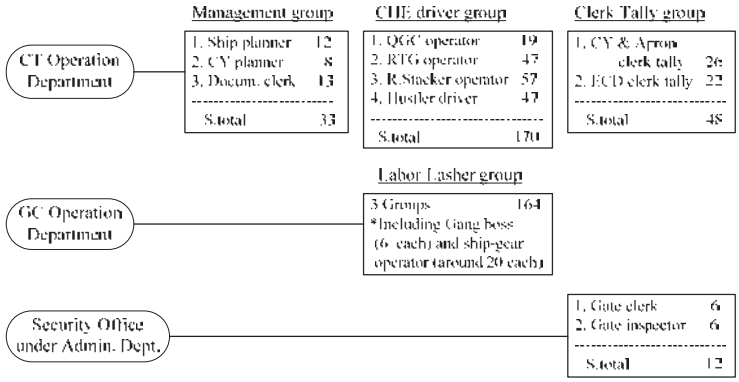
Domain	Item	Assessment
		out of commission.
Policies and legal system	System of policies and laws, availability of public funds	Declaration on Port Facility Security of the KINGDOM of Cambodia and Sub-decree on Vessel Security and Port Facility Security are the relevant laws. ISPS code was applied in 2004.
	Capabilities for drafting financial policies	Security office doesn't have its own budget. Administration-Human Resource Department administers the budget as a whole.
Society	Public, society	Female and handicapped personnel don't work in the security office.
	Private sector	Not applicable
Organization	Quantitative allocation for and capabilities of human resources	Port security is the responsibility of the directorate of Administration- Human Resource Department (AHRD), which is comprised of nine (9) offices (See Figure 4.3-1). Among them, security office headed by PFSO (Port Facility Security Officer) concurrently as the deputy directorate of AHRD directly manages port security. Port security office comprises three (3) chiefs and six (6) sections under chiefs with a total staff of seventy-seven (77) persons. Each chief and sections with numbers of staff are listed below: 1) Deputy director (Port Facility Security Officer) (1 person) 2) Chief of Port Security (1 person) 2) Chief of Port Safety (1 person) 3) Chief of Port Traffic Order (1 person) a) Gate Clerk (8 persons) b) Gate Checker (6 persons) c) Office Staff (4 persons) d) Gate Security (36 persons) e) Maritime Security (4 persons) f) Mobile Security (15 persons) Working hours are divided into three (3) shifts: 6:00am-12:00am, 12:00am-18:00pm and 18:00pm-6:00am. Ninety-five percent of the jobs are technical while 5 % are administrative. The practice of periodically transferring personnel within the security office for acquiring new skills has not been adopted. When a vacancy occurs, officer can be supplied from within the security office. The functions of security office are 1) gate operation, 2) surveillance monitoring, 3) patrol of sea area by boat, 4) patrol of inside of the port and maintain a traffic-control sign.

Domain	Item	Assessment
		 **Figure 4.3-1 Organization structure of Administration-Human Resource Department**  **Figure 4.3-2 Organization Structure of Security Office** Drills and exercises are conducted at least once every three months according to the ISPS code.
	Finances	Security office doesn't have a budget.
	Physical and intellectual resources (techniques)	Monitor of Surveillance system and server of ID pass control system are operated and maintained by the security office staff in an air-conditioned room. The picture of surveillance system is saved by hardware equipped in the same operation room.
	Project process and project implementation capabilities	There is a lack of cooperation in documentation works with customs, Camcontrol and immigration police at the gate for export and import of containers.
	Organizational quality	Efforts to enhance the capability of staff are being done by training.
Education and research status in related	Status of occupational training, higher education, and	The staff is educated by training.

Domain	Item	Assessment
sectors	research activities	

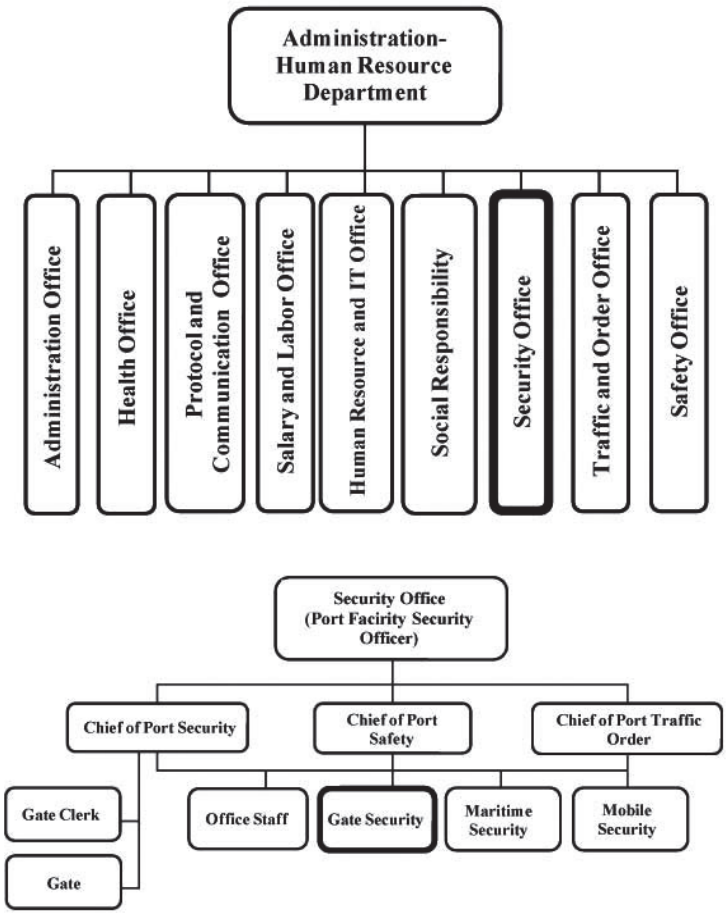
(6) Container operation

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	Container Terminal Operation Department (280 persons) is responsible for the container operation management. General Cargo Operation Department is also responsible for the container operation by supplying stevedoring labors (164 persons).
	Related aid activities	JICA has continuously assisted to the improvement of container operation.
	Issues of the field, indicators	Installation of CTMS devices for covering ECD area. Productivity of Ship operation (target is 25 lifts/GC or 2SG/hour) in net and CY-gate operation (target is 15 minutes as turn-time; from gate-in to gate-out; for external trucks).
Policies and legal system	System of policies and laws, availability of public funds	Not applicable
	Capabilities for drafting financial policies	Not applicable
Society	Public, society	Not applicable
	Private sector	Not applicable
Organization	Quantitative allocation for and capabilities of human resources	An organization chart related to container operation is shown in Figure 4.3.3. Container Operation Department (7 persons as managers) is composed of General Affairs Office (20 persons), Data Office (15 persons), Container Terminal Planning Office (68 persons) and Operation Office (170 persons, including 19 QGC operators, 47 RTG operators and 57 Reach Stacker drivers). Stevedore management office in General Cargo Handling Operation Department (4 persons in charge) is composed of three (3) Stevedore Groups (52, 57 and 55 persons each, including 6 foremen/gang-bosses and around 20 ship-gear operators in each group.

Domain	Item	Assessment
		 **Figure 4.3-3 Organization related to Container Operation**
	Finances	Not applicable (Handled by Billing Department; though the base data are prepared by Container Terminal Operation Department.)
	Physical and intellectual resources (techniques)	QGC, RTG, Reach Stacker, Hustler Truck and Chassis. Two (2) more units of RTG are required for handling the upsurge of containers on Saturdays at present. Container Terminal Management System (CTMS) is available.
	Project process and project implementation capabilities	Poor, due to 1) ineffective leadership of managers in the CT Ops Department, 2) cooperation between other operational departments is inadequate, and 3) knowledge and skills of management staff are not sufficient.
	Organizational quality	PAS has more than 20 years of experience in container operation. However, PAS has only 3 years of experience using a modern container handling system and equipment such as CTMS, QGC and RTG. Ship and CY-Gate operations are executed without clear concepts or procedures among related operation departments.
Education and research status in related sectors	Status of occupational training, higher education, and research activities	Skills of container handling equipment (CHE) operators such as QGC and RTG is maintained and enhanced through internal training. Skills of Ship and CY planners are also enhanced through training from JICA experts; however, more training is required. More OTJ training is required for planners.

(7) Surface traffic control

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	PAS has jurisdiction over the gate approach road (length of 280 m), which connects the gate and the public road (Phe Street), and is responsible for controlling traffic there. The measures needed to control traffic in front of the gate are the following: 1) set barricades at the entrance of the approach road, and restrain trucks from accessing the gate on Saturdays; and 2) set barricades in front of the gate in order to keep the u-turn space for trucks without required documents.
	Related aid activities	N/A
	Issues in the field, indicators	Heavy traffic congestion during weekends is a big issue for PAS, freight forwarders, and citizens. Effective measures have not yet been implemented.
Policies and legal system	System of policies and laws, availability of public funds	N/A
	Capabilities for drafting financial policies	N/A
Society	Public, society	Heavy traffic congestion of container trucks has retarded the general traffic flow of vehicles. In order to avoid long queues of trucks on the public road (Phe Street), the police have implemented traffic control.
	Private sector	N/A

Domain	Item	Assessment
Organization	Quantitative allocation for and capabilities of human resources	Twelve gate operations personnel under the Gate Security Section are secondarily in charge of traffic control as mentioned above. Their main job is gate operations. The organizational charts are shown below. 
	Finances	N/A
	Physical and intellectual resources (techniques)	N/A
	Project process and project implementation capabilities	It seems that communications with the police is insufficient.
	Organizational quality	N/A
Education and research status in	Status of occupational training, higher	Training and education on traffic control have not yet been implemented.

Domain	Item	Assessment
related sectors	education, and research activities	

(8) Maritime traffic management

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	Harbor Master Department (84 persons) is responsible for the maritime traffic management. All foreign ships calling or leaving Sihanoukville Port are subject to compulsory pilotage.
	Related aid activities	Not applicable
	Issues of the field, indicators	Installation and maintenance of navigational aids such as buoys, lighthouse and leading lights. Proper maintenance of 5 tugs boats (42, 36, 23 and 11 years old), a pilot boat (33 years old) and a mooring boat (11 years old).
Policies and legal system	System of policies and laws, availability of public funds	Policy targets related to this field are set in the implementation plan of MPWT under NSDP as below; "Implementation of international treaties in respect of the maritime transport and port sector", "Establishment and implementation of a Waterways Master Plan", "Enactment of port related acts" and "Securing of ship and port security and safety" Maritime Code applicable to all ports in Cambodia are not prepared yet. A marine safety regulation of Sihanoukville Port come into force in 1983 and was revised in 1986. This regulation is outdated and does not match to the current social circumstance.
	Capabilities for drafting financial policies	Not applicable
Society	Public, society	A part of the water area protected by breakwaters is occupied by the fisherman. Approx. 1,000 persons have settled illegally along a part of the coast within the port boundary. The occupation is permitted silently and has becomes a vested right.
	Private sector	Not applicable
Organization	Quantitative allocation for and capabilities of	Harbor Master Department (3 persons) is composed of Harbor Master Office (41 persons), Pilot Office (21 persons) and

	human resources	Harbor Means Office (20 persons). Improvement plan of the navigational aids can hardly be realized due to the budget constraint
	Finances	Revenue from pilot due, tonnage due, mooring, berthing, garbage disposal, sludge treatment, water supply, anchoring and channel as well as the use of tug boats.
	Physical and intellectual resources (techniques)	Pilot boat and tug boats are too old to repair. Vessel Traffic Management System(VTMS),Auto Identification System(AIS) and radar are available
	Project process and project implementation capabilities	Skills of staff is maintained and enhanced through trainings.
	Organizational quality	Job is performed without particular problems.
Education and research status in related sectors	Status of occupational training, higher education, and research activities	Skills of staff are maintained and enhanced through trainings.

(9) SEZ operation

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	70 ha of land was developed as Sihanoukville Port SEZ by PAS. SEZ operation is directly carried out by PAS.
	Related aid activities	Japan has been carrying out financial and technical assistance for development and operation of the Port SEZ.
	Issues of the field, indicators	To attract appropriate investors to the Port SEZ, and to achieve synergy effect of port and SEZ. To introduce the most efficient and economical logistics system linking the port and the SEZ.
Policies and legal system	System of policies and laws, availability of public funds	Legal framework for SEZs has been established.

Domain	Item	Assessment
	Capabilities for drafting financial policies	Not applicable
Society	Public, society	Not applicable
	Private sector	Investors have interests in Cambodian SEZs in general due to the low cost of land and labor force. However PAS has not succeeded in attracting interests of investors in the Port SEZ due to its slightly higher land price.
Organization	Quantitative allocation for and capabilities of human resources	Marketing and SEZ Department is in charge of SEZ management and operation.
	Finances	Besides the budget prepared in the course of JICA project, PAS's budget for promoting the SEZ is very limited.
	Physical and intellectual resources (techniques)	Not applicable
	Project process and project implementation capabilities	Not applicable
	Organizational quality	The quality of the organization is being improved by the assistance of a JICA advisor.
Education and research status in related sectors	Status of occupational training, higher education, and research activities	Not applicable

(10) Environmental management

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	Main pollution sources of the port include: - Ships (container ships, bulk carriers, cruise ships, general cargo ships) - Stockyard of bulk commodities (coal, wood chip) - Bulk berth - Maintenance workshop - Cargo trucks

Domain	Item	Assessment
	Related aid activities	There has been no aid activities specific to environmental management
	Issues of the field, indicators	Existing or potential pollution issues: [Ships] - Water pollution through discharge of ship wastewater (e.g. bilge water) - Accidental oil spill - Transportation of invasive species through ballast water - Maritime accident (e.g. collision with fishing vessels) [Stockyard] - Fugitive dust emission from bulk commodities (e.g. wood chip, coal) - Fire hazard (e.g. wood chip, coal) [Bulk berth] - Water pollution through spillage and rainwater runoff [Maintenance workshop] - Oil pollution through inadequate waste management [Cargo trucks] - Air pollution through exhaust emission - Noise pollution through noise emission
Policies and legal system	System of policies and laws, availability of public funds	Relevant international conventions: - International Convention for the Control and Management of Ships Ballast Water & Sediments - International Convention for the Prevention of Pollution from Ships (MARPOL) Relevant national laws/regulations: - Law on Environmental Protection and Natural Resource Management - Sub-decree on Air Pollution Control and Noise (2000) - Sub-decree on Water Pollution Control (1999) - Sub-decree on Solid Waste Management (1999) Port regulations: - Currently there are no port regulations related to environment
	Capabilities for drafting financial policies	Not applicable
Society	Public, society	Not applicable
	Private sector	Not applicable

Domain	Item	Assessment
Organization	Quantitative allocation for and capabilities of human resources	There is no specific department within PAS that is responsible for environmental management. Currently the Port has a sanitary section and oil spill response team. The sanitary section is responsible for clean-up and waste collection works, which consists of 51 personnel.
	Finances	Not applicable
	Physical and intellectual resources (techniques)	[Currently available resources] - Waste bins for collecting solid wastes such as plastics, wood chip, bottles, tins, papers etc. The wastes are collected by a private company (CINTRY Co., Ltd.) and are disposed at the city's waste disposal area. - Waste oil treatment facility - Oil spill response equipments [Necessary additional resource] Hard component: - Waste oil reception/treatment facility for ships - Dust suppression system at stockyard - Fire extinguishing system at stockyard - Temperature monitoring system at stockyard - Sedimentation pond at bulk berth - Air and noise monitoring system Soft component: - Rules for wood chip and coal storage - Rules for ship wastewater and ballast water discharge
	Project process and project implementation capabilities	Not applicable
	Organizational quality	Not applicable
Education and research status in related sectors	Status of occupational training, higher education, and research activities	Not applicable

(11) Information technology

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	"Human Resources and IT Office" under "Administration-Human Resource Department" is responsible for IT relevant job in PAS.
	Related aid activities	Not applicable
	Issues of the field, indicators	No comprehensive computer system is available for PAS's business fields. CTMS computer and printers sometimes down on Saturday operations due mainly to over load when containers to be processed are heavily concentrated. It is needed to encounter this problem. The recovery work of shutdown computer system is conducted by the staff of "Data Office" under "Container Operation Department" but "Human Resource and IT Office". Coordination work among two offices to encounter the shutdown computer is not well performed.
Policies and legal system	System of policies and laws, availability of public funds	Policy target related to this field is set in the implementation plan of MPWT under NSDP as "Development and application of state-of-art technology" Integration of SWS (Single Window System) and CTMS (Container Terminal Management System) is conducted by NIDA (a government agency responsible for IT technology).
	Capabilities for drafting financial policies	Not applicable
Society	Public, society	Not applicable
	Private sector	CTMS has been developed by a private company (Mitsui ship Building). The company responds to the request of system recovery from PAS in case of the system failure. Their response could not be expected much beyond its responsibility.
Organization	Quantitative allocation for and capabilities of human resources	"Human Resources and IT Office" (12 persons) with 4 computer system engineers and 4 IT specialists works under "Administration-Human Resource Department" (3 persons)
	Finances	Provision of PAS's budget is a source of finance. However, the budget is not enough to respond to such a request as the capacity increase of printers.

	Physical and intellectual resources (techniques)	The computer and severs are installed and maintained in an air conditioned room. An Uninterruptible Power Supply (UPS) is prepared for electricity cut down.
	Project process and project implementation capabilities	Cooperative work with NIDA functions well and has no problem in an integration of SWS and CTMS. Cooperative work with "Container Operation Department" is required for the operation of the integrated system of SWS and CTMS. The management is not informed about occasional shut-downs of the computer and printers which occur during busy times on Saturdays.
	Organizational quality	Efforts to enhance the capability of staff are being made by training.
Education and research status in related sectors	Status of occupational training, higher education, and research activities	The staff is educated by training.

(12) Maintenance of facilities and equipment

Domain	Item	Assessment
General (basic) items	Basic information, characteristics of the field in question	Technical Materials-Construction Department (TMCD) (total staff of 155 persons) is responsible for the maintenance of port facilities and cargo handling equipment as well as port construction. Furthermore, TMCD covers a wide range of matters related to technical aspects and construction. Details of the TMCD's duties are described below: -Introduces technical specifications and guide for usage of all equipment of cargo handling, transport and construction of PAS and monitors compliance in terms of maintenance and repair. -Conducts studies on technical aspect of all mechanical and electrical equipment as well as fuel, spare parts and construction materials. -Procures and stores spare parts, technical materials, fuel and other construction materials for maintenance and repair purposes as well as port facility development. -Carries out the maintenance and repair works of all equipment including tug boats. -Estimates the cost for maintenance and repair for those equipment including construction & development projects in the port. -Annual planning of budget with consideration on demand of spare parts and technical and electrical materials, and fuel for construction and development projects.

Domain	Item	Assessment
		Machinery department (MD) (total staff of 8 persons) is also responsible for maintenance of cargo handling equipment but it is indirect management. MD mainly does the documentation for the check list of periodical maintenance, statistics of working hours /downtime for maintenance. Tasks of MD are as follows: -Manages and takes care of all Cargo Handling Equipment: 1) Forklift, Mobile Crane, RTG (Rubber Tired Gantry Crane), Quayside Crane (QC), Shore Crane, Mobile Harbor Crane 2) Spreader, etc -Compiles all technical instructions for using, maintaining and repairing Cargo Handling Equipment. -Sets up training for all operators/drivers in learning how to use and maintain all Cargo Handling Equipment. -Daily routine inspection to ensure all equipment is properly used. -Follows up and inspects all Cargo Handling Equipment to be repaired. -Sets up planning for repair of all cargo handling equipment. -Sets up other training as necessary. -Takes part in other planning when assigned by top management.
	Related aid activities	Not applicable
	Issues of the field, indicators	The old jetty should be as used for as long as possible. Maintenance of cargo handling equipment will be carried out properly.
Policies and legal system	System of policies and laws, availability of public funds	Not applicable
	Capabilities for drafting financial policies	The maintenance budget was 1.5 Million USD for 2010 and around 1.65 Million USD in 2011. Machinery department doesn't have its own budget.
Society	Public, society	Not applicable
	Private sector	TMCD basically can manage maintenance of cargo handling equipment and port facilities by themselves. However, for difficult cases, PAS invites foreign experts (e.g. from Singapore, Thailand or others) or original vender to deal with such specific issues.
Organization	Quantitative allocation for and capabilities of human resources	Technical material-construction department (TMCD) has two (2) offices and eight (8) sections directly controlled by the deputy director. Four (4) sections (total staff of 37 persons) of Storage of tech-materials and spare parts, Workshop, Procurement of tech-materials & spare parts and Equipment materials are responsible for maintenance of cargo handling equipment. On the other hand, construction office (total staff of 16 persons) is responsible for maintenance of port facilities (See Figure 4.3-4).

Domain	Item	Assessment
		Machinery department is divided into three (3) chiefs under the deputy director and total staff is eight (8)(See Figure 4.3-5).

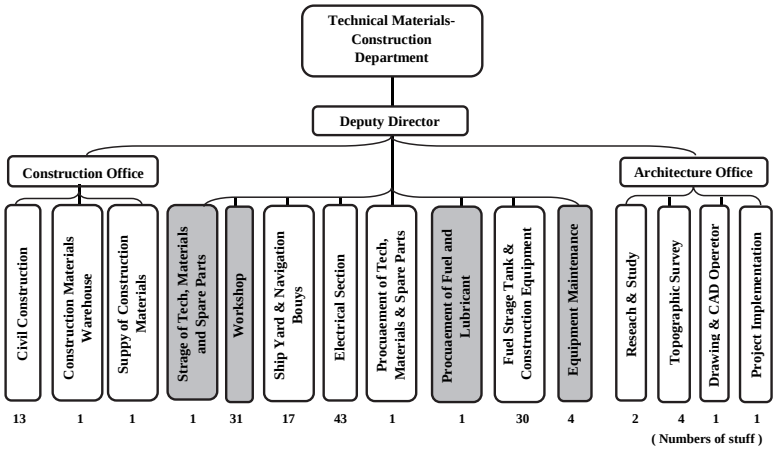


Figure 4.3-4 Organization Structure of Technical Material-Construction Department

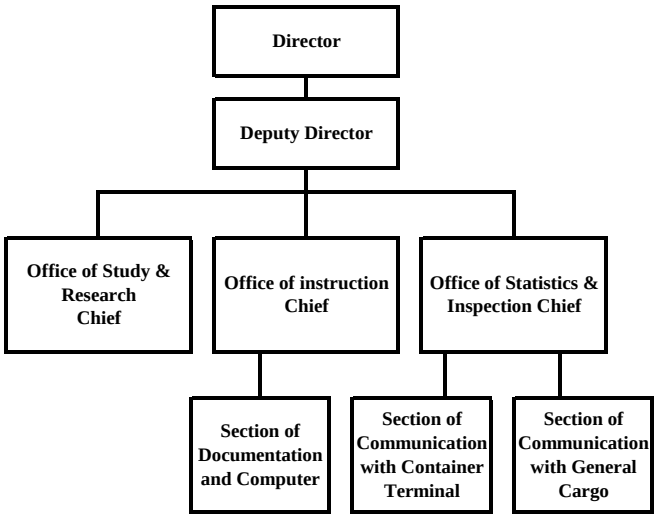


Figure 4.3-5 Organization Structure of Machinery Department

		PAS encourages staff to undergo training both inside and outside of the country. Skill of staff is maintained and enhanced through training.
	Finances	Not applicable
	Physical and intellectual resources (techniques)	All cargo handling equipment has its own technical record book. The conducted maintenance and repair works are recorded in these books. Construction office has a prescribed data filing system for comparing between before and after repair works with photos.
	Project process and project	Skills of staff are maintained and enhanced through TMCD's

Domain	Item	Assessment
	implementation capabilities	training system.
	Organizational Quality	Job is performed without particular problem except in case of outsourcing when equipment cannot be performed internally.
Education and research status in related sectors	Status of occupational training, higher education, and research activities	There is no training institute or research institute for maintenance in PAS.

4.3.2 Post capacity assessment

(1) Enabling environment in the target year

The Enabling Environment in the target year is shown in the business environment analysis in the formulation of PAS's vision discussed in Chapter 3.

(2) Required capacity for the service improvement

Major targets for the improvement of PAS's service are as below;

- To reduce the time needed for lifting-on and lifting-off containers
- To reduce ship berthing time
- Rationalize port related charges
- Conducting safe port management and operation
- Enabling document processing by using EDI
- Strengthening the shipping network

PAS personnel need to have the capacity to accomplish the targets mentioned above. The capacity is composed of the physical capacity and the human capacity. Further, the physical capacity can be divided into civil facilities and mechanical facilities. The human capacity contains two aspects, namely, quantitative and qualitative.

PAS personnel should have the physical and human capacities as shown in Table 4.3-1 in order to accomplish the targets.

Table 4.3-3 Required Capacity for the Service Improvement of PAS

Service to be improved		Required Capacity	
Target	Method	Physical Capacity	Human Capacity
1. To reduce the time needed for lifting-on and lifting-off containers	1. To streamline the entry of export container trucks and lift-off of the containers in the terminal	1. Construction of new gates for customs clearance processing before the PAS gates 2. Construction of parking lots for export container trucks around the terminal 3. Preparation of parking space at the roadsides of Phe Street or elsewhere	1. Ability to control traffic and entry and exit of trucks before the terminal gates 2. Capacity of PAS gate clerks to conduct entry processing 3. Appropriate use of CTMS 4. Competent yard planners 5. Ability to operate cargo

		4. Expansion of the provision of container handling equipment such as RTGs and reach stackers	handling equipment 6. Ability to properly maintain cargo handling equipment
	2. To prepare parking area for trucks waiting for receiving import containers	1. Construction of parking lots outside and near the terminal or inside the port area for bare chassis trucks	1. Ability to control traffic for the entry and exit of the parking lots for bare chassis trucks
	3. To receive import containers immediately after lifting-off of export containers and to depart from the terminal	1. Expansion of the provision of container handling equipment such as RTG and reach stacker 2. Construction of parking lots in the port area for trucks waiting for the scanning and customs clearance before exit	1. Ability to conduct import clearance document processing of customs and Kamsab 2. Ability to properly maintain cargo handling equipment*
2. To reduce ship berthing time	1. To hasten container handling operation	1. Expansion of the provision of container handling equipment such as QGCs and RTGs	1. Ability to conduct yard planning management 2. Ability to operate cargo handling equipment* 3. Ability to properly maintain cargo handling equipment* 4. Ability to manage cargo handling operation labor 5. Ability of cargo handling operation labor
3. Rationalize port related charges	1. To reduce port tariff corresponding to the increase of cargo handling volume	Not required	1. Ability to analyze tariff and tariff structures of neighboring ports
	2. To simplify and rationalize the port tariff	Not required	1. Ability to analyze tariff and tariff structures and formulation of possible tariff revision
	3. To eliminate the collection of informal charges	Not required	1. Observance of the work discipline 2. Ability of organization management
4. Conducting safe port management and operation	1. To properly manage port entry and exit	1. Installation of fences surrounding the container terminal	1. Ability to control and streamline traffic at the port and maintain port safety
	2. To install proper navigation aids	1. Renewal of aged tug boats 2. Installation of navigation aids such as leading lights and buoys	1. Ability to properly maintain port vessels including tug boats 2. Capable pilots
5. Enabling document	1. To conduct electrified port	1. Introduction of an IT system	1. Ability to introduce and operate EDI system

processing by using EDI	call and departure document processing		
	2. To promote information exchanges among customs, the harbor master and Camcontrol	1. Introduction of an integrated port information system including data related to import/export, port entry and exit, Camcontrol and customs	1. Ability to introduce and operate a port information system
6. Strengthening the shipping network	1. To promote marketing for the opening of new shipping routes	Not required	1. Ability to grasp and analyze world-wide maritime transport trend and formulate a new business plan 2. Marketing ability for shipping business

Prepared by Project Team

(3) Required capacity for managerial and financial improvement

Organizational reform is crucial to PAS's managerial and financial improvement. Reviews of management strategy, financial operation, personnel administration and labor force management play a key role in effective management of PAS. Management of PAS shall tackle the following requirements and develop the capacity of staff members who shall cope with these issues.

- To increase the sales of PAS;
- To meet requirements of port users;
- To eliminate non-tariff charges (speedup money) at port;
- To reduce operating cost;
- To reduce administration cost (non-operation cost);
- To increase Net Profit Margin;
- To ensure payment of dividends;
- To rationalize investment in port development;
- To assess cost and revenue of each service (department);
- To monitor performance of management and introduce incentives for improvement; and
- To introduce a risk management system.

Related to the management of private companies including state owned enterprises, the following strategies shall be prepared in view of promotion of their business and self-supporting management. Skillful human resources shall be assigned to such tasks and take charge of implementing these strategies.

- Growth of company activities;
- Diversifying business operations;
- Withdrawal from unprofitable business;
- Cooperation with other companies;
- Pricing strategy;
- Marketing strategy;
- Organizational reform plan (Shareholding company, Affiliated company, Autonomous divisions in PAS);
- Personnel management;
- Financial management strategy; and
- Utilizing information technology.

1) Business maneuver

PAS's mission is to develop and operate an international port (Sihanoukville Port) as a state owned company. The port is important for the country's economic development and international trade. The mission does not include profit making as a private enterprise however it will become an important issue once PAS changes to a joint stock company owned by shareholders.

As a joint stock company, PAS is required to increase sales through handling more cargo, reduce operation cost which is comparatively higher than neighboring ports, and also reduce non operating cost such as fuel grants to port workers.

In addition to the abovementioned mission, PAS will be required to increase Net Profit Margin as a joint stock company and pay dividends to shareholders. It is therefore important to develop capacity for making business strategy maneuvers and business implementation plans. It is also critical to develop capacity to tackle any obstacles to business maneuvers and to finding solutions for business promotion.

2) Financial management

As shown in section 4.2.1 (Financial Situation of PAS), Return on Assets, Operating Profit Ratio and Net Profit Margin of PAS are comparatively lower than those of PPAP and PAT (Thailand). In order to improve this situation, it is essential to assess the cost and revenue of each activity and cut redundant expenditure. Activities which need separate accounting or analysis of cost and revenue are as follows:

- Operation of container terminal;
- Stevedoring and storage of general cargoes, Lease of yards;
- Calls of passenger ships;
- Operation of SEZ;
- Pilotage service;
- Tug boat service; and
- Maritime services for ships calling at private oil terminals.

Cost of fuel, personnel, maintenance and other operational work shall be assessed separately in accordance with the abovementioned activities. Revenues of the abovementioned activities shall also be assessed separately, and port dues and channel dues shall be divided into those categories, i.e. container cargo operation, general cargo operation, passenger shipcalls, and private terminal operation.

The planning department makes a budget plan every year, however, it is not based on strategic business maneuvering. PAS shall prepare cost revenue analysis of major activities and make a budget for strategic management of its business.

After PAS changes to a joint stock company, it is crucial to publicize financial statements and make a certain level of profit for shareholders. Necessary capacity for improving financial management shall include the following:

- Procurement of low interest loans and management of long-term debts;
- Management of financial resources to be borne by SEZ;
- Financial risk management of investment; and
- Revision of port tariff in accordance with business maneuvers.

3) Organizational reform

Establishment of PAS is stipulated by Sub-Decree No.50 (RGC) on Establishment of Sihanoukville Autonomous Port dated 17 July, 1998. Duties of PAS, location of headquarters, amount of capital, board of directors, employees, financial report and other necessary operational matters are decided by Articles of Sihanoukville Autonomous Port approved by Ministers of MPWT and MEF. PAS is a state owned company and follows provisions of the corporate law including payment of income tax and VAT. It is also stipulated in Article 24 that the Board of Directors shall exercise powers of general meeting of shareholders which are stipulated in the corporate law.

Internal departments of PAS are decided in "Job Description for each Department, 07 July 2003" decided by the Board of Directors. Job description of the container department, general cargo department and technical-material department were revised in 2009 after receiving official approval of Minister of Public Works and Transport.

The PAS's mobilization, demobilization, liquidation, or privatization may be decided by sub-decree of government in accordance with the recommendation of the Board of Directors (Articles 43 and 44). Since the Board of Directors are authorized to propose such organizational reform, PAS shall have capacity to study, plan and find solutions for improving efficiency of their services and organization.

In particular, service ports, which provide all kind of port services such as stevedoring, pilotage, tug boat service, terminal operation, development and maintenance of facilities, have changed to landlord ports or private ports in many countries. It is necessary for PAS to study future organizational reform of themselves. Issues on organizational reform are as follows:

- Establishment of efficient organization, rational size of staff;
- Provision of competitive port services by private companies;
- Reform from a state owned enterprise to a joint stock company

4) Personnel/ labor management

Personnel/labor management plays a key role in managerial improvement. Personnel Statute of Sihanoukville Autonomous Port, dated 04 April 2003, has provisions on personnel recruitment, job classes, wages, dismissal of employees and other personnel affairs. Basic wages and several benefits are decided by the Personnel Statue and applied to all employees. However, there is no mechanism to pay more for satisfactory work and less for unsatisfactory work. It is indispensable to introduce a wage assessment system by supervisors and give employees an incentive for good performance.

It is also important to simplify the command system to direct and supervise operational workers. Particularly, all operational workers for a container terminal shall be under one department, while they are presently under three departments and the present command system for their operation is not efficient. Major issues on personnel/labor management are as follows:

- Introduction of a wage assessment system by supervisors, simplification of allowances, abolition of outdated allowance;
- Prohibition on collection of tea money;
- Rational size of port staff at each department;
- Transparent recruitment and promotion of personnel;
- Proper management of employee work time;
- Introduction of other necessary regulations and incentives to better performance.

5) Capacity of individual person, organization, institution/society

Capacity of better business maneuvering has to be improved in three tiers, i.e. individual level, organization level and social/institutional system level. The necessary capacity for individual level is the ability to identify problems, find solutions and implement the necessary activities.

The necessary capacity for organization level is good leadership to achieve managerial improvement, appropriate personnel/labor management, and good governance based on organizational culture. PAS was originally established as a department of the Ministry of Transport and changed to a state owned company. As PAS will change to a joint stock company in the near future, the ability to manage a private company will become necessary for the organization.

The necessary capacity for institutional/social level management is proper implementation of laws and regulations. Cambodia has already established Laws on the Privatization of Public Enterprise and State's Assets, Anti-Corruption Law, Corporate Law and the like. However, implementation of these laws and regulations are not enough to support the activities of individual persons or organizations to achieve better port management and operation. For institutional/social improvement, it is critical to

promote transparency and accountability of business activities, government approval, supervision or regulation, and to encourage free and fair competition.

(4) Evaluation of capacity gap

1) Assessment of the gap

In order to grasp the size of the gap between the current capacity and the required capacity to carry out current work, interviews were carried out for around 80 top and middle management staff. Through the survey, their capacities were assessed. Time consumed for the work was around one hour for each staff member, though it varied by section and status.

2) Results of assessment

The results are summarized as follows.

（Administration staff）

- Density of work differs by Department and section within the Department. It differs among staff as well.
- Planning and research function seems to be weak.

(Port operation staff)

- Staffs directly engaged in port operation are well acquainted with knowledge and procedures. Although systems in the container terminal are computerized, due to breakdown, the system does not work smoothly resulting in a lack of competitiveness. Manuals are prepared for port operation and operation is carried out according to these manuals. However, a problem lies in cargo handling procedures that are not always done according to the manual. This brings about low productivity in port operations.
- Technical departments prepare the manual and their operation is done smoothly.

While communication between organizations is sufficient, communication within the organization is lacking. In this regard, the absence of teamwork poses a problem. For small matters, there are no serious problems; but for important matters, a serious problem arises because they should be dealt with under the full commitment of all staff under PAS. In this sense, improvement in communication is indispensable.

4.3.3 Filling capacity gap

(1) Organizational reform of PAS

Since privatization of public services started in the UK in the early 1980's, railways, telecommunications and ports have been transferred to or reorganized as private companies. The port management system has changed from one of service port, where the port authority provides all services, to tool port or landlord port where private companies provide cargo handling and other port services competitively.

Following these trends, ports in ASEAN also changed to tool ports or landlord ports. Firstly Malaysia encouraged port privatization in the 1990's. Singapore corporatized the Port of Singapore Authority in 1996 and established a port administration organization (MPA) as a department of the Ministry of Transport.

The Port Reform Toolkit[1] issued by the World Bank categorizes port management bodies (port authorities) into four types, i.e. service port, tool port, landlord port and fully privatized port.

1) Service port

A service port is under full public control regarding planning, regulation, development, and

[1] Port Reform Toolkit, Second Edition, The World Bank, 2007, Module 3 "Alternative Port Management Structures and Ownership"

operations. In this sense, a service port can be called an all-in-one type port or comprehensive type port.

Service ports are usually controlled by a competent ministry, and the chairman is a civil servant appointed by the competent ministry.

2) Tool port

A tool port is the type that the port authority owns, develops, and maintains the port infrastructure as well as the superstructure, such as quay cranes, forklift trucks, warehouses, sheds, and other cargo handling equipment.

Port authority staff usually operate all equipment owned by the port authority. Private companies are usually allowed to carry out other cargo handling on board as well as on the quay by contract with the shipping agents or other principals.

3) Landlord port

A landlord port is the port where the port authority acts as regulatory body and as landlord, and private companies usually provide the superstructure including cargo handling equipment and carry out port operations.

4) Private port

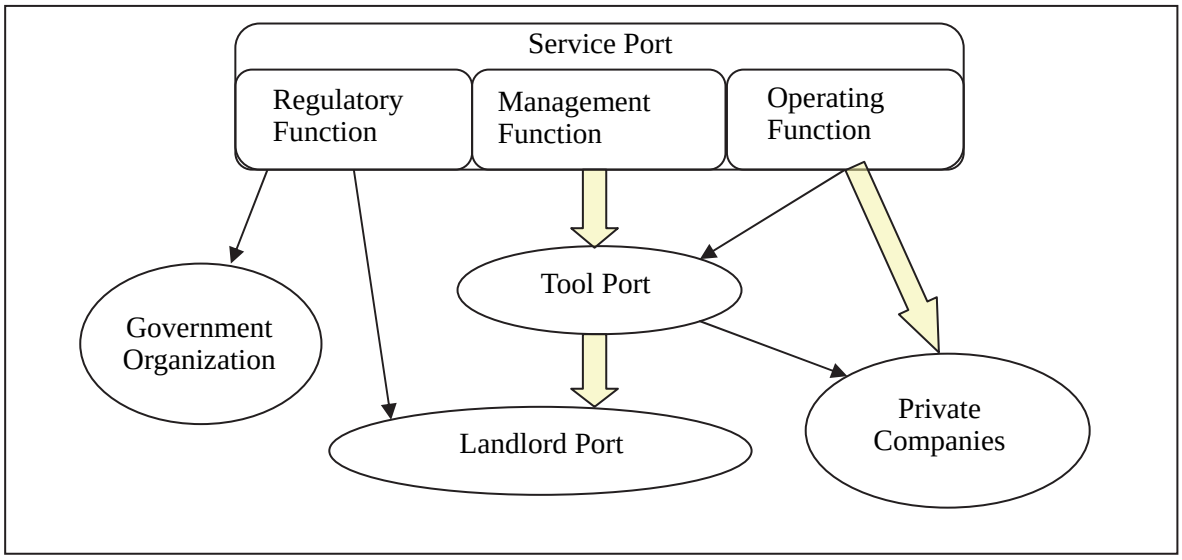
A fully privatized port is the type that private companies own, develop, maintain and operate port facilities with their own capacity, where the government has a policy of no intervention in port management except in safety, security and environmental matters. This type can be found mainly in the United Kingdom (U.K.) and New Zealand. Full privatization is considered as an extreme form of port reform.

5) Public and private interests

Service and tool ports mainly focus on the realization of public interests. Landlord ports have a mixed character and aim to strike a balance between public and private interests. Fully privatized ports focus on private (shareholder) interests.

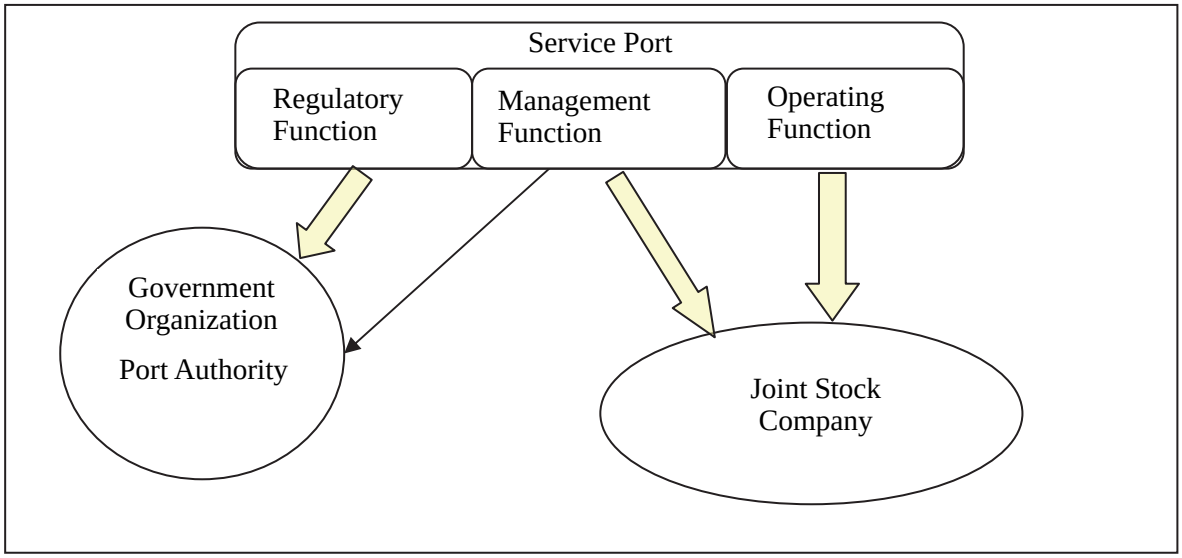
To improve port productivity and services, it is important to separate regulatory responsibility for port activities and introduce competitive operation in port management. Service ports around the world are often separated into regulatory and operational parts to introduce private competitive services to port operation. The World Bank Port Reform Toolkit recommends that a service port shift to a landlord port. A Tool Port is a transitional stage in the process of shifting to a landlord port. Figure 4.3-6 shows a shift from service port to landlord port and Figure 4.3-7 shows a shift from service port to fully privatized port.

While PAS will change to a joint stock company in 2012, PAS shall aim at changing to a landlord port and establish a port operation company for providing stevedoring and other port services. When the new port development is planned, it may be appropriate to invite private operators to invest in the terminal development.



Source: Draft of National Port Policy: The Project for Establishment of National Port Policy and Administration System in Cambodia, October 2011

Figure 4.3-6 Shift to Landlord Port



Source: Draft of National Port Policy: The Project for Establishment of National Port Policy and Administration System in Cambodia, October 2011

Figure 4.3-7 Corporatization of Service Port

(2) Reform of internal structure of PAS

1) Rational size of workforce

Number of PAS employees is about 1,100 (inclusive of 65 contract personnel) in 2012 as shown in section 4.3.1 (Pre Capacity Assessment). Due to modern cargo handling equipment and information technology, a necessary number of employee redundancies will be observed from the 1,100 present employees. Table 4.3-4 shows workforce numbers for cargo handling and transport. Table 4.3-5 shows workforce for other site operations such as security office, gate control, traffic order office, pilotage service, and tug boat operations.

a) General cargo department

The general cargo department has workforce of 240 employees, in which 163 employees belong to the Technical Handling Office and engage in lashing and unlashing container boxes. A rational number of workers for lashing and unlashing is estimated at about 100 for handling 500,000 TEUs. It

may be appropriate to reduce the number of staff members to 2/3 of the present size.

Taking into account that cargo owners prepare their own workforce for handling cement and coal, and that this trend will be expanded to other bulk/break bulk cargoes in the future, the size of the Transport and Cargo Handling Office may be considerably reduced.

b) Technical-material department

The technical-material department has technical staff for buoy maintenance (23 persons), electric work (57 persons), fuel tank maintenance and construction material procurement (43 persons) and some other work. The department is in charge of maintenance of container handling equipment. The necessary number of workers for container handling equipment is estimated at about 30 persons for handling 500,000 TEUs. Taking into account that power generation will be stopped in the near future, it will be possible to downsize the technical-material department.

c) Container terminal operation department

Container crane operators and other cargo handling equipment drivers belong to the container terminal operation department, however, lashing and unlashing work for container boxes is carried out by the Technical Handling Office of the port authority. Gate operation is carried out by the Security Office of the Administration department. Except for lashing workers and gate operation workers, the necessary number of workers is estimated at about 200 persons for handling 500,000 TEUs. It will be possible to downsize workforce to 4/5 of the present size.

Table 4.3-4 Workforce for cargo handling and transport (2012)

Dept.	Office	No. of staff
Container Terminal Operation Dept.	Operation Office	214
	Container Terminal Planning Office	40
General Cargo Operation Dept.	Transport & Cargo Handling Office	77
	Technical Handling Office	163
Technical-Materials Dept.	Technical Office	136
Total		630

Source: PAS

a) Pilotage and tug boat service

The harbor master department has a total of 84 members, of which 20 are pilots and 41 are tug boat service staff. As total shipcalls in 2011 were 877, i.e. container ships 400, general cargo ships 230, oil tankers 232 and passenger ships 15, the average number of shipcalls was 2.5 per day, which may need the pilotage service. PAS has 5 tug boats and 41 tug boat crew. A rational number of pilots and tug boat crew shall be assessed in accordance with their workload.

b) Security office, gate control, and traffic order office

The administration-human resources department has a total of 81 site operation staff, which consists of 43 in the Traffic & Order Office and 30 in the Security Office including gate control staff. These site operation staff shall be controlled by the container terminal operation supervisor as part of terminal operation. Gate control staff shall be moved to the container terminal department to unify the chain of command.

Table 4.3-5 Workforce for other site operations (2012)

Dept.	Office	No. of staff
Administration-Human Resource Dept.	Traffic & Order Office	43
	Security Office (Incl. Gate Control)	30
Harbor Master Dept.	Pilot Office	20
	Navigation Means Office	41
Total		134

Source: PAS

1) Efficient non operation departments

The number of employees in non operation departments is about 310 in 2012 as shown in Table 4.3-6. The size of non operation departments can be downsized considerably by introducing IT system in billing, accounting and other management affairs. Efforts shall be made to reform non operation departments into efficient and compact managerial organization.

Besides making efficient and compact non operation departments, it is important to strengthen the marketing department for the promotion of port throughput, the planning/commercial departments for strategic tariff revision, and the staff for financial management. As Phnom Penh dry port operates at a loss, it may be necessary to reinforce its management or sell the facility to a private dry port company.

Table 4.3-6 Non operation departments and number of staff (2012)

Dept.	Office	No. of staff
Accounts-Finance Dept.	Accounting Office	6
	Finance Office	7
Planning-Statistic Dept.	Planning and Contract Office	5
	Planning-Communication Office	4
Marketing & SEZ Dept.	APA Affair Office	1
	Customer & Promotion Office	3
	Planning & Marketing Office	4
	Administration & Accounting Office	3
	Logistic Office	3
	Training & Vocational Office	5
Audit Dept.	Audit Office	3
	Implementation & Dispute Settlement Off.	0
Administration-Human Resource Dept.	Administration Office	87
	Health Office	9
	Protocol & Communication Office	1
	Safety & Labor Office	1
	Human Resources & IT Office	12
	Social Responsibility Office	1
	Safety Office	3
Harbor Master Dept.	Harbor Master Office	20
Billing Dept.	Exploitation Office	5
	Contract & Price Office	5
Phnom Penh Dry Port	Administration & Finance Office	19

	Exploitation Office	19
Container Terminal Operation Dept.	Data Office	14
	General Affairs Office	20
General Cargo Operation Dept.	Warehouse Yard-Tally Office	22
	Recapitulation Reports Office	7
Technical-Materials Dept.	Construction Office	13
	Architect Office	5
Machinery Dept.	Standard Office	1
	Research Study Office	1
	Statistic & Inspection Office	4
Total		313

2) Improvement of efficiency of the organization

PAS is managed as a state owned company. Therefore, wages and working conditions of employees are decided by the Board of Directors as well as other personnel regulations on employees. As mentioned in section 4.3.2 (3) 4) Personnel/labor management, wages are not related to performance of individual persons. There is no incentive to follow the instructions of the supervisor or to increase his performance. In order to improve efficiency of the organization, special attention shall be paid to following measures.

- To introduce performance related remuneration system (Higher payment for good performance);
- To allow supervisors to assess bonuses of staff members under his supervision;
- To allocate the workforce in accordance with the cost and revenue of each activity;
- To adjust the number of workforce and the budget based on assessment of workload;
- To set a goal for downsizing the operation workforce and non operation staff; and
- To monitor achievements of service improvement and managerial goals.

3) Restructuring of container handling departments

PAS Container Terminal (CT) is operated by CT Operation (CTO) Dept., General Cargo Handling (GCH) Dept. and Security Office under Administration Dept. as described already. In addition to these three (3) Depts., Technical Dept. and Machinery Dept. are also involved in the CT operation through maintaining and repairing container handling equipment (CHE) PAS owns; thus, five (5) Depts. are involved in PAS' container operation in reality. On the other hand, there is generally only one organization at most CTs in the world for managing and operating CTs in a comprehensive manner.

PAS top management believe that managers and staffs in these Depts. can manage and operate a modernized CT such as PAS under the current organizational structure and system; however, there are observed many adverse effects and failures of functions among these Depts.

First, managers in some of these Depts. do not understand clearly their responsibilities concerning container operations. Moreover, they do not cooperate or collaborate with managers in other Depts. properly. As a result, they cannot prepare even functional working manuals for their staffs and labors which represents a failure of leadership, beside of inefficient CT operations of PAS.

Second, there is no competent leader in PAS' CT operation among the present related Depts. which makes it difficult to operate the CT economically. They do not prepare any business plans nor pay attention to the CT operating costs. As a result PAS' CT operating costs, especially human and fuel costs, are extremely high compared with usual RTG system's CTs in other countries.

Third, due to the above issues, there is no discipline and order among staffs and labors. They do not understand their roles and responsibilities clearly because of the lack of an effective system,

training and education. As a result, not only PAS' ships operational productivity, but also customer satisfaction level of PAS is still low.

At last, mechanic engineers cannot maintain CHE proactively by scheduled plans since all CHE are engaged in CY operation. As a result, out-of service hours of these CHE become longer once they break down which is a headache for shipping lines which have to adjusting their calling schedules.

Based on PAS' income statement in recent years, PAS has to restructure its organization and reorganize its managing leaders and staffs, especially in container handling departments, to ensure that it can maintain a financially sound condition in future.

Figure 4.3-8 and Table 4.3-7 show most recommendable restructuring plan and man-power requirements of PAS in the container handling departments at present and in the future respectively. CTO Dept. should be the leading department of the entire CT operation, and Labor Management (LM) Dept. as well as Maintenance and Repair (M&R) Dept. should be sub-departments for supporting PAS' CT operation through their professional services.

General Cargo Handling Dept. should become an independent organization for managing conventional ships and general cargoes hiring labors from LM Dept. just the same as CTO Dept.

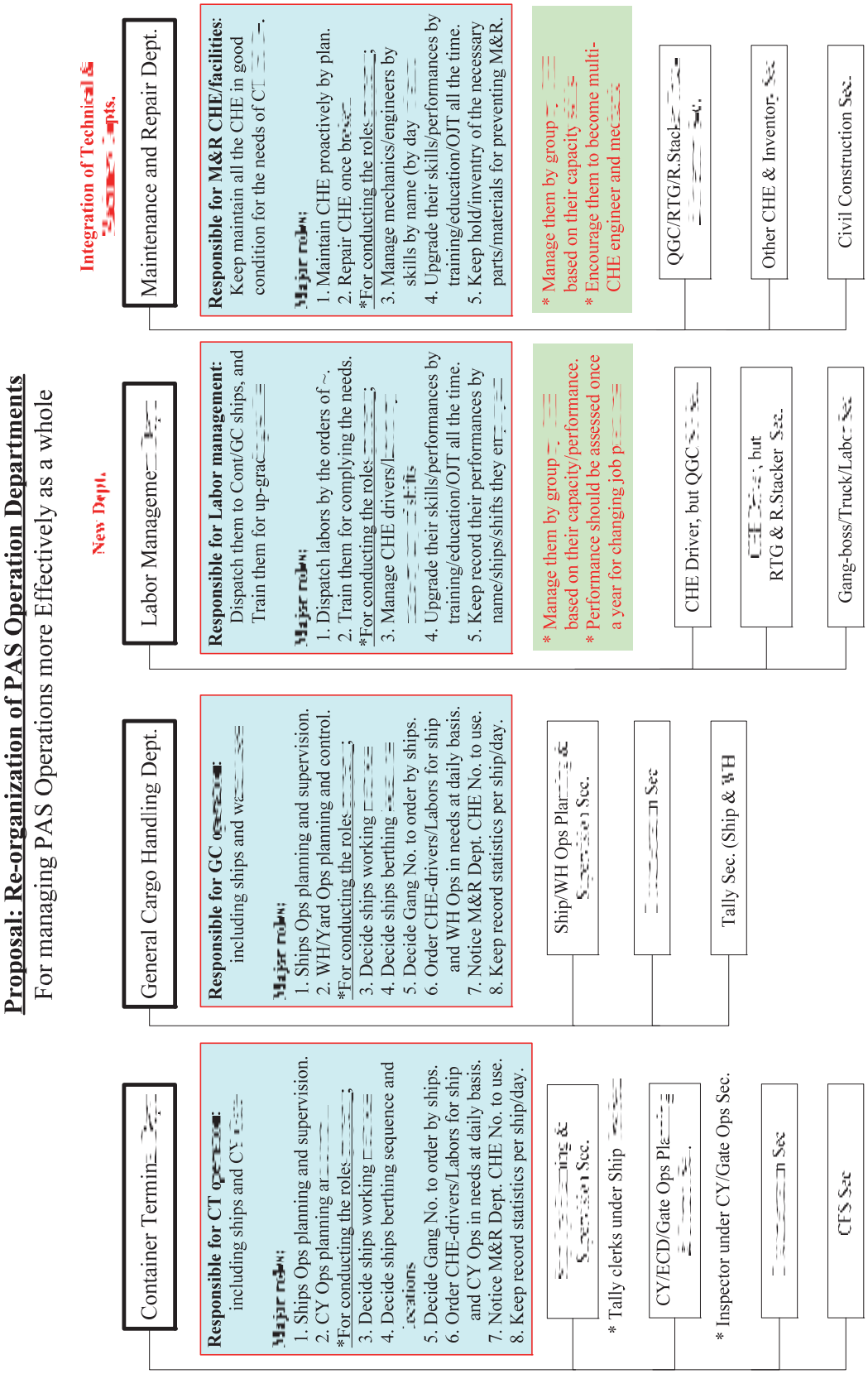


Figure 4.3-8 Reorganization of PAS operation departments

Table 4.3-7 Workforce for container terminal operation

Container Terminal Operating Cost: Human Related

Updated March 19, 2012

1) Terminal Operation Staff (Office workers)

		* 2 GC Operation					* 3 GC Operation					* 4 GC Operation				
		250,000 : TEU/Year					350,000 : TEU/Year					450,000 : TEU/Year				
		151,515 : Box/Year					212,121 : Box/Year					272,727 : Box/Year				
		*Assump.	375	: Boxes/Ship Call			*Assump.	500	: Boxes/Ship Call			*Assump.	650	: Boxes/Ship Call		
			7.8	: Ships/Week				8.2	: Ships/Week				8.1	: Ships/Week		
Department	Charge	1st	2nd	3rd	Spare	Total	1st	2nd	3rd	Spare	Total	1st	2nd	3rd	Spare	Total
Operation Department	Director	1	0	0		1	1	0	0		1	1	0	0		1
	Staff/Secretary	1	0	0		1	1	0	0		1	1	0	0		1
	Total	2	0	0		**2**	2	0	0		**2**	2	0	0		**2**
	Manager	2	0	0		2	2	0	0		2	2	0	0		2
	Staffs	0	0	0		0	0	0	0		0	0	0	0		0
	Total	2	0	0		**2**	2	0	0		**2**	2	0	0		**2**
Ship Planning	Chief	1	0	0		1	1	0	0		1	1	0	0		1
& Supervising	Planners/Supervisor	6	0	0		6	6	0	0		6	6	0	0		6
Section	Apron Cheker	5	5	5		15	5	5	5		15	5	5	5		15
	Total	12	5	5	0	**22**	12	5	5	0	**22**	12	5	5	0	**22**
Documentation	Chief	1	0	0		1	1	0	0		1	1	0	0		1
Section	Staffs	4	1	0		5	4	1	0		5	5	1	0		6
(Import/Export)	Total	5	1	0		**6**	5	1	0		**6**	6	1	0		**7**
Yard Planning	Chief	1	0	0		1	1	0	0		1	1	0	0		1
& Contoller	Staffs	4	2	2		8	4	2	2		8	4	3	2		9
Section	Total	5	2	2		**9**	5	2	2		**9**	5	3	2		**10**
CY Gate Operating	Chief	1	0	0		1	1	0	0		1	1	0	0		1
Section	Staff	4	2	2		8	5	3	2		10	5	4	3		12
	Inspector	5	3	3		11	6	4	3		13	6	5	4		15
	Total	10	5	5		**20**	12	7	5		**24**	12	9	7		**28**
ECD Operating	Chief	1	0	0		1	1	0	0		1	1	0	0		1
Section	Staff (Checker)	2	2	2		6	3	2	2		7	3	3	2		8
	Total	3	2	2		**7**	4	2	2		**8**	4	3	2		**9**
Terminal Service	Chief	1	0	0		1	1	0	0		1	1	0	0		1
Section	Staffs	2	1	0		3	2	1	0		3	3	1	0		4
(PQ/AQ/Info)	Total	3	1	0		**4**	3	1	0		**4**	4	1	0		**5**
CHE Maintenance	Manager	1	0	0		1	1	0	0		1	1	0	0		1
Department	Mechanics	12	2	2		16	12	2	2		16	14	2	2		18
	Total	13	2	2		**17**	13	2	2		**17**	15	2	2		**19**
	S.Total	**55**	**18**	**16**	**0**	**89**	**58**	**20**	**16**	**0**	**94**	**60**	**24**	**18**	**0**	**102**
										Up% is :	*6%*				*Up% is :*	*15%*

2) Labors for Ship, CY Gate & ECD Operational with 3 Work Shift System: Maximum

			* 2 GC + 2 SG Operations					* 3 GC + 1 SG Operations					* 4 GC Operation				
			250,000 : TEU/Year					350,000 : TEU/Year					450,000 : TEU/Year				
		Manning	151,515 : Box/Year					212,121 : Box/Year					272,727 : Box/Year				
		per Gang	*Assump.	375	: Boxes/Ship Call			*Assump.	500	: Boxes/Ship Call			*Assump.	650	: Boxes/Ship Call		
Department	Charge		1st	2nd	3rd	Spare	Total	1st	2nd	3rd	Spare	Total	1st	2nd	3rd	Spare	Total
Labaor Management	Manager	-	1				1	1				1	1				1
Department	Assitant Manager	-	2				2	2				2	2				2
Ship Stevedoring	Foreman	1	2	2	2		6	3	3	3		9	4	4	4		12
Section-1	GC Driver	2	4	4	4		12	6	6	6		18	8	8	8		24
(by GC)	RTG Driver	2	4	4	4		12	6	6	6		18	8	8	8		24
*Need to prepare	R.Stacker Driver	1	2	2	2		6	3	3	3		9	4	4	4		12
2 Gang/shift	Tractor Driver	3	6	6	6		18	9	9	9		27	12	12	12		36
for 4 days/week	Lasher	8	16	16	16		48	24	24	24		72	32	32	32		96
	Total	17	37	34	34	0	**105**	54	51	51	0	**156**	71	68	68	0	**207**
Ship Stevedoring	Foreman	1	2	2	2		6	1	1	1		3					0
Section-2	Gear Driver	2	4	4	4		12	2	2	2		6					0
(by Ship Gear)	RTG Driver	2	4	4	4		12	2	2	2		6					0
	R.Stacker Driver	1	2	2	2		6	1	1	1		3					0
	Tractor Driver	2	4	4	4		12	2	2	2		6					0
	Lasher	8	16	16	16		48	8	8	8		24					0
	Total	16	32	32	32	0	**96**	16	16	16	0	**48**	0	0	0	0	**0**
			* Keep 2 SG Gangs as Steady					* Keep 1 SG Gangs as Steady					* No more SG Gangs				
***Under Labor Management Dept.**																	
CY Operating	Chief	-	0				0	0				0	0				0
Section	RTG Driver	2	4	2	2		8	6	4	2		12	8	6	4		18
	R.Stacker Driver	1	2	1	1		4	2	1	1		4	2	2	1		5
	Tractor Driver	1	2	0	0		2	3	0	0		3	4	0	0		4
	Total		8	3	3	0	**14**	11	5	3	0	**19**	14	8	5	0	**27**
ECD Operating	Chief	-	0				0	0				0	1				1
Section	R.Stacker Driver	1	0	0	0		0	0	0	0		0	0	0	0		0
	E. Stacker Driver	1	2	2	1		5	2	2	1		5	3	3	2		8
	Total		2	2	1	0	**5**	2	2	1	0	**5**	4	3	2	0	**9**
Grand Total							**220**					**228**					**243**
							309					**322**			*Up% is :*		**345**

Human Cost (Roubles)

	USD/mth	Total	Annual Cost	Total	Annual Cost	Total	Annual Cost
Management Staffs;	600	13	93,600	13	93,600	13	93,600
Dock Labors;	400	296	1,420,800	309	1,483,200	332	1,593,600
		309	**1,514,400**	**322**	**1,576,800**	**345**	**1,687,200**
		USD, '000:	**1,514**	USD, '000:	**1,577**	USD, '000:	**1,687**
		per Box:	**10.0**	per Box:	**7.4**	per Box:	**6.2**
		per TEU:	**6.1**	per TEU:	**4.5**	per TEU:	**3.7**

a) Container Terminal Operation (CTO) department

CTO Dept. is the most important department of PAS, accounting for the majority of PAS' revenue and cost, by planning and managing ships stevedoring works as well as CY operations at PAS CT as shown in Figure 4.3-7. Accordingly, PAS top management has to nominate one of the best persons in PAS as a manager of the CTO Dept. without bringing any personal feelings.

Once being assigned in the position, he or she is required to restructure ship and CY operational planning functions in the Dept. for enhancing its capacities by selecting and or promoting some bright persons from CTO or other Depts. These functions are keys for any CT operator to achieve a high level of operational productivities and services based on well-considered plans drafted by sharp minds.

Required management man-power for operating PAS' CT, including M&R mechanics, should be as shown in Table 4.3-4 as;

- When handling 250,000TEU/year： 89 persons（2QGC＋2 SG gang system)
- When handling 350,000 TEU/year： 94 persons (3QGC＋1 SG gang system)
- When handling 450,000 TEU/year： 102 persons (4QGC gang only)
  - ✧ PAS can eliminate 00:00~08:00 of Gate service due to very slow operation, except Saturday at current situation. In that case, above numbers can be slightly reduced.
  - ✧ When PAS eliminates 00:00~08:00 of Gate service, PAS should change the service hours to 07:00-15:00 and 15:00-23:00 shifts, instead of the current 08:00-16:00 and 16:00-24:00 for the convenience of truckers who wait at R-4 from early mornings.

b) Labor Management Department

This department manages CHE operators and labors who work for ships both container and conventional, and CY, including ECD, as well as general cargoes in an integrated manner.

PAS can surely achieve 25.0 lifts/QGC/hour or 12.5lifts/SG/hour in net within a few months, and 30.0 lifts/QGC/hour or 15.0lifts/SG/hour within 1 year once it restructures its organization and reorganizes its managing leaders, staffs and labors.

- For achieving these targets, PAS requires that "more than 70% of export containers be ready by 10:00 Saturday" at an early stage as described many times already.

Once this is achieved, PAS can reduce stevedoring gang numbers from the current 8 (or 6) to 4 in the near future.

- In that case, PAS will sometimes have to ask some ships to wait at off harbor until the berths become available; however, this should be bearable for shipping lines provided that the productivity of services is higher than at present.
- If PAS purchases 3rd QGC, PAS can handle all the ships with 3 QGC gangs alone instead of 4 (2 QGC + 2 SG) until the volume reaches 350,000 TEU per annum or so.

Accordingly, managers of the new LM Dept. manage 2 units of QGC gang specialized for container ships, 2 units of multi-gang working for both container and or conventional ships and some other gang specialized for conventional ships, besides CHE operators and labors working for CY and or ECD/warehouse/CFS. Table 4.3-4 shows required CHE operators and labors working for container ships, CY and or ECD alone.

As the same as CTO Dept., this department is key for PAS to operate the CT smoothly and effectively; thus, PAS top management has to assign a competent person as the manager. Furthermore, PAS needs to change their compensation package system for introducing discipline and order in PAS' operational fields composing their wages by base salary, service allowance and performance payment.

Required CHE operators and labors working for container ships, CY /Gate and or ECD become as follows;

- When handling 250,000TEU/year： 220 persons（2QGC＋2 SG gang system)

- When handling 350,000 TEU/year： 228 persons (3QGC＋1 SG gang system)
- When handling 450,000 TEU/year： 243 persons (4QGC gang only)
  - ✧ 2 QGC gang specialized for container ships can be hired for 4 work-shifts per week on average when handling some 250,000 TEU per annum.
  - ✧ However, 2 SG gang assigned for multi-ships can be hired only for 1-2 shifts on container ships per week; thus, they need to be hired for conventional ships as well.
  - ✧ This is one of the reasons to develop LM Dept. for managing them more sophisticatedly giving them more working-opportunities, at least 3 to 4 shifts per labor per week.

c) Maintenance and Repair Department of CHE and facilities

CHE are maintained periodically in CTs in developing countries for keeping them in good order for daily use as well as ensuring that they can be used until the end of their service lives. Usually they are maintained and repaired monthly as well as annually by planned schedules based on respective laws of each country and/or instructions of the CHE's manufacturers.

Required manpower for the maintenance of major CHE is as follows;

- QGC: Monthly maintenance 1 day per 4-5 mechanic engineers
  Annual maintenance 2-3 days per 4-5 mechanic engineers
- RTG: Monthly maintenance 0.5 day per 4-5 mechanic engineers
  Annual maintenance 2-3 days per 4-5 mechanic engineers

Due to the implementation of proactive maintenance as shown above, one CT operator in Japan hires only 10 mechanic engineers for taking care of 5 units of QGC, 19 units of RTG, 5 units of Top-lifts and more than 25 units of tractors and chassis, besides inspection works of their facilities.

- The CT operator described above is out-sourcing the maintenance works of some CHE on some Sundays when they could not have enough time for maintaining them by certain reasons such as ship/CY congestions throughout the week.

Skill level of PAS' mechanic engineers is not assessed yet; thus, the required number is uncertain; however, once key engineers of PAS learn the proper maintenance system, required mechanic numbers of PAS should be as shown in Table 4.3-5 as maximum;

- When handling 250,000TEU/year : 17 persons (2QGC, 7RTG、7R.Stacker; due to lack of RTG)
- When handling 350,000 TEU/year：17 persons (3QGC、10RTG、5R.Stacker & others)
- When handling 450,000 TEU/year：19 persons (4QGC、12RTG、6R.Stacker & others)

They also need to keep maintaining facilities PAS owns as well as purchasing and inventorying necessary parts in case sudden repairs are necessary.

(3) Improvement in personnel and institutional frameworks

The age composition of PAS employees is unique as shown in Table 4.3.1. Employees older than 50 years old account for 32% of total employees. The number of employees younger than 30 years old is comparatively small. With such an imbalance, it is rather difficult for the younger generation to work actively. Furthermore, it is difficult for all staff to work enthusiastically. In addition, it is not so easy for all employees to tackle difficult problems that they face. It is also not easy for all staff to join in overcoming various managerial difficulties. There is a serious lack of communication between employees. How to treat elder people poses another issue. Under these conditions, it is difficult to unite all employees towards one goal. These kinds of issues should be solved before enhancing PAS's competitiveness.

Table 4.3-8 Age Structure of PAS Employees

Age Group	Number of Employees	Percentage Share (%)	Accumulated (%)
Under 30	102	10.2	10.2
30-35	113	11.3	21.5
36-40	132	13.2	34.7
41-45	167	16.7	51.4
46-50	172	17.2	68.5
Over 50	315	31.5	100.0

Source: Personnel Department at PAS

With respect to the improvement in age-based institutional structure and because the number of aged people increases year by year, it is necessary to provide positions suitable for elders. However, it is not easy because the number of posts is limited. On the other hand, the percentage of older people in society is increasing and it is not easy to find a place for them to work. Efficiency of organizations and fast and smooth decision-making abilities are also important. In this regard, preparing a staff-related business for ageing people is being considered.

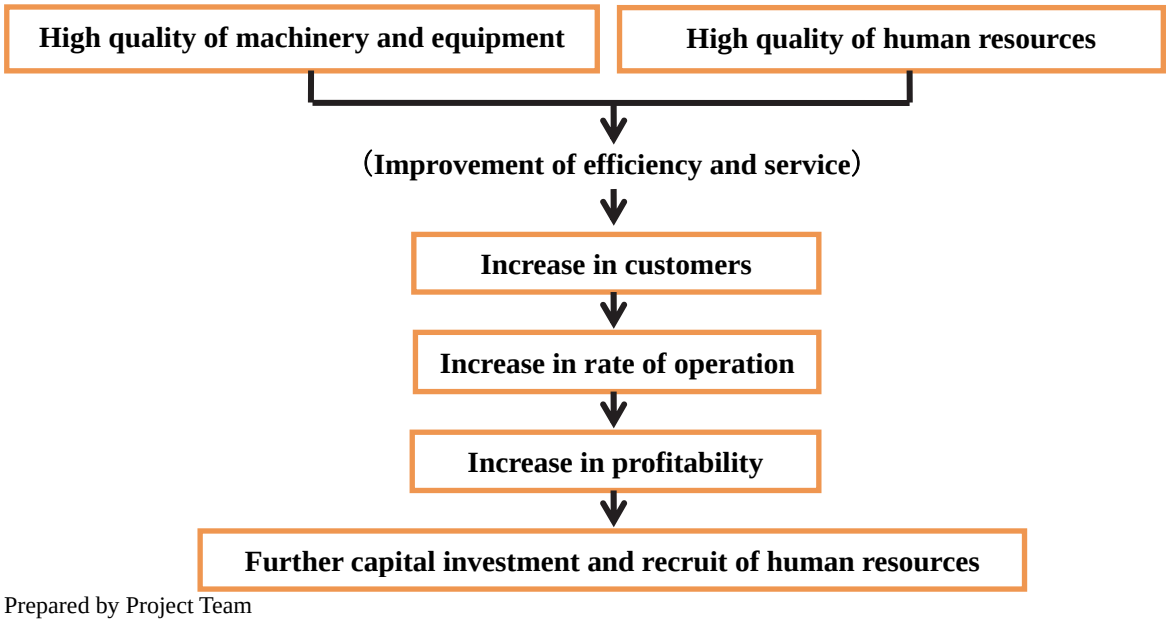
This business will create a staff organization and prepare work for them. Basically, people are provided with staff-related work, they are expected to accomplish the work within a period of time and when they finish it, they will get another staff-related work project. Since the staff-related work is quite different from line work, it is necessary to train the employees on how to proceed.

(4) Improvement in Human Resource Development in PAS

1) Competitiveness of PAS

a) Factors determining PAS's competitiveness

As shown in the chart below, competitiveness of PAS is enhanced through the introduction of high quality machinery and equipment, and recruitment of capable human resources. The high quality machinery and equipment is attained through capital investment and the investment becomes feasible only when PAS makes a profit. Whether PAS can make a profit is largely influenced by the quality of human resources.



Prepared by Project Team

Figure 4.3-9 Determination of PAS Competitiveness

More specifically, competitiveness of the port is enhanced by the following factors:

- Better customs checking / clearance / easier collection of taxes / revenue

- Better hinterland connectivity
- Better transport links / easier and cheaper transport to the associated river port
- Container facilities
- Better management
- Storage in sheds and open areas
- Refrigeration available (for reefer container terminals)
- Quicker processing / less time lost / avoid delays at associated seaport
- Less congestion at associated seaport / eases pressure at associated seaport

The final target for development of organization and human resources is to strengthen PAS's competitiveness. Competitiveness at PAS is determined by two factors: physical facilities composed of machinery and equipment, and human resources who handle the machinery and equipment. Competitiveness of a port is dependent on well-coordinated management of equipment and human resources.

To enhance PAS's competitiveness, the current organization and human resource development policy and strategy at PAS should be reviewed. In the future, appropriate function sharing with Phnom Penh Port may be important. However, the first priority is strengthening the competitiveness at Sihanoukville Port. Only when Sihanoukville Port succeeds in strengthening its competitiveness, it will become realistic to consider function sharing with Phnom Penh Port.

To strengthen Sihanoukville Port, it may be necessary to drastically change its constitution and privatize the port.

b) Importance of human resources factor in PAS's competitiveness

Generally speaking, competitiveness of human resources is strengthened through the following three factors. The first one is the capability of staff who work under an organization. The capability is influenced by the amount of education or working experience of each staff member. The second one is capability improved through "On the job training" at PAS. When PAS is ardent in educating and training the staff, the staff's capability is easily enhanced. In this sense, training and education at PAS is very important for staff capacity building. Under an organization where capacity development for its staff is neglected, the staff's capability will not be developed. The third factor is the strength of the organization. When the organization is weak and has little power to provide various opportunities for capacity development for each staff member, the staff will not grow. The staff will improve and grow only when the above three factors are successfully implemented.

Through interviews with the staff at PAS, it has been confirmed that most of them are knowledgeable and capable. However, the surrounding business environment is not always favorable. Therefore, they lack opportunities to train themselves. In this regard, two reasons can be cited. First, due to the lack of tension at PAS, the staff become lax. This can be attributed to the fact that PAS's strategy is not always clear or aggressive. When the PAS strategy for future development and business plan becomes clear and aggressive, the PAS staff will become more motivated and they will fully utilize their capability. Second, there is a lack of clear messages from the Cambodian government on how to strategically utilize PAS. For these reasons, PAS seems to be perplexed regarding their future direction.

c) Factor of cargo flow in PAS's competitiveness

The lack of competitiveness at PAS is attributed to the fact that there is relatively little cargo due to underdevelopment of the economy and industry in its hinterland. Most of the cargo for international trade is made near Phnom Penh and cargo imported to Cambodia is consumed near Phnom Penh. Only cargo made near Sihanoukville Port and materials for production are exported from Sihanoukville Port. Thus, a key factor is how to attract manufacturing companies to areas near Sihanoukville Port. For this reason, the role of the Marketing and SEZ Division at PAS is important.

d) Port operation factor in PAS's competitiveness

The competitiveness of PAS could be strengthened by increasing the efficiency of its operation.

Efficient operation brings about expansion in customers and the amount of cargo handled. With this expansion, efficiency in port operation will increase further. Efficiency in cargo handling operation is strengthened by the following four measures:

- Better customs checking / clearance / easier collection of taxes / revenue
- Introduction of the newest operation equipment and machinery and development of the newest operation system that introduces the newest information technology.
- Development of human resources, who can make the most use of high-tech, developed machinery and equipment efficiently and effectively.
- Obtaining customers' cooperation and understanding, which are crucial for securing efficient operation. Even if the most advanced and high-tech operation systems are introduced, if PAS cannot obtain customers' cooperation in handling of the equipment and systems, the system will not work and operation productivity will not improve. In order to keep a favorable relationship with customers, strengthening of the Marketing section at PAS is critical.
- Considering that efficiency of port operation is enhanced by the expansion of the handling volume of cargo, it is important to secure as much cargo as possible. In situations where port facilities and equipment are not fully utilized, efficiency and productivity of port operation tend to stay at low levels.

Improvement in shipping services makes expansion in customers and cargo handled possible. The shipping services include accurate cargo handling, speedy, accurate and timely responses to inquiries on cargo handling and provision of information to customers requests. For these conditions to be met, service sense, a strong will to develop new services for customers, and the capacity to communicate are requested to all the staff at the port.

While operation at Sihanoukville Port is a kind of public work, it is also service work. In this sense, it should be reinforced that PAS operation is a "service industry." It is difficult to enhance its competitiveness when PAS handles their operation as "government work."

The following seven factors are necessary for improvement in competitiveness of PAS:

- Shorten operation time for each handling
- Provide various services to customers
- Diversify transportation routes
- Improve facilities
- Furnish information related to shipping with customers
- Develop and furnish new services
- Shorten time necessary for custom operation procedures as much as possible

2) Current Situation of PAS Operation and its Main Issues

a) PAS's major duties for business operation and basic services

PAS's major duties are to bring vessels in and out for unloading and loading including storage and transport of cargo for customers from all social circles.

b) Main issues faced by PAS

The most important operation at PAS is container terminal operation. PAS's container terminal management system (CTMS) has been developed under cooperation with Mitsui Engineering & Shipbuilding Co., Ltd. in Japan. The key and major systems were introduced in March 2009 and were reinforced with introduction of an additional system in October 2010.

The current key systems of CTMS are the following:

- Yard Plan Computer System (YPCS)
- Vessel Planning System (VPS)

- Yard Planning System (YPS)
- Yard Operation System (YOS)

According to a brochure prepared by Mitsui Engineering & Shipbuilding Co., Ltd., the outline of each system is as follows:

YPCS is a core and backbone system of CTMS and conducts integrated management of such basic information at the container terminal as container stock management, bonded management, cargo ship information, preparation of EDI/statistical ledgers, etc. VPS assists preparation of vessel cargo loading/unloading plans and enables monitoring progress of cargo handling. YPS manages container storage locations in the yard for supporting yard planning work. YOS controls the work operations at the yard, management of reefer containers/container handling equipment machines, and work instructions to in-vehicle or radio handy terminals.

Since the above systems are fully managed by computer, whole operations are to be executed smoothly without any interruption. However, when the following problems occur, the operation tends to lack smoothness. First, exceptional cases occur in cargo handling. Second, delay in customs control brings about unexpected stoppage in cargo handling operation. In addition, when cargo volume is under full capacity of the port, it becomes a source of inefficient use of the port facility.

In order to solve the above issues and secure more efficiency, operation in the following areas should be systematized:

- Acquisition of accurate customer data and their input to data file
- Compilation of the above customer data
- Transition of the above customer data to marketing section and its use
- Statistical analysis of the above customer data and its use

In addition, customer management should be improved through:

- Customer analysis
- Analysis for possibility of deepening customer transaction
- Review and assessment of marketing strategy

Since the above works are not yet systematized, computerization work should be enhanced through the following process:

- Decision on contents of the system
- Setting the deadline for the development
- Cost estimate
- Decision making on the section responsible for development

Considering that PAS is a service industry, the above customer service should be strengthened more than ever.

c) Challenge to efficient custom clearance operation

In addition to rationalization of cargo handling operation at the yard, the customs clearance operations should be streamlined to secure total quality for cargo handling service at PAS.

3) Human Resource Development as a Key Factor for PAS Competitiveness

a) Management officers and employees at PAS

According to the Statute of Sihanoukville Autonomous Port, management staff and employees at PAS are divided into the following four frameworks:

- Department framework: Deputy Director-Generals, Directors

- Management framework: Chiefs of offices, chiefs and deputy chiefs of units, chiefs of brigades, sections and cashiers
- Administration framework: Employees working in the offices
- Production framework: Employees working in the operation line (areas other than the above three frameworks)

The criteria for each qualification are made clear and according to the criteria, the level and scale of wages for employees are set. Further, based on the levels, the salary scale is set. Each officer and employee is required to hold different knowledge and capability as follows:

- Theoretical knowledge and professional techniques
- Knowledge in physical implementation
- Administrative knowledge
- Working organization
- Employee management
- Achievement and working quality
- Activity and faithfulness
- Sanitation-Security
- Strictness and Authority
- Disciplinary Spirit
- Relationship and Unity
- Initiatives in taking corrective actions

PAS's organization is well arranged for a public organization. However, when the organization is evaluated from the viewpoint of a private institution, it has the following issues:

- Lack of aggressiveness in enhancing competitiveness
- Lack of aggressiveness in providing better services to customers
- Lack of aggressiveness in training all staff towards better service to people in Cambodia

b) Keys for human resource development

The purpose of this section is not to suggest what kind of knowledge and information should be transferred to PAS staff but to discuss how to create an atmosphere under which human resource development becomes possible. In this regard, the following two ideas are stressed. One is to make why human resource development is important understood. The other is to suggest how to a build basic environment to create human resource development. Needless to say, it is also important to recruit excellent staff and to create an effective method. However, more importantly, human resources must be trained.

It is necessary to educate on technical matters regarding port operation. More importantly, a structured organization under which human resources can grow without interruption must be developed. Following are some examples:

- To create and develop a new, strong function and organization for human resource development. At this moment, such an organization is not found within PAS.
- To create a management system under which human resource development will advance. In this regard, the following are important:

- Clarification of management philosophy

- Setting of PAS's target
- Making clear how each work item is handled
- Making clear who will undertake each duty
- Understanding the key for human resource development

In cases where PAS's direction and strategy are not made clear, any kind of education and training for staff will not be fruitful.

c) Viewpoints for human resource development

Importance of capacity development: Businesses and organizations are operated by human resources who influence the quality of these businesses and organizations. If the quality is not good, the businesses and organizations tend to become unsuccessful. To the contrary, all problems an organization faces are rather easily solved when the organization has excellent human resources. While some business problems can be solved through introduction of excellent machinery and equipment, these cases are rather limited.

Elements of "Capacity": The following are the basic capacities required for staff working at PAS. The first is knowledge required for daily operation for cargo handling at the port. The second is the capacity to communicate with customers. The third and last is having a mind for business development. Staff should be aggressive and business oriented. Only with these mind-sets, competitiveness of PAS will be enhanced. Currently, the staff at PAS tends to lack the above.

Current level of human resources at PAS: The current level is not inferior but it remains at a mediocre level. PAS does not respond to requirements from the business world with full satisfaction. In other words, the current quality of human resources does not meet the requirements for strengthening of competitiveness. PAS is a service industry. However, unlike a general service company, PAS is a technology-oriented service industry. From this viewpoint, PAS staff are equipped with technologies and techniques necessary for daily operation. However, due to a lack of cargo, staff capacity is not well utilized. In addition, even though individual staff's capacity is adequate, it is not fully utilized due to a lack of communication at various levels. There is a lack of communication between top management and staff and among all staff at PAS. Currently, PAS faces two serious issues. First, PAS's financial condition is becoming difficult since repayment of a past loan will start in the near future. Secondly, competition with Phnom Penh Port will become more intense. To overcome these issues, PAS will have to enhance its competitiveness by uniting the staff and making every effort. It is necessary for all staff and top management to share the sense of the difficulties.The first issue can be solved by the marketing section. They have a large responsibility to apply more effort to collect as much cargo as possible. The second issue seems more important at present. With the current capability and knowledge of PAS's staff, as long all staff communicate well with each other**,** their human resources will be fully utilized.

Conditions for enhancing competitiveness: Three conditions are to be met. The first is to get strong support and cooperation from private sectors in their port selection. The second is to strengthen service to customers. The third and last is to show their stance of "improvement" and "reform" in their operation.

Incentives for enhancing competitiveness in employees: The level and scale of wages for employees are set by each of four frameworks as follows:

- Department Framework: Deputy Director-Generals, Directors
- Management Framework: Office Chiefs, Chiefs of Sections, Deputy Chief of Sections, Chief of Brigade and Cashier
- Administration Framework: Employees with Diplomas, Skill employees, Employees
- Production Framework: Technical workers, operators, drivers, workers, public work force

The level and scale are well organized. However, it is also necessary to reward staff who make efforts in their daily work even if they have a low rank.Why does the situation remain unimproved?

PAS is a governmental office and is not as eager to strengthen its competitiveness as private sector businesses. Generally speaking, even though they lack competitiveness, government offices do not go bankrupt. Under such conditions, government officials tend to live easily. It is important to instill a sense of "competitiveness" in these governmental officers.

d) Current situation of human resources development

A JICA consultant met and discussed the current PAS business situation with PAS key staff. Though the discussions, the consultant noted the following:

- They understand clearly what their business is and what they should do to improve the current situation.
- They have their own ideas on how to improve their productivities and what kind of action needs to be taken for improvement.
- However, they lack communication with other parties in realizing the above ideas.

Efforts to enhance communication capability and top management's will to solve the problem seem to be weak.

Considering the above, the following two plans are important: to strengthen and polish the current capability of the staff further and to create opportunities for communication with staff in other sections. In this regard, the following actions should be taken:

- To foster a strong will to develop human resources
- To lessen the communication gap between management and employees
- To share a consensus on PAS strategy among all parties concerned
- To understand that PAS is a service company
- To confirm that as a technology, technique-oriented organization and development of human capital are the key factors for PAS's development and prosperity.

Human resource development should be strengthened based on:

- Clear future picture of PAS and basic strategy for realizing the picture
- Strong will to be more competitive
- Importance of cooperation among staff
- Introduction of a merit system under which all staff efforts are fairly rewarded
- Stress the necessity of "Capacity to communicate."

e) Required human resources

Considering the importance and role and function of PAS, the following ideals are indispensable for PAS staff:

- Fully understand the importance and necessity of service to customers
- Recognize that the most important aspect of their work is customer satisfaction
- Share a sense of "Port service" and "Port management."

Each staff member is required to share the following attitudes:

- Consider the future of PAS seriously
- Devote more to the organization than to the individual
- Understand the importance and necessity to train and educate subordinates
- Strategic thinking

- Capacity to communicate.

Each staff member's capacity is to be evaluated by judging the following:

- Whether the staff member is equipped with necessary knowledge required to perform his or her job
- Whether the staff member has strong motivation to accomplish his or her job
- Whether the staff member has spirit of cooperation with his or her colleagues
- Whether the staff member has enough capability to solve problems.

To enhance each staff member's capability, the following two items are important. First, each staff member must have a good personality and adequate knowledge on port business. Second, PAS needs a long-term strategy for its business and must make each staff member's role clear.

f) Issues for human resources development observed in the organization chart

First of all, it is noted that there is no specific section that handles human resource development on the organization chart. This may suggest that training of staff is handled in each section depending on the section's needs. Specific personnel staff for training employees seems to not yet be appointed. This may be attributable to the fact that PAS is a government office and not a profit-oriented organization.

Training and education is provided through daily operation. However, education and training on how to cultivate customers and how to strengthen service for the cultivation for long-term development of PAS seems to be weak.

g) Direction of human resource development

Because competition among ports is intensifying, human resource development is becoming more important to win the competition. Human resources development is directed towards the following three areas:

- Acquisition of basic knowledge on each task
- Strengthening the PAS organization through maximum utilization of each staff's capability
- Utilizing power of PAS strategically with its full strength

The first one is related to the individual strength, the second one is related to the institutional strength, and the last one is related to the nation's strength. Unless these three conditions are met, human resources at PAS will not be fully utilized.

Acquisition of basic knowledge on each task

It is necessary to recruit staff who possess basic knowledge required for port operation and business. If they have these skills, it will be rather easy for PAS to train them whenever and wherever necessary. The following curriculum should be mastered:

- Port distribution theory: port and trade, port operation and information technology regarding port distribution
- IT regarding distribution: transportation, loading and unloading, storage, packaging, information technology
- Port logistics: distribution system in general (customs clearance, supply chain, laws and regulations, port theory, inventory control, quality control, fee calculation, accounting, distribution company, loading and unloading, air freight, machinery handling, IT distribution system design)

Strengthening the PAS organization so every staff member can fully utilize his potential

Staff must be trained and educated when it becomes necessary depending on the changes in the business environment. To accomplish this, PAS is requested to have an internal training system.

Utilizing power of PAS strategically with its full strength

It is necessary for the nation to show PAS its role and strategic policy. In order to strengthen PAS's competitiveness, the following environment should be created:

To provide basic education and training on port operation systems: It is important to train port operation staff on every aspect of their job. Mitsui Engineering and Shipbuilding Co., Ltd. trained 46 staff when PAS introduced their port operation system. The system covers operation training, application training and maintenance training. This kind of training should be intensified in response to environmental changes in the future. Further, the current system will become obsolete as technology changes. Thus, it will become necessary to revise the current systems towards more advanced ones. At the same time, it will become important to train staff on the newly developed system. As for the basic port operation system, it is recommended that all staff at PAS be trained.

To strengthen the marketing section: In order to secure a very efficient port operation system, a good, smooth relationship between the port and customers is required. To ensure this, involvement of the marketing section is important. The staff in the section has to master how cargo operation advances and how to negotiate shippers. In this regard, a new training section for the staff in charge will become necessary.

To strengthen basic education and training on the customs clearance system: Training and education for the customs clearance section is also important. Detailed knowledge will be delivered by a specialist on the matter, but staff who can educate on the essence of the system will also be recruited. In order to train and educate PAS staff in the above three areas, it may be necessary to create a new organization of Training Section under the Administration and Personnel Dept. or to strengthen the current function under the Human Resources and IT Office. The role of the organization is to provide training to young staff. The most important work is to educate staff who are engaged in marketing and negotiations with related organizations such as the customs clearance office. Finally, considering that strengthening of PAS competitiveness is a key issue for all the sections in PAS, it is necessary to campaign the importance of competitiveness to all staff at PAS. In this regard, it is recommended to start a new project team named **"Competitive PAS"** under the top management's initiative. The team will be responsible to work for PAS to strengthen PAS's competitiveness. The chairman will be the second in command of PAS. The organization is a temporary one which will continue until the obligations have been fulfilled.

4) Qualifications required for each staff

Two qualifications are required for each staff at PAS. One is the basic and general attitude in PAS, and the other is to obtain knowledge required for execution of each work item.

a) Basic attitude shared by every staff at PAS

Every staff should be educated and trained on the following:

(Teambuilding)

- Why teambuilding is necessary and important
- How to construct teamwork
- How to hold discussions within a team
- Importance of reporting within the team

(Role of staff)

- What is staff
- Basic requirements for staff

- Keep time
- Refrain from spreading rumors
- Listen to the people working on site

- Go to the site and confirm whether it is true if you feel differently
- Understand the importance of cooperation
- Highlight the strong points of staff rather than weak points

(Management's basic stance)

- Fair and right
- Confirm the truth by going to the place where issues are happening
- Highlight the staff's strong points rather than weak points

(Communication skills)

The capacity of each staff member seems to be at the required level. However, it seems that their capability is not fairly evaluated because they are poor at communicating with each other in PAS. When communication within the work place goes well, the capability of problem solving within PAS will improve and it will lead to better competitiveness of PAS.

b) Qualifications required for each staff

Overall planning staff

(Macro and micro economy)

- Understanding of the current situation of the Cambodian economy, industry and corporations and on future prospects
- Understanding of the current situation for investment by industry, country and area, and on future prospects
- Understanding of the current situation of trade and future prospects
- Understanding of the profiles of importers and exporters
- Understanding of the current major customers

In relation to the above, foreign investment trends in Asian countries including Japan, China, Korea and Taiwan are becoming more important year by year. Business societies in these countries plan their investment for not only domestic markets but also for foreign markets. In other words, companies in these countries determine their investment plan upon examining economic and industrial changes in this region. These changes yield different cargo flows. In order to capture cargos produced within Asian countries, PAS has to carefully monitor the changes in their investment behavior. All of the staff in the Overall Planning Section should be serious and are responsible for the analysis. Relatedly, the staff in this office is expected to make frequent contact with central government officers in Cambodia who are responsible for formulating industrial policies and strategies for Cambodia. Through the contact, PAS officers should ask Government officers to formulate industrial policies and strategies on industrial development and to consider function sharing between Phnom Penh Port and Sihanoukville Port.

(Port operation)

- Process of cargo handling
- Understanding of key factors to facilitate the operation

(Contact with various parties concerned)

- Political society
- Business society
- Educational institutions such as universities and technical institutions
- People living near the port

- Donors such as JICA
- International ports in foreign countries: Vietnam, Thailand, Japan, etc.

Marketing staff

(Macro and micro economy)

- Understanding of the current situation of the Cambodian economy, industry and corporations and on future prospects
- Understanding of the current situation for investment by industry, country and area, and future prospects
- Understanding of the current situation of trade and future prospects
- Understanding of the profiles of importers and exporters
- Understanding of current major customers

(Port operation)

- Process of cargo handling
- Understanding of key factors to facilitate the operation

Operation staff

(Port operation)

- Process of cargo handling in detail
- Understanding of key factors to facilitate the operation in detail
- Understanding of the container terminal management system (CTMS) in detail

(Macro and micro economy)

- Understanding of the outline of the current situation of the Cambodian economy, industry and corporations and on future prospects
- Understanding of the outline of the current situation for investment by industry, country and area, and future prospects
- Understanding of the outline of the current situation of trade and future prospects
- Understanding of the outline of profiles of importers and exporters
- Understanding of the outline of current major customers

Personnel officer and Training officer

(Macro and micro economy)

- Understanding of the current situation of the Cambodian economy, industry and corporations and on future prospects
- Understanding of the current situation for investment by industry, country and area, and future prospects
- Understanding of the current situation of trade and future prospects
- Understanding of the profiles of importers and exporters
- Understanding of current major customers

(Port operation)

- Process of cargo handling in general
- Understanding of key factors to facilitate the operation

(Human resources at PAS)

- Understand the strengths and weaknesses of all PAS staff
- Specialties recognized in all staff
- Experience of past training for all staff

(Others)

- Contact points in other countries

5) Pre-capacity Assessment

Table 4.3-9 shows a summary of the Pre-capacity Assessment on PAS's organization capability and human resource, though it is only preliminary and needs to be verified through further study.

Table 4.3-9 Summary of Pre-capacity Assessment

Areas	Evaluation (Positive)	Evaluation (Negative)
1.Organization (1) Structure	● Simple and well organized	● The following needs to be improved: -- Too many sections. Consolidation will be necessary and is possible -- Too much horizontal organization
(2) Human resource allocation	● Allocation to competitive areas	● More human resource allocation to the Business development sector
2.Communication	● Communication within each Dept. seems good	● Communications between departments seems to be insufficient. The same issue is seen in communications between top management and each department.
3.Financial position		● Data on financial position are not satisfactory ● Financial data by main department is necessary ● The disclosure is not timely
4.Human resource (1) Quality (2) Development	● Seems to be favorable ● Large potential ● Positive attitude for human resources development by managers ● Positive attitude for training of subordinates by managers	● Seems to be underutilized
5 Business strategy	● Some top managers seriously consider	● Seems to be unclear ● Some top managers hold their own strategies, but do not share with other top managers ● Seems not to be discussed

Prepared by Project Team

6) Training of PAS staff

For smooth and efficient operation at port, the following knowledge and exercises are indispensable:

Cargo distribution

- Port operation and trade
- Goods loading and unloading
- Information technology and operation based on the technology

Information on goods distribution

Port logistics

- Outline of customs clearance
- Supply chain
- Port related laws and regulations
- Inventory management
- Quality control management
- Fair calculation for distribution and its accounting
- Distribution company
- Distribution related machinery training
- Port information handling training
- Design of distribution system

Education for efficiency of port operation

Education on the following two areas is important as shown in Table 4.3-10. One is how to make operation more efficient and the other is how to maintain safety at the port operation site. The latter is important because when the operation is done safely, competitiveness will enhance due to the decrease in accidents. For efficiency of port operation, the following training is necessary in 14 areas. It will take around 23 workdays for its completion.

Table 4.3-10 Examples for Training on Port Operation

Areas	Days
Forklift operation and techniques	5
Cargo handling operation and techniques in the ship	3
Slinging techniques	3
Bulk loading safety lecture	2
Instructor for reference by pointing	1
Operation of lifting equipment	1
Operation of loading machinery	1
Loading and unloading operation of cargo	1
Operation at seaside	1
Forklift operation	1
Training for safety and health	1
Training for disaster prevention	1
Special training for chainsaw operation	1
Lecture on lifesaving and emergency treatment	1

Prepared by Project Team

Among the above lecturers, the most important is slinging operation. The operation needs knowhow and techniques. Operation under a moving crane is done through the following procedures. Specific training is required for handling the crane as presented in Table 4.3-11.

Table 4.3-11 Basic Examples for Slinging Operation Training

Procedure	Content of the Training
Machinery used Tools used Tools used for protection	Moving crane Wire ropes Safety helmets, Leather covers
Expected disasters	Dropping cargo, Cutting wire rope, Cargo collision
Preparation stage	1. Confirmation of operation and proceedings 2. Check tools for slinging operation
Operation	1. Signal of start, lower crane hook 2. Slinging of cargo 3. Fix rope on hook 4. Signal the operation and winding of wire ropes 5. Signal stoppage 6. Move away from cargo 7. Signal slinging a little 8. Signal slinging 9. Suggest where the cargo is moved 10. Suggest where the cargo is placed 11. Signal loosening the crane 12. Signal stoppage 13. Suggest where the cargo is placed 14. Signal unwinding the crane 15. Signal stoppage 16. Signal unwinding the rope 17. Signal stoppage 18. Loosen the slinging rope 19. Unhook
Return the tools to the place where they are kept	1. Confirm condition of the cargo 2. Check slinging tools and return them to the place where they are kept.

Prepared by Project Team

<u>Human resource development for strengthening of PAS's competitiveness</u>

In addition to the above, the following training is indispensable for PAS's competitiveness in soft business strategy areas.

- Education and training on fostering long-term prospects for port business
- Training on how to construct a new long-term view on future port operation
- Education for fostering new ideas on port business
- Fostering strategic thinking capability

In particular, the following capability is to be fostered: planning, operation power and communication capability of "Capacity to communicate."

7) Proposed Organizational Reform for Human Resources Development at PAS

a) Revitalize PAS

The following are necessary measures to revitalize PAS:

- Top management should announce clear messages on the future of PAS based on their insight and vision

- Fair and equal treatment for all staff at PAS
- Strong leadership

To achieve the above, top management personnel should communicate with each other.

b) Proposed organizational reforms and their reasoning

Strengthening management of various meetings held within PAS: Various meetings are held inviting staff and parties concerned. These meetings are the main information sources; therefore, information should be shared among PAS staff. When communication lacks among staff, PAS management will not go smoothly. Better communication among staff and between staff and top management is really an important source of better communication.

Strengthening strategic overall planning for PAS: The existing planning department is strengthened considering the fact that strategic thinking is becoming more important day by day. The new department periodically prepares three kinds of management plan: One-year annual plan, Mid-term (three years) plan and Long-term (five years) plan. The data and information necessary for preparing these plans are listed below and are provided by each department concerned. The role of the Overall Planning and Strategic Department is to gather these data and information, analyze and compile them according to the relevant plan, report to the CEO, and prepare the official plans that will be submitted at the meetings mentioned above.

(Basic data to be prepared)

- Cargo throughput by type of cargo, by customer and by route
- Profit and loss account
- Number of employees required
- New investment
- Cash flow by year

Outlines of the above management plans are reported to all of employees through the above meetings. For strengthening of the above functions, one officer and two assistant officers are assigned for the work. One of the newly assigned assistant officers is specifically engaged in dialogue with government sectors concerned to obtain information that is important for PAS's decision making. When it becomes necessary for PAS to make a long-term Sihanoukville port development plan as the result of this Master Plan Study, this strategic overall planning department will undertake the work. Taking into consideration the volume of the work, several new staff will be assigned.

Creation of a new committee for enhancing efficiency at PAS: The effect of patchwork style reform is limited. Total and comprehensive reforms are to be searched. In this reform, all of the staff at PAS should be involved. A Deputy Director General for the Administration Division will be assigned as the Head of the committee. One officer and one assistant officer will be assigned as staff to manage the committee.

Creation of a new section for overall MIS development: Development of MIS is PAS's lifeline. PAS's current MIS has been restructured and improved. The new section will be set either in the Administrative Division or as a new independent department. MIS covers the following information:

- Basic data on customers
- Data on daily operations
- Data on internal management
- Data on revenue and profit

For system development, one officer and two assistant officers are assigned. In addition, system engineers are temporarily recruited for development of the computer system.

Strengthen Business Division: By using staff who become available as the result of efficient operation, new businesses will be created. Around port operation, several service works, including

husbandry, are to be created. In addition, SEZ prepared adjacent to the port will need various kinds of operation services such as transportation and storage of cargos. These needs will be carried out by the Division. Further, looking around the world, the word "Port" is welcomed by people with a good image as is shown in cases such as Yokohama and Kobe Ports. These ports are developing not only for the cargo handling business but also for local tourism. Considering the beautiful scenery and sand in Sihanoukville, it is quite natural to develop Sihanoukville port as a tourism area. The newly created Division is expected to develop these port related businesses in Sihanoukville. Officers at the Division are requested to have a wide view of connecting PAS's traditional role of sea transportation for cargos with development of the regional economy of Sihanoukville. Considering the importance of the Division, one officer and one assistant officer are newly assigned to intensify the activities.

Strengthen Marketing and SEZ Department: A high priority should be given to securing customers. To accomplish this, the current Marketing and SEZ Department should be strengthened by increasing the number of marketing officials. Increased staff will also be involved in creating new PAS related businesses. Major works requested for marketing staff are as follows:

- Preparation of documents and brochures. Materials necessary for marketing activities are to be gathered, analyzed and prepared in a timely manner. These include PAS brochures, lists of existing and potential customers and basic statistics relating to PAS's activities.
- Analysis of the above basic statistics for further marketing activities. The statistics cover cargo data and information for neighboring countries such as Thailand, Laos, Vietnam, Singapore and China.
- Analysis of current customer activities in details.
- Analysis of cargos from neighboring countries. Changes in investment behaviors are carefully analyzed.
- Based on the above procedures, daily marketing activities are developed. The Department will hold a seminar inviting customers to Sihanoukville once in a year. In addition, staff will visit neighboring countries including Japan, Korea, China, Singapore, Thailand, and Vietnam for port sales once a year.

Assign a new Personnel officer: One officer will be assigned to communicate with all staff at PAS. He will be placed under the Deputy Director General, Administration Division. He will be involved in the selection of staff to attend educational training courses in foreign countries. Under the new officer, one assistant officer is assigned for support.

Assign a Training officer: The officer will be responsible for planning and execution of education and training for all staff at PAS. Under him, three staff will be assigned as his subordinates. The officer will also be involved in selection of staff who are to be sent abroad for high-level, intensive training. Under the Training officer, three staff are assigned for support. As a result, a total five officers and eleven assistant officers are to be assigned for the new operational works. They are to be selected and assigned from existing departments taking their capability into consideration.

5. STRATEGIC MASTER PLAN FOR THE DEVELOPMENT OF SIHANOUKVILLE PORT

5.1. Methodology for the Planning

5.1.1 General

The Strategic Master Plan for the Development of Sihanoukville Port will be formulated by following the steps below:

A) To clarify the roles of Sihanoukville Port toward socio-economic development of Cambodia and to identify the functions with which the port shall be furnished in order to discharge its roles.
B) To estimate the demands for each function in the country in the target year.
C) To identify the demands for Sihanoukville Port considering rational demarcation among ports including Phnom Penh Port and other international gateways.
D) To identify the gap between the demands for Sihanoukville Port and the port's capacity of supply in the target year taking account of improvement both in the existing infrastructure/superstructure and software such as container operation.
E) To identify the quantity of facilities which need to be newly constructed taking account of functional reorganization of the existing facilities.
F) To identify the available space for port development considering the existing and planned special utilization, natural conditions etc.
G) To determine the space for port development in the target year considering socio/natural environment and the growth direction of the port in ultra long term (beyond the target year).
H) To select the optimum layout plan of facilities from alternative plans considering functionality, cost efficiency, safety, future growth and socio/natural environment.
I) To study required measures toward implementation of the plan, such as PPP.

The item A) has been discussed in Chapter 3 and the roles of the port were identified as "Reduction of international transportation cost to/from Cambodia", "Provision of competitive transportation service to support implementation of the national strategies in various fields" and "Acceleration of industrial development in the littoral zone". Regarding items B) and C), demands in transport sector were discussed also in Chapter 3. Demands for industrial land were studied in "The Study on Regional Development for the Phnom Penh - Sihanoukville Growth Corridor" conducted by JICA in 2003. Based on the study, the demands for industrial land in port zone will be discussed in this Chapter. Item D) and thereafter will be discussed in this chapter.

5.1.2 Process of Strategic Environmental Assessment

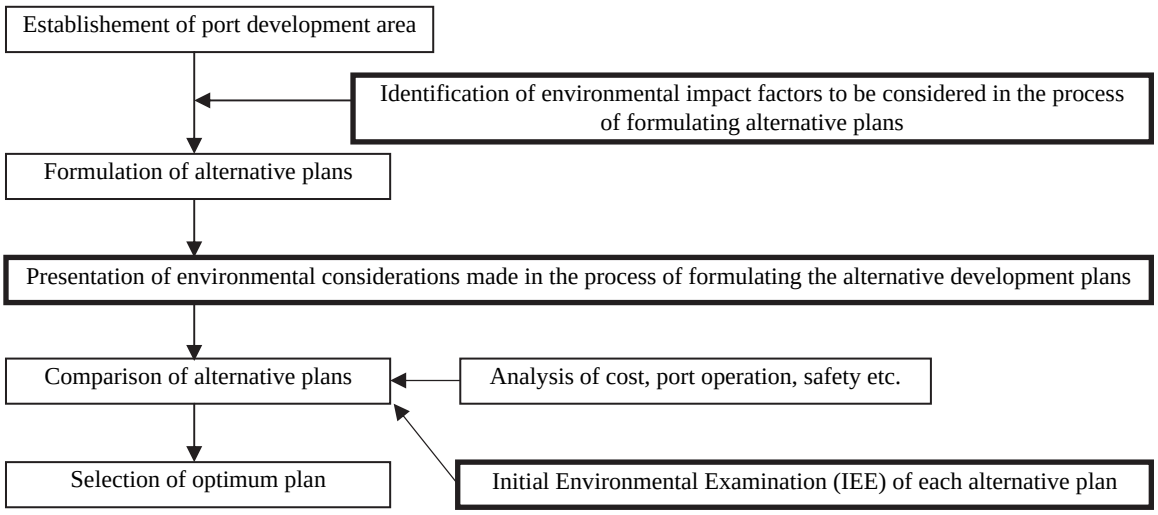
(1) General concept

During the course of formulating the development plan of Sihanoukville Port, Strategic Environmental Assessment (SEA) was conducted so to try to devise a plan with minimal environmental impact. In this study, SEA is referred to as the environmental considerations implemented in the overall process of formulating the optimum development plan. The environmental considerations implemented in the process of development plan formulation are as follows:

- Identification of environmental impact factors to be considered in the process of formulating the alternative development plans (see Section 5.1.2(2) for more details)
- Formulation of alternative development plans by considering the identified environmental impact factors (see Section 5.8.1(5) for more details)
- Presentation of environmental considerations made in the process of formulating the alternative development plans (see Section 5.8.5 for more details)

- Implementation of Initial Environmental Examination (IEE) for each development plan and comparison of environmental impacts (see Section 5.9 for more details)
- Selection of optimum plan by considering factors such as cost, port operation, safety and environmental impacts (see Section 5.10.1 for more details)

Figure 5.10-1 shows the overall flow of development plan formulation and environmental consideration.



Note: The bold frame shows the implemented environmental considerations
Prepared by Project Team

Figure 5.1-1 Overall flow of development plan formulation and environmental consideration

(2) Environmental impact factors to be considered in the process of formulating alternative plans

Based on JICA's Guidelines for Environmental and Social Consideration, 30 environmental impact factors were initially selected for potential consideration, and the most applicable factors were identified through consultation with stakeholders and JICA Advisory Committee. Eventually, 11 environmental impact factors were selected as applicable. Table 5.1-1 shows the selected environmental impact factors (as indicated by a check) and justification.

Table 5.1-1 Selected environmental impact factors and justification

	Impact factor			Justification
Social environment	1	Involuntary Resettlement	✔	Port development may require resettlement of local communities.
	2	Local Economy such as Employment and Livelihood, etc	✔	Port development may affect local economic activities such as fishing and tourism.
	3	Land Use and Utilization of Local Resources	✔	Port development may affect existing land use.
	4	Social Institutions such as Social Infrastructure and Local Decision - making Institutions	✔	Port development may result in division of local communities.
	5	Existing Social Infrastructures and Services	✔	Port development may affect existing social infrastructures.
	6	The Poor, Indigenous and Ethnic people	—	There are no exceptionally poor or indigenous and ethnic people in the development area.
	7	Misdistribution of Benefit and Damage	✔	Port development may result in misdistribution of benefit and damage.
	8	Cultural heritage	—	There are no cultural heritage in the development area.
	9	Local Conflicts of Interest	—	To be considered as part of factors 2 and 7.
	10	Water Usage or Water Rights and Communal Rights	—	To be considered as part of factors 2 and 7.
	11	Sanitation	—	Not applicable to consider at this stage but will be considered in the IEE stage.
	12	Hazards (risk) Infectious Diseases such as HIV/AIDS	—	Not applicable at this stage but will be considered in the IEE stage.
Natural environment	13	Topography and Geographical Features	✔	Port development may alter coastal topography by inducing coastal erosion.
	14	Soil Erosion	—	No impacts are expected through port development.
	15	Groundwater	—	No impacts are expected through port development.
	16	Hydrological Situation	—	There are no lakes or rivers in the development area.
	17	Coastal zone	—	No impacts are expected as development area will be limited within existing port area.
	18	Flora, Fauna and Biodiversity	✔	Possible impacts on terrestrial flora/fauna through construction of new access road.
	19	Meteorology	—	No impacts are expected through port development.
	20	Landscape	—	No impacts are expected as development area will be limited within the existing port area.
	21	Global Warming*	—	Not applicable at this stage but will be reconsidered during the formulation of the basic development plan.
Pollution	22	Air Pollution	✔	Possible impacts on local community if the new access road runs through sensitive areas such as residential area.
	23	Water Pollution	✔	New port structure may reduce water exchange and create water stagnant areas.
	24	Soil Contamination	—	No impacts are expected through port development.
	25	Waste*	—	Not applicable at this stage but will be considered in the IEE stage.
	26	Noise and Vibration	✔	Possible impacts on local community if the new access road runs through sensitive areas such as residential area.
	27	Ground Subsidence	—	No impacts are expected through port development.
	28	Offensive Odor	—	No impacts are expected through port development.
	29	Bottom Sediment	—	To be considered as part of factor 23.
	30	Accidents	—	Not applicable at this stage but will be considered in the IEE stage.

*: Although the JICA Advisory Committee recommended that "Global Warming" and Waste" be considered, the Project Team decided that these items were inapplicable at this stage. However, these factors will be considered in the ensuing stages.
Prepared by Project Team

5.2. Present Capacity of Port Facilities

5.2.1 Outline of existing facilities and equipment

Commonly, port facilities can be categorized into seven (7) facilities: waterways & basins, protective facilities, mooring facilities, transportation facilities, cargo sorting facilities, storage facilities and other facilities.

Based on information from PAS, Table 5.2-1 shows a summary of the port facilities in Sihanoukville Port (as of 2012) and Figure 5.2-1 describes the location map of the port facilities, particularly for civil & architectural. Also, Table 5.2-2 presents chronological events related to port facilities in the Port. Referring to the tables and figure, each facility categorized is generally explicated as follows:

Waterways & Basins (Nos. 1, 2, 3 &4): there are an approach channel with dimensions of 1,700 meters long, 125 meters wide and -10 m deep, and three (3) basins: tugboat, new port and container berth basins are situated respectively in front of the tugboat quay, new quay and container berths. Depths of these basins are correspondingly -3, -9 and -10 meters. According to PAS however, the actual depth of the tugboat basin is -1.5 to -2.5 meters. The approach channel, new port and container berth basins were recently dredged from 2006 to 2008.

Protective Facilities (Nos. 5, 6 & 7): three (3) breakwaters formed by rubble stones are located on the north and south sides of the Port area. On the north side bordered above the quay line of the new port and container terminal, there are two breakwaters: the north breakwater (north) is 3,350 meters long, 8.3-14 meters wide with +0.5 - +4.0 meters top elevation and the north breakwater (south) is 550 meters long, 8.3 meters wide with +4.0 meters top elevation. Ingress/egress of the harbor is just between the two breakwaters as shown in Figure 5.2-2. On the south side bordered below the quay line, the shortest breakwater called the south breakwater is located with dimensions of 300 meters long, 2.6 meters wide with +2.5 meters top elevation. All the breakwaters were constructed in the 1960s.

Mooring Facilities (Nos. 8 to 15): there are five (5) mooring facilities in the Port. Two (2) mooring facilities are made of concrete blocks: the new quay and the container berth stay inside the harbor area. The dimensions of the new quay are 350 meters long, -9 meters deep, +3.0 meters top elevation with a 9,056 square meter apron, and the container berth is 400 meters long, -10 meters deep, +3.0 meters top elevation with a 15,810 square meter apron. In the old port area, there are two (2) mooring facilities: one is the Old Jetty located on the west side facing the outer sea and made of a pier structure with dimensions of 2 x 290 meters long (both offshore and inshore sides), -9 meters deep and +5.2 meters top elevation. The other is the tugboat quay located at the tugboat basin made of concrete blocks with dimensions of 270 meters long, -3 meters deep, +2.0 meters top elevation with a 7,000 square meter apron. One isolated mooring facility is located at about 9 kilometers northeast of the Port area, which is called the oil jetty along an oil berth pier currently managed by a private sector. The dimensions of the jetty are 53 meters long x 6 meters wide RC superstructure on concrete piles, -4 meters deep and +2.6 meters top elevation. Except for the container berth, all the mooring facilities were constructed in the 1960s.

Transportation Facilities (Nos. 16 to 20): there are four (4) roads in the Port area: the west side road (15,611 square meters), internal roads behind warehouses No. 3 and Nos. 4&5 (11,952 and 38,136 square meters), and the access and internal roads of the container terminal (9,200 and 34,587 square meters). The west side road constructed in 1969 is made of only asphalt concrete pavement. The internal roads located behind the warehouses constructed in 1969 are made of concrete pavement. Likewise, the access and internal roads of the container terminal constructed in 2003 are made of concrete pavement durable for heavy-duty vehicles and other relevant cargo handling equipment.

Table 5.2-1 Major Port Facilities of Sihanoukville Port (As of 2012)

No	Category	Item		Basic Dimension Length (m)	Width (m)	Depth (CDLm)	Radius (m)	Elevation (CDLm)	Unit (nr or ls)	Area (m^2)	Type/Specification	Built or Procured in	Remark
1	Waterways & Basins	Approach Channel		1,700	125	-10	-	-	-	-	-	2005	
2		Tug Boat Basin		-	-	-3	-	-	-	-	-	1964	Actual depth: -1.5m to -2.5m
3		New Port Basin		-	-	-9	460	-	-	-	-	2006	
4		Container Berth Basin		-	-	-10	360	-	-	-	-	2008	
5	Protective Facilities	North Breakwater (north)		3,350	8.3 - 14	-	-	+0.5 - +4.0	-	-	Riprap stone mound	1967	60% completed facility. 500m opened (design 200m)
6		North Breakwater (south)		550	8.3	-	-	+4.0	-	-	Riprap stone mound	1967	
7		South Breakwater		300	2.6	-	-	+2.5	-	-	Riprap stone mound	1965	With 80m concrete block type quay for tug boat
8	Mooring Facilities	New Port	New Quay	350	-	-9	-	+3.0	-	-	Concrete block	1969	Concrete curbs damaged and some ladders lost.
9			Apron	-	-	-	-	+3.0	-	9,056	AC pavement	1969	
10		Container Berth	Container Berth	400	-	-11.5	-	+3.0	-	-	Concrete block	2004 - 2007	
11			Apron	-	-	-	-	+3.0	-	15,810	ILB pavement	2004 - 2007	Minor settlement observed
12		Old Jetty		290 x 2	-	-9	-	+5.2	-		P/C beam/caisson	1964	Refer to Sub-section 5.2.2
13		Old Port	Tug Boat Quay	270	-	-3	-	+2.0	-	-	Concrete block	1964	Some deflection at coping concrete occurred
14			Apron	-	-	-	-	+2.0	-	7,000	AC pavement	2011	Newly overlaid
15		Oil Jetty		53	6	-4	-	+2.6	-	-	RC deck on concrete piles	1976	Damaged
16	Transportation Facilities	West internal road		-	-	-	-	-	-	15,611	AC/ILB pavements	1969/2007	Located at west side of port area
17		Internal Road	behind warehouse No. 3	-	-	-	-	-	-	11,952	Concrete pavement	1969	
18			behind warehouse Nos.4&5	-	-	-	-	-	-	38,136	Concrete pavement	1969	
19		Access Road	for Container Terminal	-	-	-	-	-	-	9,200	Concrete pavement	2003	
20		Internal Road		-	-	-	-	-	-	34,587	Concrete/ILB pavements	2003/2012	Minor settlement observed
21	Cargo Sorting Facilities	Cargo Handling Equipment	QGC	-	-	-	-	-	2	-	30.5 tons	2009	
22			QGC rails	358 x 2	-	-	-	-	-	-	H-steel bolt-fixed	2004 - 2007	
23			RTG	-	-	-	-	-	7	-	35.6/40 tons	2001/2009	
24			Reach Stacker	-	-	-	-	-	9	-	45 tons	1995 - 2008	
25			Forklift	-	-	-	-	-	1	-	15 tons	1993	
26			Trailer Head and Chassis	-	-	-	-	-	31	-	20'/40'	1985 - 2009	
27			Mobile Harbor Crane	-	-	-	-	-	2	-	64 tons		
28		Container Yard	inside Container Terminal	-	-	-	-	-	-	42,000	ILB pavement	2002 - 2006	
29	Storage Facilities	Storage Yard	behind Warehouse No. 3	-	-	-	-	-	-	5,328	Concrete pavement	2001 - 2007	
30			behind Warehouse Nos. 4&5	-	-	-	-	-	-	19,094	ILB/Concrete pavements	2001 - 2007	
31		Warehouses	No.1	-	-	-	-	-	-	6,760	RC, Steel frame	1962	
32			No.2	-	-	-	-	-	-	6,760	RC, Steel frame	1962	
33			No.3	-	-	-	-	-	-	13,875	RC, Steel frame	1967 - 1969	
34			No.4	-	-	-	-	-	-	6,988	RC, Steel frame	1968 - 1969	
35			No.5	-	-	-	-	-	-	6,988	RC, Steel frame	1969 - 1969	
36	Other Facilities	Navigation Aids	Navigation Buoys and light	-	-	-	-	-	9	-	Red, Green and Yellow colored	2005	Some spare buoys stored at Old Port apron
37		Port Security Facilities	VTMS	-	-	-	-	-	1	-		2008	
38			X-ray Scanning System	-	-	-	-	-	1	-		2008	Under jurisdiction of the Custom
39			Container Checking Building	-	-	-	-	-	1	-		2008	γ-ray Scannning System, the Custom's jurisdiction
40			CCTV System	-	-	-	-	-	1	-		2008	Damaged by lightning but repaired afterward
41			Perimeter Fence						1	-			
42		Special Boats	Tug Boat	-	-	-	-	-	3	-	800HP x 2		
43			Tug Boat	-	-	-	-	-	2	-	800HP		
44			Pilot Boat	-	-	-	-	-	1	-	390HP		
45			Mooring Boat	-	-	-	-	-	1	-	175HP		
46			Patrol Boat	-	-	-	-	-	1	-	210HP x 2	2008	
47		Ship Yard		-	-	-	-	-	1	-		1962	Concession to private sector
48		Weigh Bridge		-	-	-	-	-	1	-			
49		Buildings	Administration Building	-	-	-	-	-	1	-	RC	2007	
50			Maintenance Workshop	-	-	-	-	-	1	-	RC, Steel frame	2007	
51			Utility Buildings	-	-	-	-	-	1	-	RC	2005 - 2007	
52			Gate No.1	-	-	-	-	-	1	-	RC	1962	
53			Gate No.2						1		RC	1997	
54			Gate No.3	-	-	-	-	-	1	-	RC, Steel frame	2008	
55		Railway		-	-	-	-	-	1	-		1962	Under rehabilitation by ADB project

Note: AC, ILB and RC respectively mean "Asphalt Concrete", "Inter-Locking Block" and "Reinforced Concrete".

Source: PAS, Project Team

Source: PAS, Google Earth, Project Team

Figure 5.2-1 Location Map of Port Facilities in Sihanoukville Port

Table 5.2-2 Chronological Events Related to Port Facilities in Sihanoukville Port

Year/Date	Chronological Event
1956/02/29	Grant Assistance of French Government for the Old Port given on the amount of FF 3.2 billion with a local counterpart fund of Riel 30 million (exchange rate was FF10=Riel 1 approximately at the time)
1956	Design of the Old Port executed by two French companies " De Dragages et de Travaux Publics" & "Eiffel"
1956/05/16	Commencement of construction of the Old Port by French companies
1959/08/15	Completion of construction works of the Old Port
1960/04	Opening of the Old Port
1960	Design of the New Port carried out by French Company " Dumez" and local company " Chhrun"
1962	Completion of Warehouse Nos. 1&2
1964	Partial Dredging of Port Basin carried out at the New Port
	Completion of Tug Boat Basin Quay
1960's	Construction of New Railway Line between Phnom Penh and Kompong Som by Cambodian National Railway
	Construction of National Road No.4 between Phnom Penh and Kompong Som
1967	Construction of North Breakwater (but later abandoned at the progress 60%)
1967-1969	Construction of the New Port upon the budget of US$ 18,125,000- including: 1) -10m (ACD) depth Quay, 350m long 2) Warehouse Nos. 3&4 3) Dredging of Port Basin at the New Port 4) Reclamation of the New Port area
1975-1979	Construction of Groyne at eastside of the New Quay
1986	Excavation in front of the New Port Quay from -6m to -7.5m by mobile crane with grab bucket
1987	Replacement of P/C beams by steel beams at the corner between main Jetty and Access Bridge Repair of P/C beams by mortar filling at Old Port
1989	Riprap filling underneath the P/C beams in Pier Nos. P1 and P2 of Access Bridge of Old Jetty to recover the damaged span
1994-1995	Restoration of Warehouse Nos. 1, 2 and 4 by ADB sub-project T-23
	Procurement of container stacking trucks by ADB sub-project T-14
	Procurement and installation of navigation light buoys and beacons along South Channel
1995-1996	Repairs of seaside cantilever P/C slabs by ADB sub-project T-25
	Installation of new fender system for the Old Jetty by ADB sub-project T-25
	Upgrading of container yard pavement and lighting by ADB sub-project T-24
1996-1997	Repairs of P/C beams of the Old Jetty by ADB sub-project T-25
	JICA SHV Port Master Planning and Feasibility Study
1999	Renovation of fender system at the old Jetty
1999-2001	Detailed design of SHV Port Urgent Rehabilitation Project (Phase I) by JBIC Loan
2002-2005	Construction of SHV Port Urgent Rehabilitation Project (Phase I) including: 1) -11.5 m depth Quay, 250m long (container berth) 2) 7 ha Container Yard 3) 536,000 cu.m Reclamation (+2.5) 4) -10 m depth, 758,000 cu.m Dredging (basin and approach channel) 5) 13.3ha Access and Diversion Roads 6) Electrical System for terminal including Generator Sets (800kw x 3) 7) Water Supply and Fire Fighting System 8) Yard Drainage System 9) 928m Yard Fence 10) Buildings (Generator House, Pump Control Room & Underground Tank, 60t Weighing Bridge, Gates) 11) 7 units of Navigation Buoys
2005	Detailed design of SHV Port Urgent Rehabilitation Project (Phase II) by JBIC Loan
	Replacement of Fender System of the New Quay
2005-2007	Construction of SHV Port Urgent Rehabilitation Project (Phase II) including: 1) -11.5 m depth Quay, 160m long (container berth extension) 2) 30,000 sq.m Apron & Container Yard including Terminal Building Area 3) 95,000 cu.m Reclamation 4) -10m depth, 380,000 cu.m Dredging (basin and offshore disposal) 5) Fence and Gate around Administration Building 6) Administration Building 7) Maintenance Workshop 8) Security Box 9) Terminal Utilities around Administration Building 10) Two (2) Patrol Boats
2006	Design of Port Security Project by JICA Grant Aid
2007-2008	Construction of Port Security Project including: 1) VTMS 2) X-ray Scanning System 3) Container Checking Building 4) Pavement around Container Checking Building 5) CCTV system
2011	5cm Asphalt Overlay at the Old Port Apron and the Old Jetty

Source: PAS, 1997 JICA Study Report

Cargo Sorting Facilities (Nos. 21 to 28): PAS owns cargo handling equipment and accessories such as 2 units-QGCs (30.5 tons), 2 x 358 meter long-QGC rails, 7 units-RTGs, 9 units-reach stackers, 1 unit-forklift, 31 units-trailer head with chassis and 2 units-mobile harbor cranes, which have been procured since 1985. In the container terminal, there is a 42,000 square meter container yard made of inter-locking concrete block pavement with container and RTG concrete foundations. These facilities were constructed from 2001 to 2007.

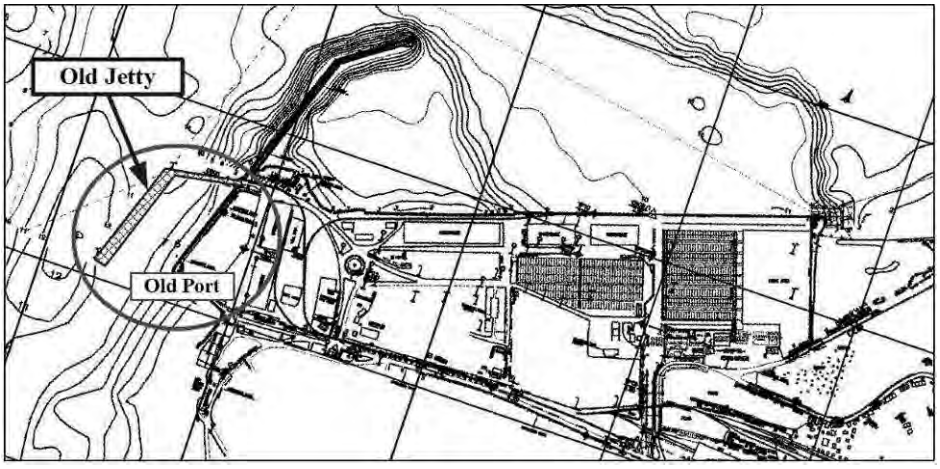
Storage Facilities (Nos. 29 to 35): Two (2) storage yards constructed after 2001 and located behind warehouses No.3 and Nos. 4&5 have areas of 5,328 and 19,094 square meters with concrete pavement. Warehouses Nos. 1 and 2 are made of reinforced concrete with a steel frame structure and are located in the old port area. Both their floor areas are 6,760 square meters. Warehouses Nos. 3, 4 and 5 were also made the same as Nos.1 and 2 and are located in the new port area. Respectively, the floor areas are 13,875, 6,988 and 6,988 square meters. All the warehouses were built in the 1960s.

Other Facilities (Nos. 36 to 55): 8 units-navigation buoys and 1 unit-navigation light are provided and installed at present. Some spare buoys are stored on the old port apron. VTMS, an X-ray scanning system and a container checking building (under the jurisdiction of Customs) and a CCTV system have been recently provided as port security facilities by the Grant Aid of Japan. Perimeter fence of the Port area behind the old and new ports, which is made of concrete walls, is already provided in 1960s but the one of expansion area at such as container terminal, which is made of cyclone wires, is newly installed at the construction of the terminal. There are eight (8) special boats working in the Port area: 3 units-tugboats (2 x 800 HP), 2 units-tugboats (800 HP), 1 unit-pilot boat (390 HP), 1 unit-mooring boat (175 HP), and 1 unit-patrol boat (2 x 210 HP). The patrol boat is also a item of the Grant Aid of Japan. Six major building facilities exist inside the Port area: the administration building, maintenance workshop, utility buildings, and Gate Nos. 1, 2 and 3. Except for Gates Nos. 1 and 2 respectively built in the 1960s and 1990s, all the buildings were constructed between 2005 and 2007. The other facilities are the shipyard (under concession to the private sector), the weighbridge located beside the new port and the railway previously used for transportation from 1960s to 1990s.

5.2.2 Structural Soundness of Old Jetty

(1) General

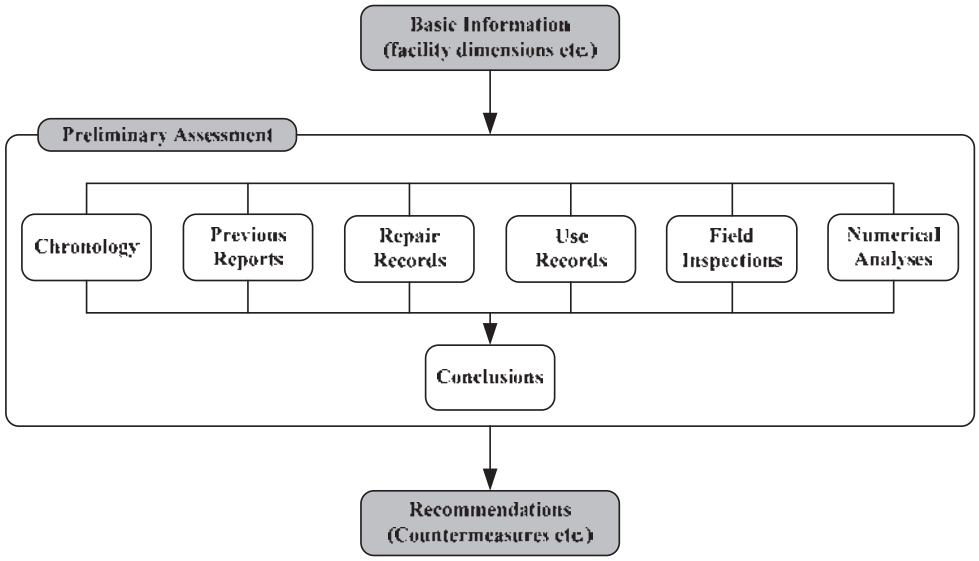
Old Jetty is located west of the Sihanoukville Port area as a part of the port facilities at Old Port constructed in 1959 as shown in Figure 5.2-2. The Jetty is composed of a 290 m long berth and a 180 m long access bridge with -9 m depth. The Jetty, as a symbol of independence from being colonized by foreign governments, is shown on the 1,000 Riel bill.



Prepared by Project Team Survey Map

Figure 5.2-2 Location of Old Jetty

This subsection discusses the structural soundness of the existing Old Jetty, and consists of basic information of the facilities given by PAS, a preliminary assessment including chronology, review of the previous reports, repair records, use records, filed inspections and numerical analyses, and recommendations inclusive of some countermeasures that might be considered for the future improvement of the Jetty. Figure 5.2-3 presents a flow diagram of components of the structural soundness of the Jetty as aforementioned.

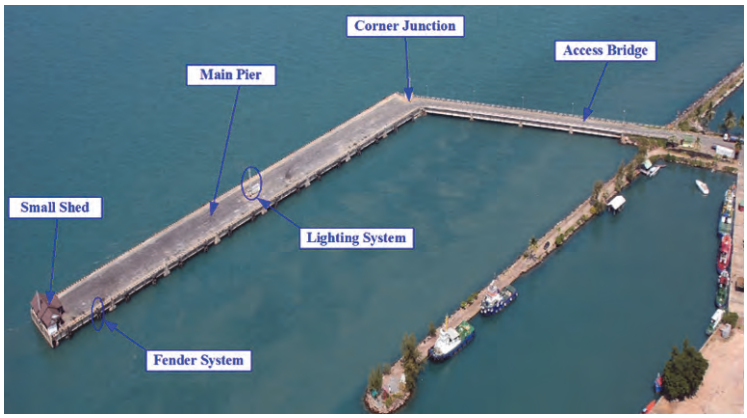


Prepared by Project Team

Figure 5.2-3 Flow Diagram of Structural Soundness

(2) Basic Information

The Old Jetty is composed of the main pier, access bridge, corner junction between the main pier and the access bridge, fender and lighting systems, a small shed and other miscellaneous items as shown in Figure 5.2-4.



Source: PAS, Project Team

Figure 5.2-4 Components of Facilities

Figure 5.2-5 illustrates the general layout, typical sections of the main pier, the access bridge and the P/C beam and Table 5.2-3 shows the general dimensions of the major facilities of the Old Jetty.

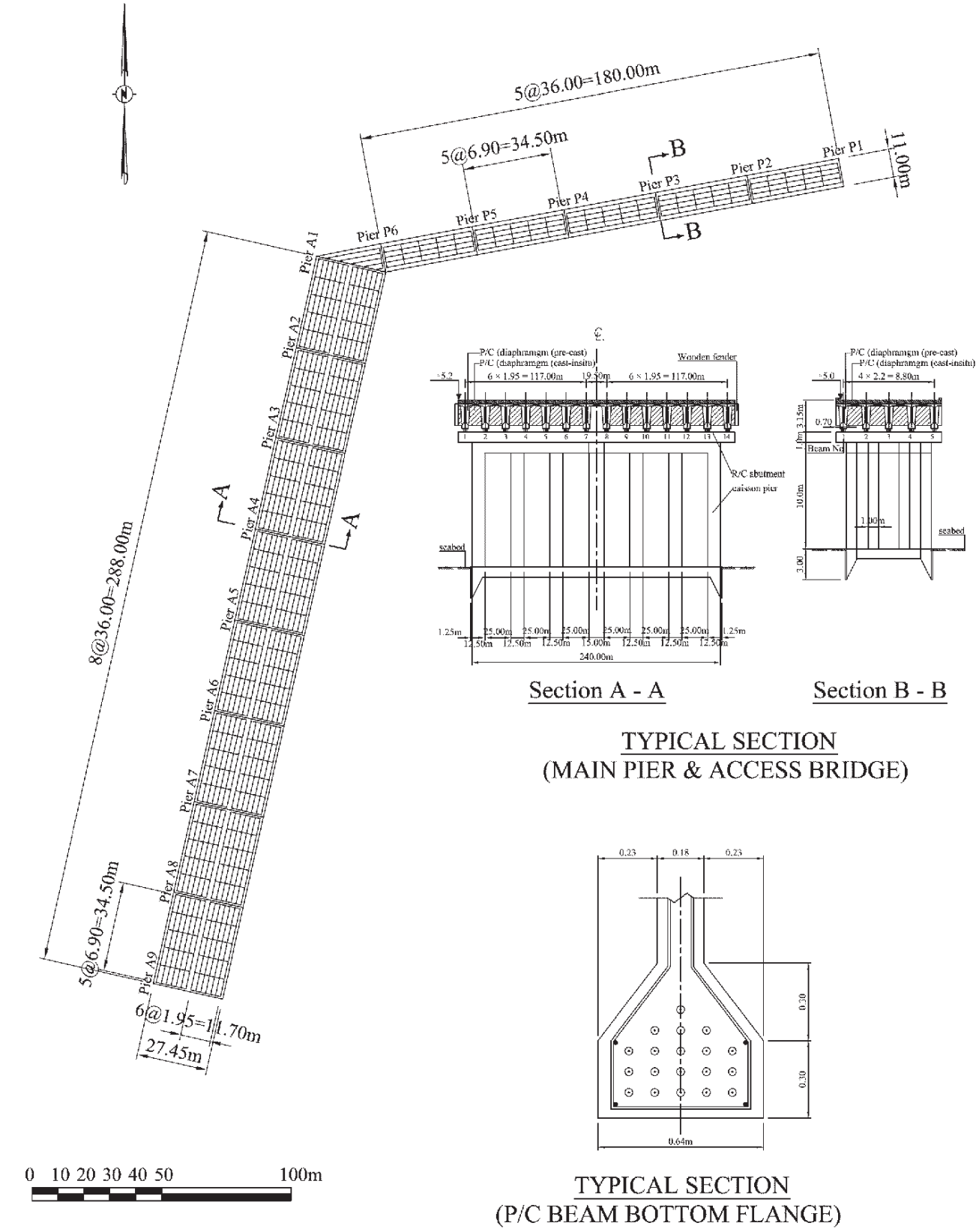
As described in the table and figure, both the main pier and access bridge are of the same structural type, which consists of T-shaped P/C beams supported by pneumatic caisson piers. The

corner junction is also the same type. However, the corner junction had serious damage where some P/C beams deteriorated and were accordingly replaced by H-shaped steel beams. This was caused by concentrated waves coming from the offshore northwest direction, which directly attacked the underneath of the corner junction. The caisson pier foundations were constructed on bare rock seabed at -10 to -11 m depth at intervals every 36 m as supporting foundations of T-shaped P/C beams. As seen in the figure, the T-shaped P/C beam is the same shape throughout the beam. All the beams are of pre-stressed reinforcement type. The diaphragms and horizontal top flange of the beams are transversely connected with each other. The total number of beams at the main pier is fourteen (14) numbered as No. 1 on the inshore side to No. 14 on the offshore side and these are connected with six (6) diaphragms into two lattice beam groups as Nos. 1-7 and 8-14. The beams at the access bridge are also connected to each other with six (6) diaphragms into one lattice beam group.

As shown in the table, the fender system is composed of tire protection and circular type rubber fenders with H-shaped steel piles. The numbers of the fender system are totally 25 units, composed of 9 units at the offshore side and 16 units at the inshore side. According to PAS, the base structure of the system was constructed from 1995 to 1996 in the ADB T-25 Sub-Project and some renovation works, such as the addition of tire protection and painting, were conducted in 1999. The H-shaped piles were driven to a suitable depth below the seabed and were connected with extension H-shaped steel members up to the same elevation as the pier deck. Two piles were also connected by H-shaped steel members with bolt joints.

The lighting system is quite simple and comprises three (3) yard type lighting towers on the main pier. Five (5) street type lighting poles on the access bridge were once installed but now removed. The system seems to function with occasional maintenance. Connected to the lighting system, the main pier has one (1) CCTV camera that has been recently installed to monitor security of port activities on the pier.

At the tip of the main pier, there is a small open shed about 170 sq m^2 without door. The shed is not for cargo loading/unloading activities, but it is often used for ceremonial events on the pier.



Source: PAS, Project Team

Figure 5.2-5 General Layout, Typical Sections of Old Jetty

Table 5.2-3 General Dimensions of Old Jetty

Item	Specification	Length (m)	Width (m)	Area (m^2)	Elevation (CDL)	Number (nr)	Remark
Main Pier	Pavement: Asphalt Concrete Pavement Slab: P/C, Rainforced Concrete Beam:T-shaped P/C Beam Foundation: Pnecumatic Caisson	288	27.45	–	+5.2	-	
Access Bridge		180	11.00	–	+4.5~+5.0	-	
Corner Junction		–	–	–	+5.0~+5.2	-	Triangle-shaped
Fender System	Tire Protection and Circular type Rubber Fender with H-shaped steel piles	-	-	-	-	9	Offshore side
						16	Inshore side
Lighting system	Yard Light type	-	-	-	-	3	Main Pier
Small Shed	RC	–	–	170	-	1	

Source: PAS, Project Team

(3) Preliminary Assessment

1) Chronology

According to the previous JICA report and the latest information newly provided by PAS, the updated chronological events of the Old Jetty are summarized in Table 5.2-4.

Table 5.2-4 Chronological Events of Old Jetty

Date	Historical Event
1959/08/15	Completion of construction works of the Old Jetty
1960/04	Opening of the Old Jetty
1987	Relacement of P/C beams by steel beams ath the corner between main Jetty and Access Bridge Repair of P/C beams by mortar filling at Old Jetty
1989	Riprap filling underneath the P/C beams in Pier Nos. P1 and P2 of Access Bridge of Old Jetty to recover the damaged span
1995-1996	Repairs of seaside cantilever P/C slabs by ADB sub-project T-25
	Construction of new fender system for the Old Jetty by ADB sub-project T-25
1996-1997	Repairs of P/C beams of the Old Jetty by ADB sub-project T-25
1999	Renovation of fender system at the old Jetty
2011	5cm Asphalt Overlay at the Old Port Apron and the Old Jetty

Note: ADB sub-project T-25 included 1) repair of cantilevered P/C slabs along seaside edge of Main Jetty, 2) installtion of 25 sets of rubber fenders with fender piles, and 3) repair of damaged P/C beams with epoxy and silane coating

Source: 1996 JICA Study Report and PAS

As seen in the table, the Old Jetty opened in 1960 and the age of the facility is currently 51 years. 17 years after opening, some structural repair works were required for some of the P/C beams at the corner junction between the main pier and the access bridge and for those of the main pier and access bridge.

From 1995, ADB started Sub-Project T-25 including repair of cantilevered P/C slabs along the seaside edge of the main pier, installation of 25 sets of rubber fenders with fender piles, and repair of damaged P/C beams with epoxy and silane coating. The sub-project was consequently completed by 1997.

Recently, at their own expense, PAS carried out 5 cm pavement overlay work on the surface of the Old Jetty. Also, PAS has independently continued repair works for the Old Jetty since 1997, referring to repair methods recommended by ADB.

2) Previous Reports

In the relevant reports collected through the Project, three (3) previous reports provide significant information relative to the Old Jetty. Among the three reports, two (2) reports discussed technical aspects, especially for repair methods, field inspections, structural analysis, etc. The other one (1) report briefly mentioned operational aspects of the Jetty, e.g. historical trend of cargo handling

volume. The following are noted individual summaries and key points:

a) ADB Sub-Project T-25 for Sihanoukville Jetty (1995-1997)

The ADB Sub-Project T-25 provided technical assistance for the Old Jetty to assess deterioration state and level, to propose repair methods, and to implement repair works for the existing damaged concrete structural members of the Jetty from 1995 to 1997. The assessment and proposal were given in the report for concrete repairs of the Old Jetty[1] and its summary is presented in Table 5.2-5.

Table 5.2-5 Summary of ADB T-25 Sub-Project Report (Concrete Repairs)

Item	Methdology/Content	Result/Conclusion
Visual Inspection	Conducting walk-over visual inspeciton with recording inspection sheets including scetch drawings	Surface cracks of cantilevered slab did not form a regular pattern due to the dusty and irregular nature of deck surface and were not possibly structual cracks
		Sginificant number of P/C beams were in an advanced level of deterioration with conrete spaling at the nderside of the main pier and access bridge
		Two P/C beams at the underside of the main pier and acceess bridge had longitudinal cracks up to 5 meters in length and 20 mm in width, and had spalled areas where P/C cables were exposed, and, in some cases, rusted to an extent where there appeared to be no effective steel cross section left
		P/C beams under the corner junction where waves are always splashing much higher than other areas, causing extensive damage, had been replaced by steel beams
Concrete Repair Method (Previous Report)	Classifying conrete damage into six (6) repair types with specifications of recommended repair materials be used	A report of repair method of the Old Jetty, preapred by Patterson Britton & Partners Pty Ltd, was referenced to this report, which stated that the basic philosophy behind the rapairs was to to extend the life of the jetty for approx. ten years, and that the prestressed concrete was extreamly difficult to repair and highlighted the hazards associated with such repair works, particularly removal of saline concrete
		The following were specified repair types in the report:
		Type 1 Small Cracks (less than 0.3 mm wide), sparay application of silane
		Type 2: Medium Cracks (0.3 mm to 1.0 mm wide), apply flood coat of silane, knife into cracks, a pate consisting of mixture of silane and silica fume, apply flood coat of silane
		Type 3: Large Cracks (lager than 1.0 mm wide), chisel out old concrete to form a Vee, wash surface of concrete with freash water and dry, trowel into crack, purpose-designed repair mortar (e.g. by SIKA, FOSROC, MBT, EPIREZ)
		Type 4: Delaminated Concrete, remove loose concrete and other areas of drummy concrete which are not contributing to the strength of the beam, wire brush exposed tendons and concrete surface to remove loose rust, dust and aggregate etc., wash with freash water and dry, apply protective epoxy paint coating to tendons, wet concrete surface, apply coating of cement/water slurry, repair concrete using vibrated comentitious concrete (1:3 cement sand mortar), and tie large reapirs into existing concrete using steel anchors and additional reinforcement
		Type 5: Spalled Concrete, repair method as for Type 4
		Tpe 6: Mechanical tie, complete all the surface reapirs, attach steel plate by epoxy to the bottom and the both sides of flange covering certain longitudnal length affected, fix the steel encasement at the both sides of the flange
Repair Quantification	Quanlitying repair volumes upon specified damaged portions	700m2 of delamination/spall surface repairs, 49 m3 of delamination/spall repaires(70 mm thk.), 105 m of crack reapirs, 10,700 m2 of silan spray coat for the bottom flange and 150 mm web surfaces, and 6,500 litters of saline material
Recommendation	General evalauation for the above	The proposed repair methods by Patterson Britton & Partners Pty Ltd.
		The quatations for specialist repair materials and silane spraying equipment are requested from overseas suppliers, followed by the placing of an order
		The repair work is supervised on a full-time basis by an expatriate supervisor experienced in remedial concrete work

Source: 1995 ADB Sub-Project T-25 Report on Concrete Repairs of Sihanoukville Jetty

As mentioned in the table, the report generally consists of four (4) major items: visual inspection, concrete repair method, repair quantification and recommendations. The major key points of the report are highlighted as follows:

- Visual inspection introduced some structural damage previously observed in 1994 and 1995. In particular:
  - The existing P/C beams were in an advanced level of deterioration.
  - Some of the existing P/C beams had serious longitudinal cracks up to 5 m long and 20 mm wide and had spalled areas where P/C cables were exposed and/or rusted.
  - Some structural members at the connection junction were structurally weak because of wave splashing caused by wave reflection generated between two abutting beam walls.
- Since difficulty of repair and reinforcement of the existing pre-stressed P/C beams was indicated and careful execution of the works was advised upon the actual implementation, six (6) concrete repair methods proposed by an Australian specialist consultant were recommended, which included Types 1 (small cracks), 2 (medium cracks), 3 (large cracks), 4

[1] SMEC (1995), Report on Concrete Repairs to Sihanoukville Jetty, Project Implementation Unit PIU-MPWT, Ministry of Public Works and Transport, Kingdom of Cambodia, ADB

(delaminated concrete), 5 (spalled concrete), and 6 (mechanical tie).

- The importance of providing certain specified materials by overseas suppliers and of supervising all the repair works on a full-time basis by an expatriate supervisor experienced in remedial work was highlighted.

b) JICA Study on M/P & F/S for Sihanoukville Port (1996-1997)

At almost the same time as the ADB T-25 Sub-Project, a Mater Plan & Feasibility Study was conducted by JICA from 1996 to 1997. The study included a structural diagnosis of the Old Jetty based on visual inspection, chemical test, non-distractive tests, and structural analysis. The diagnosis was given in the report[2] and its summary is shown in Table 5.2-6.

Table 5.2-6 Summary of JICA M/P&F/S Report

Item	Methdology/Content	Result/Conclusion
Visual Inspection	Identifying damage level of the existing P/C beams upon six (6) damage levels classification	Specifically, 9 out of 132 P/C main beams (7%), or 6 out of 21 lattice beams groups (21%) were damaged in serious condition
		P/C beam No.4 between pier Nos. P6 and P5 at access bridge was precarious compared to others, which might be collapsed depending on loading conditions
		Except for the above beam No.4, damage and deterioration of the P/C beams generally tended to occur at the both ends of each beam where splash made by coming or reflecting waves always wetted the concrete surface
		41 out of 96 traverse P/C cable concrete encasements (43%) were damaged probably by ship berthing, which might cause looseness of the traverse P/C cables originally pre-stressed and was deemed to be no longer effective as lattice beam structures
		30% of offshore cantilever P/C slabs along beam No. 14 were damaged by moored ships and replaced with R/C (reinforced concrete) slabs which seemed to be no longer effective equivalent to durability of P/C slabs
		Some diaphragm connections in between piers Nos. A5 and A4, and Nos. A6 and A5 were seriously damaged in correspondence to damaged P/C beams in front
Saline Contents Test	Sampling two Specimens A&B by core drillingmachine, cuting each test peace by 15mm, and conducting chemical analysis in Japanese laboratiry in compliance with JIS No. R5202	Two Specimens A and B identified as Grade III of damage level classification in the visual inspection, sampled from beam No. 11 between pier Nos. A6 and A5, and beam No. 12 between pier Nos. A3 and A2, indicated serious infiltration of saline contents.
		Especially, the infiltration reached rebars and even some P/C cables for Specimen B
		This situation implied possible damages of reinforcing rebars and P/C cables certainly for some other beams identified as Grades III, IV as well as V.
Half-cell Potential Test	Measuring potentials along the surface of a P/C beam bottom flange (main jetty) in compliance with ASTM C876-91	The actual measurement results showed much more negtive levels than a classification "greater than 90% probability that reinforcing steel corrosion occurs
Compressive Strength Test	Using shmidt Hammer to seven (7) points of the existing P/C beams	Large fluctuations were shown in range of avarage strength between 395 and 600 kg/cm2 or bigger
		Some strengths seemed lower than the measured in consideration of long duration of concrete hydration
Structural Analysis	Allowable stress method	Case I (orginal structural conditions, assuming no any damages and 1.5 t/m2 uniformly loaded) was within allowable stresses
		Case II (present structural conditions, assuming one half of bottom flange concrete and P/C cables are lost, and 1.5 t/m2 uniformly loaded) was beyond allowable stresses
		Case III (present structural conditions, assuming one half of bottom flange concrete and P/C cables are lost) obtained maximum 0.9 t/m2 of applicable unfom load as calcurated backward
Structural Diagnosis	General evaluation of the above	Structure of the Old Jetty will be usable for coming several years with careful operation under certain restriction of loads, taking the present conditions into consideration

Source: 1997 JICA M/S&F/S Final Report, Vol.2

As stated in the table, the report generally consists of six (6) major items: visual inspection, saline contents test, half-cell potential test, compressive strength test, structural analysis and structural diagnosis. The major key points of the report are highlighted as follows:

- Visual inspection found progressive damage and deterioration classified by six (6) damage levels defined as Grades 0 (no damage), I (small cracks), II (slight damage), III (medium damage), IV (heavy damage) and V (serious damage). In particular:
  - 7% of main beams (9 of 132 main beams) or 29% of lattice beams groups (6 of 21 lattice beams groups) were seriously damaged in the main pier and access bridge. Over 50% of the concrete section of the bottom flange was lost resulting in exposure of P/C cables.
  - P/C beam No. 4 between pier Nos. P6 and P5 on the access bridge might collapse due to

[2] The Overseas Coastal Area Development Institute of Japan (OCDI), Pacific Consultants International (PCI) (1997), Final Report, Vol. 2 Master Planning, The Study on Master Planning and Feasibility Study of the Sihanoukville Port in the Kingdom of Cambodia, JICA

serious damage that has occurred at the center of the beam. Other beams generally had damage and deterioration at both ends of each beam where the wave splashed concrete surface was always wet.

- 43% of traverse P/C cable encasements at the main pier and access bridge were damaged by ship berthing and the pre-stressed concrete might be loosened and not effective as a lattice beam structure.
- 30% of seaside cantilever P/C slabs along beam No. 14 had been damaged by mooring ships and were replaced with reinforced concrete.
- Some of the diaphragms between pier Nos. A5 and A4, and A7 and A6 were cracked in connection with the serious P/C beam damage.

- Serious saline infiltration reaching all the outer P/C cables was confirmed at the two sampled specimens designated as Grade III in the visual inspection, which was related to wide-ranging erosion of reinforcing steels resulted from half-cell potential test.
- Maximum applicable uniform load for the existing P/C beams was estimated at 0.9 tf/m² under the damaged structural conditions and it was assumed that one half of the bottom flange concrete and P/C cables were lost. This result is 60% of the uniform load assumed (1.5tf/m²) for the original P/C beams without any damage.
- Although the development of damage and deterioration were expected to grow worse in the future due to saline effects into the existing structural members and their process and behavior seemed uncertain, the Old Jetty would be usable for the near future with careful operation under restricted loading conditions.

c) JICA SAPROF for Sihanoukville Port Urgent Development (2008)

Recently, Special Assistance for Project Formation (SAPROF) was carried out by JICA in 2008 for urgent development of an oil supply base & multi-purpose terminal. The SAPROF reviewed the Old Jetty especially from the aspect of cargo operation in the report[3] and the major key points are highlighted as follows:

- Cement and fertilizer are the main cargoes that have been handled at the Old Jetty.
- The cargo trends characterize three (3) situations composed of small-scaled fluctuation up to 1998 with the cargoes less than 200,000 tons, large scaled fluctuation from 1999 to 2004 with the cargoes between 200,000 to 600,000 tons, and diminishing fluctuation after 2005 to the present with the cargoes approximately under 100,000 tons.

3) Repair Records

As previously presented in Table 5.2-4, the first repair work was carried out in 1987 and included replacement of the damaged P/C beams with I-shaped beams and mortar filling. After two years, riprap filling was implemented underneath the broken P/C beams between pier Nos. P2 and P1 at the access bridge. In 1995, full-scaled repair work of P/C beams was conducted by ADB T-25 Sub-Project, which consisted of repairs of P/C slabs, a fender system and P/C beams. In particular, repairs of the P/C beams were the most essential and were designated as Types 1 to 6 as described in Table 5.2-5. The repair work was completed in 1999. After the ADB Project, PAS successively executed the repair works with reference to the same repair methods and incorporation of a modified method to Type 6. Table 5.2-7 shows a summary of the repair methods for P/C beams that were independently financed and undertaken by PAS. The table illustrates six (6) repair methods depending on damage level to be identified upon visual inspection. Types 1 to 5 are the same methods as those proposed in the ADB Project; however, Type 6 is divided into two (2) methods: Types 6-1 and 6-2. Although the basic concepts are the same for both, they are modified and improved by PAS to be

[3] Nippon Koei, OCDI, (2008), Special Assistance for Project Formation for Sihanoukville Port Urgent Development for Oil Supply Base & Multi-purpose Terminal in the Kingdom of Cambodia, JICA

suitable for the actual damage conditions.

Among the collected data and information, it is difficult to accurately identify the actual repaired portions by type, since many different repair methods have been applied on the same areas by PAS after the ADB Project. In addition, not enough systematic records remain. Some chronological damage transition may be implied in traceable repair records mentioned in sub-section 3) "Field Inspections." In this situation, a repair record is prepared by PAS only for Types 6-1 and 6-2 with verification of the actual field condition as shown in Figure 5.2-6. The figure represents the distribution of the actual repair methods applied as Types 6-1 and 6-2, which are supposed to indicate serious progressive damage and deterioration with saline reaction, e.g. loosening of some P/C cables resulting in further corrosion of steel materials, developing new cracks and spalling, etc. The following are observations of the distribution:

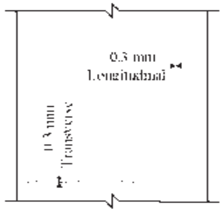
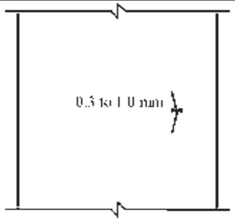
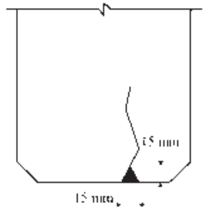
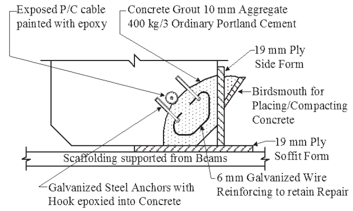
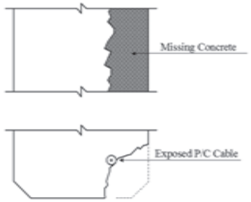
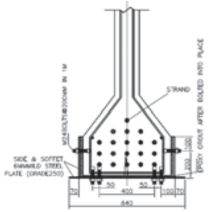
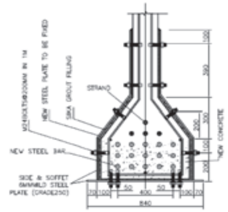
- 29% of main beams (38 of 132 main beams) or 76% of lattice beams groups (16 of 21 lattice beams groups) in the main pier and access bridge have been repaired by Types 6-1 or 6-2, which have had serious progressive damage and deterioration due to saline reaction.
- 12% of main beams (16 of 132 main beams) in the main pier and access bridge were designated as Types 6-1 or 6-2, where serious progressive damage exists at the center of their beams and bending stress has reached the maximum level.
- 38% of lattice beams groups (8 of 21 lattice beams groups) in the main pier and access bridge, which were already repaired by Types 6-1 or 6-2, have extensive damage in the same group and are in a hazardous condition.

4) Use Records

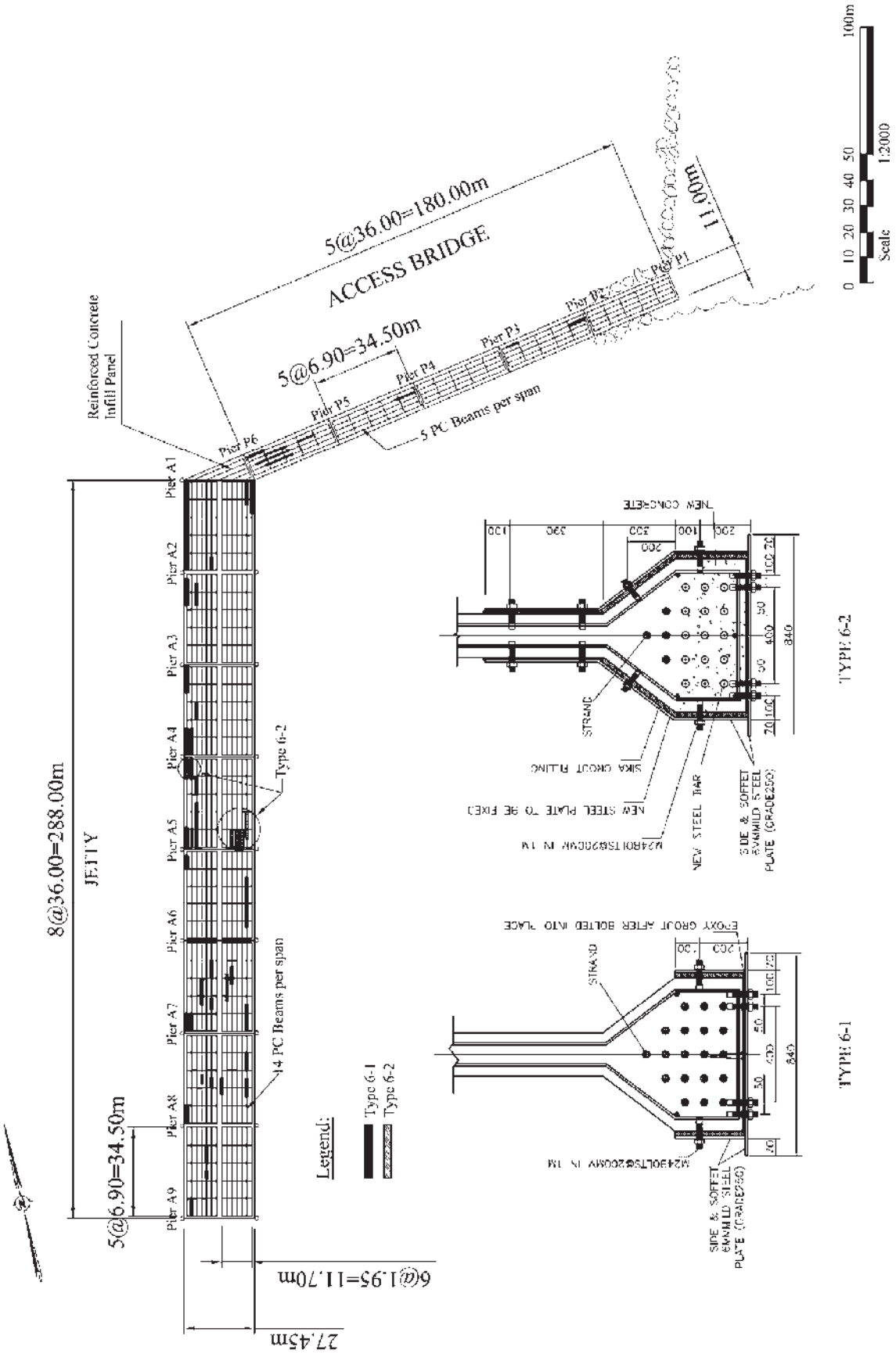
The 2008 SAPROF Report gives cargo volumes handled at the Old Jetty from 1992 to 2008 in order to discuss the use of the Jetty that has been used for docking passenger ships and barges due to the shortage of berthing facilities. Figure 5.2-7 presents an updated historical trend of cargo volume handled at the Old Jetty, with information from the SAPROF Report and new statistics provided by PAS. As seen in the figure, the cargo volume decreased from 1996 to 1998, probably due to the recommended loading restriction in the 1996 JICA Report that took the actual usage into account. However, the volume quickly increased to approximately 400,000 to 560,000 tons from 1999 to 2003, which was 2-3 times of the volume in 1999. In 2004, the volume stopped increasing and decreased rapidly up to 200,000 tons, which might have been consequently affected by a ban enforced by the Cambodian Government for maritime transport of cement. After 2005, the volume increased once in 2006, but has continuously decreased as described in the figure. This decrease is probably related to the increased cargo loading volume of cement at Okinha Mong Port even after the said ban was cancelled, which has been developed and operated by the private sector. Assuming the most frequent calling vessels at Old Jetty are an average of 10,000 DWT general cargo with a length of around 130 m, based on several field observations during loading operation with consideration of a 70% practical loading factor, the following estimates are given:

- 2.4 berthing vessels berth monthly at the Jetty, where total cargo handling volume is 200,000 tons per year (=200,000 tons/yr / (10,000 tons x 0.7) / 12 months)
- 6.7 berthing vessels berth monthly at the Jetty, where total cargo handling volume is 560,000 tons per year (=560,000 tons/yr / (10,000 tons x 0.7) / 12 months)

Table 5.2-7 PAS Repair Methods for P/C Beams

Type	1	2	3	4
Schematic Drawing				
Method	a) Apply SIKA roof seal after concrete surface is cleared by brushing and fresh water	a) Apply SIKA roof seal after concrete surface is cleared by brushing and fresh water	a) Chisel out old concrete to form a Vee shape, b) Wash surface of the concrete with fresh water, let it dry, c) Trowel into crack repair by mortar e.g. by SIKA	a) Remove loose concrete and other drummy concrete (hallow drummy sound when tapped with small metal striker and cracks along most of boundary of the area), b) Wire brush exposed tendons and concrete surface to remove loose rust, dust and aggregate etc., c) Prepare formwork supported by scalffliding, d) Apply protective epoxy paint cating to tendons (if P/C cables are heavily rusted or broken at large repaired area, cut and repalce these by high strength reinforcing steel with connection by welding to sound part of P/C cables), e) Wet concrete surface and apply coating of cement, SIKA LATEX and water slurry, f) Repair concrete using cementitious concrete with admixture (e.g. SIKA LATEX.. Increasing adhension, reduce shrinkage)
Remark	* Modified by PAS (previously spray of silane was applied to this type, which was suggested in SMEC report of ADB T-25 sub-project)	* Modified by PAS (previously mortar comprising silane and silica fume were applied to this type, which was suggested in SMEC report of ADB T-25 sub-project)	* Application of cementitious mortar is depending on manufactuerer's instruction of such as SIKA, FOSROC, EPIREZ or MBT	
Type	**5**	**6-1**	**6-2**	
Schmatic Drawing				
Method	a) Basically same as Type 5 from a) to f)	a) Basically same as Type 4 from a) to f), b) After a), install steel plates encased to the bottom flange and fixed by bolts, c) Infill epoxy grout between the plates and the concrete surfaces after the bolts are fixed	a) Basically same as Type 4 from a) to f), b) After a), install steel plates encased to the middle of I-shaped beam and fixed by bolts, c) Infill epoxy grout between the plates and the concrete surfaces after the bolts are fixed	
Remark	* Same method of Type 4 is basically applied to this repair type	* This method is for more serious damaged case than the one of Type 5, which is developed by PAS based on a suggestion made in SMEC report of ADB T-25 sub-project	* This method is for more serious damaged case than the one of Type 6-1, which is developed by PAS, which is developed by PAS based on a suggestion made in SMEC report of ADB T-25 sub-project	

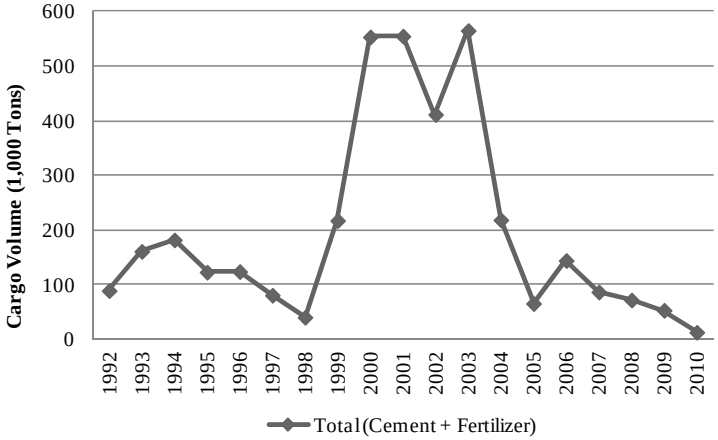
Source: PAS & Project Team



Source: PAS & Project Team

Figure 5.2-6 Repair Record for P/C Beams (Types 6-1 and 6-2)

The aforementioned cases are simply converted to 0.6 to 1.7 berthing vessels a week (assuming four (4) weeks a month) for the past 15 years from 1992 to 2010. It is deemed that the frequency of the berthing is smaller but invisible impacts may accumulate on the jetty structures even if the use is under restriction by PAS.



Source: 2008 SAPROF Report and PAS

Figure 5.2-7 Historical Trend of Cargo Handling Volume at Old Jetty

5) Field Inspections

Field inspections were carried out with three (3) approaches. The first, defined as "Facility Assessment" was to comprehensively inspect all the components of the Old Jetty. The second, defined as "Detailed Inspection" was to exclusively observe the damage level of P/C beams and other relevant members referring to the inspections previously and periodically conducted by JICA and PAS. The third, defined as "Non-Distractive Test" was to confirm concrete strength for the existing P/C beams at the site by using an instrument.

a) Facility Assessment

The facility assessment refers to a method of a general inspection and diagnosis using a general inspection sheet developed in a Japanese manual issued by the Costal Development Institute of Technology (CDIT)[4]. The inspection and diagnosis were basically carried out by a visual inspection according to the common items and criteria listed in the said sheet for allover facilities. Table 5.2-8 presents the deterioration criteria as specified in the said manual. The criteria define four (4) levels of condition of member(s) as seen in the table.

Table 5.2-8 Deterioration Criteria for Inspection and Diagnosis

Level	Condition of Member(s)
a	Quality and performance conspicuously lowered
b	Quality and performance lowered
c	Disturbance started, but quality and performance not lowered
d	No defect confirmed

Source: Technical Maintenance Manual of Port Facilities in Japan

Based on the classification of the deterioration level, the manual indicates a method for assessment of objective facilities. Considering the impact on higher safety grade of the Old Jetty, the following assessment criteria were consequently applied to the facility assessment as described in Table 5.2-9.

[4] Coastal Development Institute of Technology (CDIT), Port & Airport Research Institute (PARIS), (2007), Technical Maintenance Manual of Port Facilities in Japan (Japanese Edition)

Table 5.2-9 Applied Facility Assessment Criteria

Classification	A	B	C	D
Facility Condition	Capacity and performance apparently lowered	Capacity and performance might be lowered, in case of neglect	Continuous observation required, even no disturbance confirmed for capacity and performance	Satisfactory capacity and performance remained without any defect
Assessment Criteria	"a" is more than one (1) and capacity and performance of facility are already lowered	Either "a" or "b" is more than one (1) and capacity and performance of facility might be lowered	Except for A, B, C	All are "d"

Source: Technical Maintenance Manual of Port Facilities in Japan

Tables 5.2-10 and 5.2-11 respectively show the results of the facility assessment of the main pier, corner junction and access bridge. Figures 5.2-8, 5.2-9 and 5.2-10 present the actual site conditions of the inspected items of the Jetty. Remarkable notes of the results of the assessment for the main pier, and corner junction and access bridge are summarized below:

- **Main pier** (refer to Table 5.2-10 and Figures 5.2-8, 5.2-9 and 5.2-10)

The main pier has ten (10) major inspection items, including the drainage system, mooring bollard, fender system, concrete curb, quay alignment, apron, superstructure, foundation, lighting system and building. As seen in Table 5.2-10, the main pier has three (3) seriously damaged facilities for which the capacity and performance are being lowered/might be lowered as indicated as “A” and “B” upon classification.

The fender system is one of the serious damaged facilities mostly aggregated to the offshore side. However, the damage on the inshore side is minimal even though some minor deterioration was observed (refer to Figure 5.2-8). In the damage on the offshore side, about 70-80% of the fender systems have medium-heavy and/or serious conditions against the total of the offshore side. Such fender systems have serious cracks observed on the surface and the connections with fitting bolts of rubber circular fenders. It is assumed that such damaged fender systems cannot fully perform energy absorption of vessel berthing force depending on the size of the calling vessel and its berthing condition. According to pilots of PAS, vessels berthing to the Old Jetty have difficulty in maneuvering when the southwest wind comes during the rainy season. This probably leads to unexpected berthing forces that make fender systems move in unforeseen ways not considered in their design. Also, the system had another problem where some supporting H-shaped steel piles were deformed due to the same reason and the uncontrolled berthing vessels directly striking the beams. The axis of the deformed supporting piles was not parallel to quay alignment and was inappropriate. Such damage is pronounced only on the offshore side whereas the damage on the inshore side is minimal because berthing vessels on the inshore side are normally smaller-sized, the numbers of the fender system installed are sixteen (16) compared to nine (9) on the offshore side, and easier maneuvering conditions are created by the pier structures acting as protective cover for coming winds, waves, currents, etc.

The superstructure of the Old Jetty is well known as the most seriously damaged and was also reported in the 1996 JICA Study Report. Major structural components are P/C beams and P/C and RC slabs. Although damage and deterioration of the P/C beams have progressed gradually, some repair works have been simultaneously on-going by PAS since 1998, based on the PAS established repair methods as seen in Figures 5.2-9 and 5.2-10, which includes Type 1 to 6-1 & 6-2 categorized according to corresponding damage levels.

Generally speaking, by the continuous efforts of PAS, the damaged and deteriorated portions of the beams were less than anticipated in terms of appearance, even though some new damage was observed. It is noted that the most of the portions with cracks, damage and/or breakage were the

portions previously repaired by epoxy mortar and/or filling concrete with new reinforcement (Types 1-5). Some portions where steel plate encasement was applied (Types 6-1 and 6-2) still work stably even though the steel materials have rusted slightly due to seawater and its splash. Also, as reported in the previous report, it is presumed that the edge and portions of the beams where waves and/or splash frequently come tend to have heavier damage and/or deterioration. In addition, it was also observed that some traverse P/C cable concrete encasements had damage and breakage, especially at the offshore side with several end caps of the cable exposed.

Based on visual inspection, the foundation of P/C beams comprising traverse abutting beams and caisson piers is probably less deteriorated than those of the P/C beams. It is recognized that the unconfirmed caisson piers in the seawater seem stable, but about 80% of the abutting beams on the offshore side show rusted rebars and lost corners of concrete originally well shaped, which also may be a result of wave washing, deterioration, being struck by calling vessels, etc. as found in Figures 5.2-9 and 5.2-10. As shown in the figures, it is also observed that the biggest abutting beam located at the tip of the main pier has progressive damage and deterioration and exposure of rebars at the corners, and 20-30% of the abutting beams on the inshore side have some small breakage and exposure of rebars.

Moreover, the assessment gives "C" or "D" to other inspected items such as the drainage system, mooring bollard, concrete curbs, quay alignment, apron, lighting system and building, which are presumed to be newly constructed and continuously maintained in an appropriate manner and have less damage and deterioration.

Table 5.2-10 Facility Assessment on General Inspection (Main Pier)

Part of Jetty / Insction Item			Main Pier A9	A8	A7	A6	A5	A4	A3	A2	A1	Assessment	Remark
Drainage System			d	d	d	d	d	d	d	d		D	
Mooring Bollard		Offshore	d	c	c	c	d	c	d	c		C	
		Inshore	d	d	d	d	d	d	d	d		D	
Fender System		Offshore	c	a	a	a	a	a	a	c		A	
		Inshore	d	c	c	c	c	d	c	d		C	
Concrete Curb		Offshore	d	d	d	d	d	d	d	d		D	
		Inshore	d	d	d	d	d	d	d	d		D	
Quay Alighment		Offshore	d	d	d	d	d	d	d	d		D	
		Inshore	d	d	d	d	d	d	d	d		D	
Apron			d	d	d	d	d	d	d	d		D	
Superstructure	Underneath		a	a	a	a	a	a	a	a		A	On-going repair
	Upper/Side		d	a	c	c	d	d	d	d		A	
Foundation	Abutting Beam	Offshore	b	b	a	b	b	b	c	b		A	
		Inshore	b	c	c	b	b	c	d	d		B	
	Caisson		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		-	Undone, not available
Lighting System			d	-	-	-	d	-	-	d		D	
Building	Small Shed		c	-	-	-	-	-	-	-		C	

Prepared by Project Team

Table 5.2-11 Facility Assessment on General Inspection (Corner Junction & Access Bridge)

Part of Jetty / Insction Item			Corner Junction	Access Bridge P6	P5	P4	P3	P2	P1	Assessment	Remark
Drainage System			d	d	d	d	d	d		D	
Concrete Curb			d	d	d	d	d	d		D	
Quay (Bridge) Alighment			d	d	d	d	d	d		D	
Apron (Access Road)			d	d	d	d	d	d		D	Paved Area
Superstructure	Underneath		a	a	b	b	b	a		A	On-going repair
	Upper/Side		c	d	d	d	d	b		C	
Foundation	Abutting Beam	North	-	b	b	c	c	-		B	
		South	-	c	c	c	c	-		C	
	Caisson		-	N/A	N/A	N/A	N/A	-		-	Undone, Not available

Prepared by Project Team

(1) Main Pier Overview

(2) Main Pier (inshore side)

(3) Main Pier (offshore side)

(4) Bollard (inshore side)

(5) Bollard (offshore side)

(6) Concrete Curb

(7) Circular Fender (offshore side)
Seriously damaged

(8) Circular Fender (inshore side)
Minor crack

(9) Entrance Gate

(10) Fender. Supporting H-Piles (offshore side), Deformed

(11) Fender Supporting H-Piles (inshore side), Rusted

(12) Apron (offshore side)
Restriction Markings

(13) Apron (center)

(14) Small Shed

(15) Apron Lighting System
CCTV camera attached

Prepared by Project Team

Figure 5.2-8 Site Conditions of Inspected Items at Old Jetty (a)

(16) **Damaged RC Slab (Main Pier)**
Rebars exposed

(17) **Damaged Support (Main Pier)**
Corner broken with rebar exposed

(18) **Repaired P/C Beam (Main Pier)**
Type 6-1 (Steel plate encasement)

(19) **Repaired P/C Beam (Main Pier)**
Type 6-2 (Steel plate encasement)

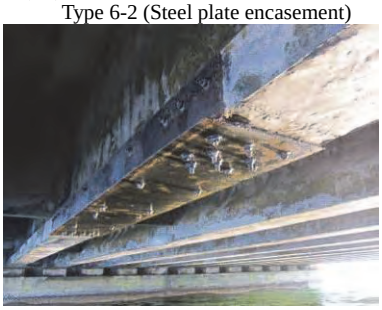
(20) **Damaged P/C Beam (Main Pier)**
Concrete broken & Rebar exposed

(21) **Cracked P/C Beam (Main Pier)**
Crack and Rusted Fluid

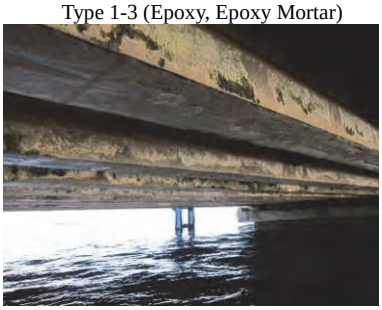
(22) **Repaired P/C Beam (Main Pier)**
Type 6-2 (Steel plate encasement)

(23) **Repaired P/C Beam (Main Pier)**
Type 1-3 (Epoxy, Epoxy Mortar)

(24) **Cracked P/C Beam (Main Pier)**
Type 4 (Concreted with new rebar)



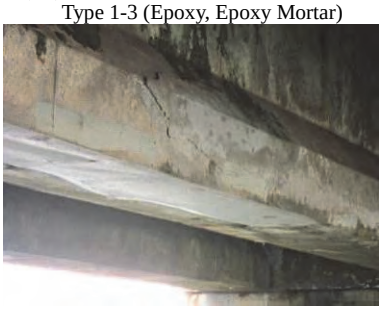
(25) **Repaired P/C Beam (Main Pier)**
Type 6-1 (Steel plate encasement)



(26) **Repaired P/C Beam (Main Pier)**
Type 1-3 (Epoxy, Epoxy Mortar)

(27) **Repaired P/C Beam (Main Pier)**
Type 6-1 (Steel plate encasement)

(28) **Cracked P/C Beam (Access Brdg.)**
Type 1-3 (Epoxy Mortar)



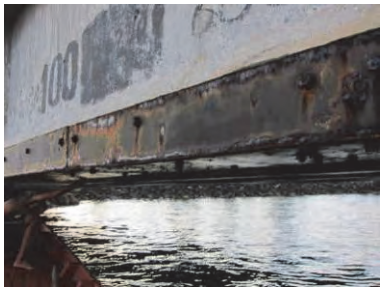
(29) **Cracked P/C Beam (Access Brdg.)**
Type 1-3 (Epoxy Mortar)

(30) **Cracked P/C Beam (Access Brdg.)**
Type 1-3 (Epoxy Mortar)

Prepared by Project Team

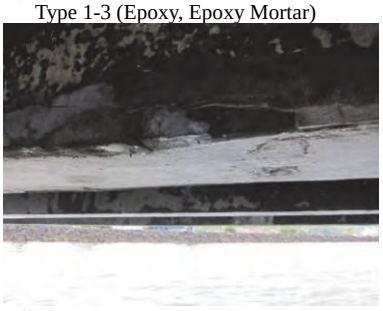
Figure 5.2-9 Site Conditions of Inspected Items at Old Jetty (b)

(31) **Cracked P/C Beam (Access Brdg.)**
Type 1-3 (Epoxy, Epoxy Mortar)

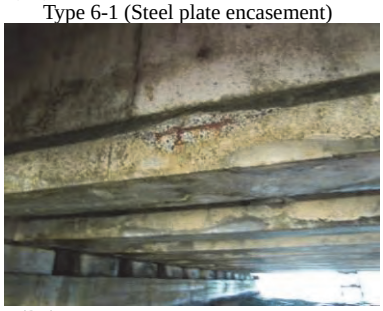


(32) **Repaired P/C Beam (Access Brdg.)**
Type 6-1 (Steel plate encasement)

(33) **Damaged P/C Beam (Access Brdg.)**
Type 4 (Concreted with new rebar)

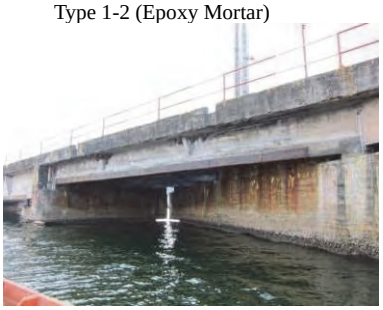


(34) **Damaged P/C Beam (Access Brdg.)**
Type 1-2 (Epoxy Mortar)

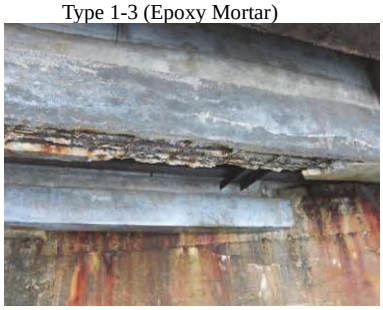


(35) **Damaged P/C Beam (Access Brdg.)**
Type 1-3 (Epoxy Mortar)

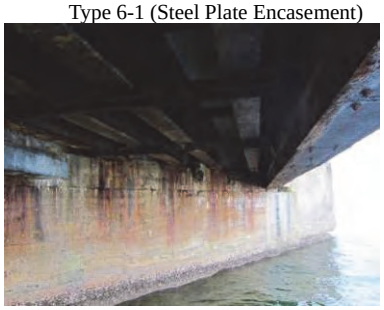
(36) **Repaired P/C Beam (Access Brdg.)**
Type 6-1 (Steel Plate Encasement)



(37) **Corner Junction Overview**



(38) **Damaged P/C Beam (Cnr. Junction)**
Type 2 (Epoxy Mortar)



(39) **Repaired P/C Beam (Cnr. Junction)**
Replaced by H-shaped Steel Beam

(40) **Damaged Abutting Beam (MP/inshore),** Rebars exposed

(41) **Damaged Abutting Beam (MP/inshore),** Rebars exposed

(42) **Damaged Traverse P/C Cable Concrete Encasement (MP/inshore)**

(43) **Damaged Abutting Beam (MP/offshore)**, Rebars exposed & concrete deteriorated

(44) **Damaged Abutting Beam (MP/offshore),** Rebars exposed & rust fluid

(45) **Damaged Traverse P/C Cable Encasement (MP/offshore)**, Some cable exposed

Prepared by Project Team

Figure 5.2-10 Site Conditions of Inspected Items at Old Jetty (c)

- **Corner Junction and Access Bridge** (refer to Table 5.2-11 and Figures 5.2-8, 5.2-9 and 5.2-10)

The corner junction and access bridge have six (6) major inspection items: drainage system, concrete curb, bridge alignment, apron (access road), superstructure and foundation. As seen in Table 5.2-11, the main pier has two (2) seriously damaged facilities for which the capacity and performance are being lowered/might be lowered as indicated as "A" or "B" upon classification.

Superstructure of the corner junction was damaged and some P/C beams were replaced with H-shaped steel beams in 1987 as aforementioned in (1) "Chronology" and (3) "Repair Record." The present structural members at the corner junction are composed of H-shaped steel beams, some remaining P/C beams, and P/C and RC slabs. As seen in Figure 5.2-10, the repaired H-shaped steel beams still work stably, even though corrosion of the beams is progressing all around. However, it is observed that the bottom of one concrete beam has fallen down and rusted rebars are exposed to the splash zone. This section requires immediate repair with appropriate methodology and urgent treatment at the site. Superstructure of the access bridge has the same components as the main pier. As the main pier, the major concern is also damage and deterioration of P/C beams. Upon observation, P/C beams between pier Nos. P6 to P5 have many traceable repaired portions categorized at serious level with application of repair methods of Type 6-1. It is characterized that the damage was most likely at the center of the beams as reported in the 1997 JICA Study Report. Although a fatal rupture of P/C beams between pier P2 and P1 could be confirmed from the side walkway toward the south breakwater, the damage was already repaired by riprap filling in 1989 and its condition currently seems steady. At the other parts of P/C beams, repair methods of Types 1 to 5 were applied throughout, depending on the level of damage and deterioration. All the P/C beams seem to be repaired overall with application of one of the repair methods established by PAS as stated in (3) "Repair Record." It is also observed that the edge of the beams and portions of the beams where waves and/or splash frequently comes tend to have heavier damage and/or deterioration like the main pier, and some traverse P/C cable concrete encasements have damage and breakage especially on the offshore side with several end caps of the cable exposed. Furthermore, it is confirmed that some repaired portions, especially those repaired by epoxy mortar and filling concrete with new reinforcement (Types 1 to 5), have some minor breakage at the corners, cracks and spalling of concrete as referred to in Figures 5.2-9 and 5.2-10.

Like the main pier, the foundation of P/C beams at the access bridge, comprising traverse abutting beams and caisson piers is probably less deteriorated than the P/C beams based on this visual inspection. About 50% of traverse abutting beams on the north side show some minor deterioration of concrete surfaces, which may be resultant from wave washing.

Other inspected items assessed as "C," such as superstructure (upper/side) and abutting beam (south side) do not show remarkable damage or deterioration. The other items assessed as "D," such as drainage system, concrete curb, alignment and road, have no defects observed to disturb the capacity and performance of the facility itself.

b) Detailed Inspection

The Detailed Inspection refers to a method of inspection to confirm the detailed conditions especially for P/C beams and P/C cable concrete encasements as major structural members of the Old Jetty. The Inspection was basically carried out as a visual inspection to observe general conditions of damage and deterioration and to chronologically compare the damage level of the said members.

General Observations

Damage and deterioration patterns for P/C and reinforced concrete (RC) members are commonly categorized into "Leakage & Free Lime," "Cracks" and "Spalling & Steel Exposure." The following are observations based on the said categories (also refer to Figures 5.2-9 and 5.2-10):

- Leakage and Free Lime

Leakage and free lime are normally observed on the surface of concrete members with signs such as water saturation sometimes with rusted fluid, white rippled marks with calcic extrusion caused by chemical reaction inside concrete, etc. It is assumed that the leakage and free lime are usually caused by a lack of concrete cover thickness. As previously stated, most concrete surfaces of the structure members have been covered by one of the established repair methods by PAS and it is difficult to identify such signs of damage and deterioration. However, because rainwater flows on some concrete side-surfaces and rusted fluid and rippled marks are attributed to the rain, cracks due to structural damage may be ignored.

- Cracks

Longitudinal Crack: this crack is commonly observed parallel to the longitudinal direction on the bottom surface of P/C beams and is usually caused by corrosion of rebars and/or P/C cables longitudinally installed inside the beams. The bottom of the beams has been exposed to the seawater and its splash sometimes made by waves is reflected to the front wall faces of the abutting beams. This environment induces the corrosive process and may reduce sections of structural steel and pre-stressed concrete around the installed cables associated with those ruptures, and may result in lowering the durability of whole structures. In this inspection, this type of crack appears on the bottom surface of the beams typically at the corner of the bottom flange of the beams and the edges of both ends of the beams.

Rectangular Crack: this crack is generally observed at the center of the bottom surface of P/C beams due to bending stress and deformation generated by live and dead loads. The appearance of this crack is due to the lack and decrease of pre-stress tension originally loaded and by successive over-loaded conditions beyond design requirements. Such cracks were not confirmed during the inspection; however, it is noted that the appearance of the crack should be carefully monitored.

- Concrete Spalling/Breakage and Exposure of Steel Materials

These are mainly caused by corrosion of steel materials associated with salt damage and carbonation of concrete. Also, it is recognized that a lack of concrete cover and compaction of fresh concrete might be an inducer of this breakage and/or deterioration. This inspection has found these broken and deteriorated portions on the bottom flange and on the repaired part of P/C beams, both edges of traverse cross beams (concrete encasements), and the surface and corner of abutting beams. Without proper measures being taken for such corrosion and the associated processes, such portions will probably be disturbed and the performance of each structure will decrease, such as less bending capacity and support defects due to the occurrence of sectional reduction and rupture of structural steel materials.

- Corrosion and Rupture of P/C Cable

These normally appear due to penetration of rainwater and/or seawater to steel materials inside concrete members on/through the upper and bottom surfaces of P/C beams and anchorage fixtures of P/C cables. Moreover, it is reported that internal steel materials, i.e. separators or spacers used for fixing formworks before concrete pouring or shaped steel materials exposed, and/or lack of concrete cover, sometime lead to water intrusion. It is deemed that not only sectional reduction but also rupture of P/C cables may arise from simple corrosion of even a part of the cable. In particular, careful monitoring is required for repaired portions of concrete members that might still have chloride infiltration, carbonation, or progressive corrosion inside the concrete, which cannot be obviously seen from the surface features. This inspection has not observed corrosion or rupture of the cables. However, as aforementioned, past photographs show that such corrosion and rupture have already happened on several portions of the bottom flanges of P/C beams, and will increase concurrently with aging.

Chronological Comparison of Classified Damage Level

Table 5.2-12 presents the classification of damage levels as specified in the 1997 JICA Study

Report. The classification defines six (6) levels of conditions of damage and deterioration. In order to assess transition of the damage levels, this classification method was adopted for this chronological comparison.

Table 5.2-12 Classification of Damage Levels

Grade	Description
0	No damage
I	Small cracks. Spots of corrosion on concrete surface.
II	Slight damage. Cracks without corrosion. Slight swelling of concrete.
III	Medium damage. Many spots of corrosion. Cracks with corrosion and swelling of concrete.
IV	Heavy damage. Wide width of cracks. Concrete about to fall off
V	Serious damage. Concrete section lost. Structure might collapse depending on unwanted load application.

Source: 1996 JICA Study Report

Based on the above classification, the Project Team conducted a visual inspection and summarized the results of the inspection. The results can be combined comparatively with the results from 1996, 2000 and 2002 obtained from the 1996 JICA Study Report and PAS. These transitions for both the main pier and access bridge are discussed respectively as follows:

- Main Pier

Figure 5.2-11 presents a chronological comparison of damage level of the P/C beams and the edges of the crossing beams by color grading, Table 5.2-13 shows the summary of the comparison digitalized by number, and Figure 5.2-12 describes their transition of the damage level by year.

As displayed in Figure 5.2-11, most damage was concentrated on the edge of the P/C beams, especially the beams between pier Nos. A7 and A6, A4 and A3, and A2 and A1 with serious damage levels of Grades IV and V in 1996. In 2000, ten (10) beams: beam No.13 between pier Nos. A9 and A8, beam No. 14 between pier Nos. A8 and A7, beam No. 2 between pier Nos. A7 and A6, beams Nos. 13, 5, 4 and 2 between pier Nos. A5 and A4, and beams Nos. 14 and 1 between pier Nos. A2 and A1, had progressive damage which changed from Grades II or III to V. The progress of such damage characterizes successive damage distribution in the same beam, which means the members of the beams were completely damaged. Also, beam No.2 between pier A6 and A5 and beam No.4 between pier Nos. A2 and A1 seemed to be in the most critical condition because the damage was concentrated in the center of the beams. In 2000, based on the observation record, it seems that no repair measures were taken. In the next visual inspection conducted in 2002, unlike 2000, no significant progressive damage was confirmed except for three (3) beams: beam No. 7 between pier No. A8 and A7 and beams Nos. 14 and 12 between pier No. A3 and A2. All the beams designated as Grade V in 2000 were repaired by repair Types 6-1&6-2 (steel plate encasement). It is presumed that some preventive measures were taken, which included not only repairing works such as some patch work and epoxy mortar repairing works but also some load restrictions on the pier.

Source: 1996 JICA Study Report (1996), PAS (2000 & 2002), and Project Team (2011)

Figure 5.2-11 Chronological Comparison of Classified Damage Level (Main Pier)

Table 5.2-13 Summary of Classified Damage Level (Main Pier)

Year	Grade	PC Beam between Pier Nos.																Total	
		A9-A8		A8-A7		A7-A6		A6-A5		A5-A4		A4-A3		A3-A2		A2-A1			
		(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)
1996	0	0.0	0.00	0.0	0.00	0.0	0.00	10.0	0.14	0.0	0.00	2.0	0.03	4.0	0.06	7.0	0.10	23.0	0.04
	I	27.0	0.39	26.0	0.37	17.0	0.24	19.0	0.27	15.0	0.21	15.0	0.21	14.0	0.20	14.0	0.20	147.0	0.26
	II	19.0	0.27	22.0	0.31	24.0	0.34	23.0	0.33	26.0	0.37	23.0	0.33	27.0	0.39	17.0	0.24	181.0	0.32
	III	22.0	0.31	21.0	0.30	14.0	0.20	17.0	0.24	24.0	0.34	21.0	0.30	25.0	0.36	16.0	0.23	160.0	0.29
	IV	2.0	0.03	1.0	0.01	12.0	0.17	1.0	0.01	2.0	0.03	7.0	0.10	0.0	0.00	15.0	0.21	40.0	0.07
	V	0.0	0.00	0.0	0.00	3.0	0.04	0.0	0.00	3.0	0.04	2.0	0.03	0.0	0.00	1.0	0.01	9.0	0.02
	Total	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	560.0	1.00
2000	0	0.0	0.00	0.0	0.00	0.0	0.00	10.0	0.14	0.0	0.00	2.0	0.03	4.0	0.06	7.0	0.10	23.0	0.04
	I	27.0	0.39	26.0	0.37	17.0	0.24	17.0	0.24	15.0	0.21	15.0	0.21	14.0	0.20	13.5	0.19	144.5	0.26
	II	19.0	0.27	22.0	0.31	24.0	0.34	23.0	0.33	26.0	0.37	23.0	0.33	27.0	0.39	14.0	0.20	178.0	0.32
	III	21.0	0.30	20.0	0.29	13.5	0.19	16.0	0.23	20.0	0.29	21.0	0.30	25.0	0.36	14.0	0.20	150.5	0.27
	IV	2.0	0.03	1.0	0.01	12.0	0.17	1.0	0.01	2.0	0.03	7.0	0.10	0.0	0.00	14.0	0.20	39.0	0.07
	V	1.0	0.01	1.0	0.01	3.5	0.05	3.0	0.04	7.0	0.10	2.0	0.03	0.0	0.00	7.5	0.11	25.0	0.04
	Total	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	560.0	1.00
2002	0	0.0	0.00	0.0	0.00	0.0	0.00	10.0	0.14	0.0	0.00	2.0	0.03	4.0	0.06	7.0	0.10	23.0	0.04
	I	27.0	0.39	25.0	0.36	17.0	0.24	17.0	0.24	15.0	0.21	15.0	0.21	14.0	0.20	13.5	0.19	143.5	0.26
	II	19.0	0.27	22.0	0.31	24.0	0.34	23.0	0.33	26.0	0.37	23.0	0.33	26.0	0.37	14.0	0.20	177.0	0.32
	III	21.0	0.30	20.0	0.29	13.5	0.19	16.0	0.23	20.0	0.29	21.0	0.30	24.0	0.34	14.0	0.20	149.5	0.27
	IV	2.0	0.03	1.0	0.01	12.0	0.17	1.0	0.01	1.0	0.01	7.0	0.10	0.0	0.00	14.0	0.20	38.0	0.07
	V	1.0	0.01	2.0	0.03	3.5	0.05	3.0	0.04	8.0	0.11	2.0	0.03	2.0	0.03	7.5	0.11	29.0	0.05
	Total	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	560.0	1.00
2011	0	0.0	0.00	0.0	0.00	0.0	0.00	10.0	0.14	0.0	0.00	2.0	0.03	4.0	0.06	7.0	0.10	23.0	0.04
	I	23.0	0.33	17.0	0.24	11.0	0.16	17.0	0.24	14.5	0.21	15.0	0.21	14.0	0.20	13.0	0.19	124.5	0.22
	II	19.5	0.28	19.5	0.28	22.5	0.32	18.0	0.26	23.5	0.34	21.5	0.31	24.0	0.34	14.0	0.20	162.5	0.29
	III	23.0	0.33	27.0	0.39	14.5	0.21	20.0	0.29	17.5	0.25	20.0	0.29	24.5	0.35	14.0	0.20	160.5	0.29
	IV	2.0	0.03	1.0	0.01	12.0	0.17	1.0	0.01	0.0	0.00	5.0	0.07	0.0	0.00	13.0	0.19	34.0	0.06
	V	2.5	0.04	5.5	0.08	10.0	0.14	4.0	0.06	14.5	0.21	6.5	0.09	3.5	0.05	9.0	0.13	55.5	0.10
	Total	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	70.0	1.00	560.0	1.00

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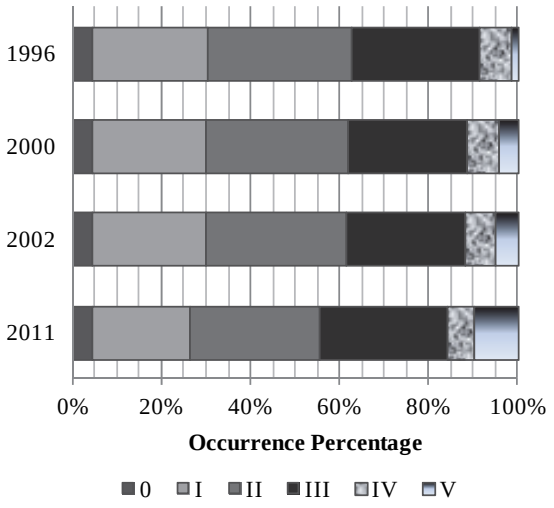
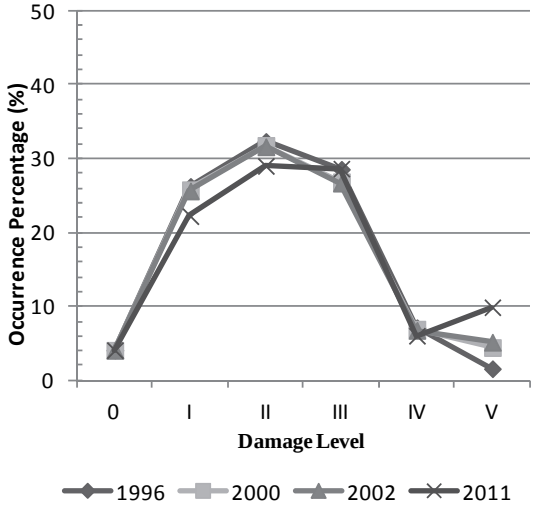


(i) Comparison of Occurrence Percentage



(ii) Transition of Damage Level

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Figure 5.2-12 Transition of Occurrence Percentage and Damage Level (Main Pier)

In 2011, from the results of the inspection with the same classification which was conducted by the Project Team, the nine (9) year time elapse brought some significant changes on the conditions of each beam. It is observed that some more traces of repair works by PAS have been seen throughout and some progressive damage has arisen from the deterioration process. Notwithstanding repair works done by PAS, the damage seems to have seriously spread at the center of the beams that were previously graded as Grades I or II before 2002. All the damage levels became almost 1 to 2 grades higher. The situation implies that the active process of damage and deterioration are still widely progressing, especially in the beams that have not been fixed by effective prevention measures for progressive deterioration of saline concrete and/or corroded steel rebars since these repair works only concentrated on obvious damaged portions. Moreover, it seems that some concrete encasements for

fixing P/C strands, which were mainly damaged by vessel berthing, have not been repaired and present exposure of broken concrete bodies and P/C strands at specified locations.

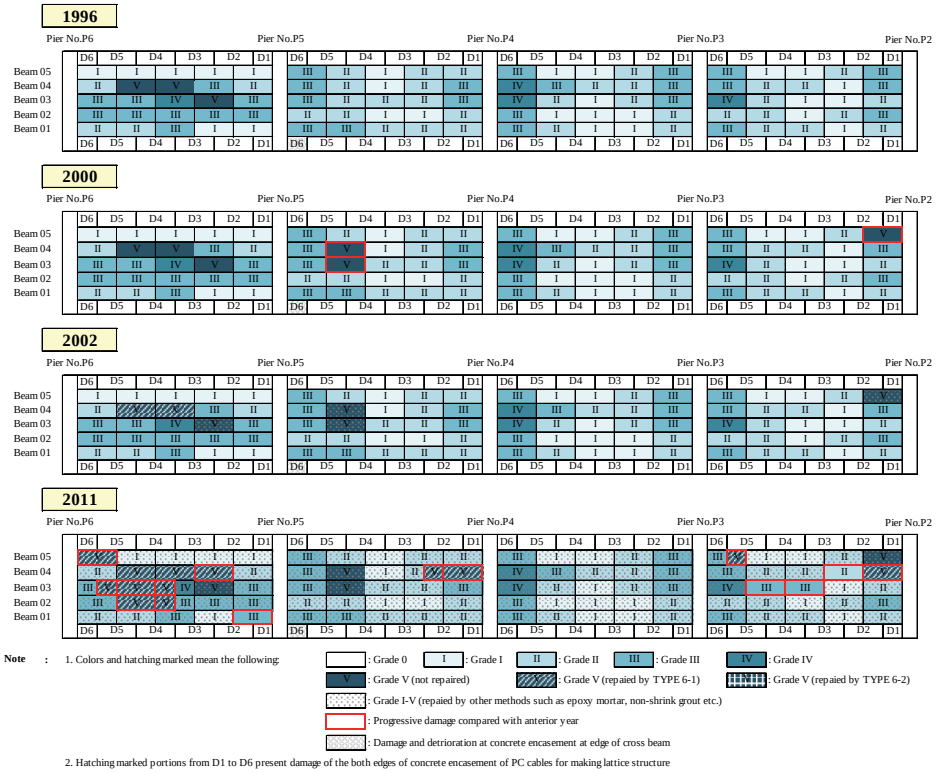
As seen in Table 5.2-13 and Figure 5.2-12, the trend shows a decrease in Grades I and II and an increase in Grades III, IV and V. In 1996, the combined proportion of Grades 0, I and II was about 65% and the rest 35% were over Grade III. After 2000, the proportion has become worse with damage over Grade III reaching 45% in 2011 for the proportion in 1996.

- Access Bridge

Figure 5.2-13 presents a chronological comparison of the damage level of the P/C beams and the edges of the crossing beams by color grading, Table 5.2-14 shows the summary of the comparison digitalized by number, and Figure 5.2-14 describes their transition of the damage level by year.

As displayed in Figure 5.2-13, most damage was concentrated in the center of P/C beams, especially beams Nos. 4 and 3 between pier Nos. P6 and P5 with serious damage levels of Grades IV and V as shown in 1996. In 2000, three (3) beams: beams Nos. 4 and 3 between pier Nos. P5 and P4 and beam No. 5 between pier Nos. P3 and P2, had progressive damage that changed from Grades II or III to V. In 2002, no significant progressive damage was confirmed similar to the case at the main pier. All the beams diagnosed as Grade V in 2000 were repaired by repair Types 6-1&6-2 (steel plate encasement). Likewise, it is presumed that some preventive measures were taken, which included not only repairing works such as patch work and epoxy mortar repairing works but also some load restrictions on the pier. Through an inspection applying the same classification, which was conducted by the Project Team in 2011, it was observed that some repair works by PAS had been carried out and some more progressive damage had arisen from the deterioration process. In particular, beams Nos. 4, 3 and 2 have serious damage at the center of each beam. Other beams are not progressing much at this moment. Through speculation, the reason for the concentrated damages of beams between pier Nos. P6 and P5 is that the segment between pier Nos. P6 and P5 is the most affected portion where all the vehicles turn with an external force applied to the outer wheels. Compared to the situation at the main pier, the situation of the access bridge is less serious because there is no loading/unloading operation on the access bridge. In case of the access bridge, concrete encasements for fixed P/C strands have not been so damaged because unlike the main pier, no vessels berth.

As seen in Table 5.2-14 and Figure 5.2-14, the trend shows a decrease in Grades I and II and an increase in Grades III, IV and V like the main pier. In 1996, the combined proportion of Grades 0, I and II was more than 60% and the rest were over Grade III. After 2000, the proportion has gradually become worse with damage over Grade III reaching 43% in 2011 compared to 38% in 1996.



Source: 1996 JICA Study Report (1996), PAS (2000 & 2002), and Project Team (2011)

Figure 5.2-13 Chronological Comparison of Damage Level (Access Bridge)

Table 5.2-14 Summary of Classified Damage Level (Access Bridge)

Year	Grade	PC Beam between Pier Nos.								Total	
		P6-P5		P5-P4		P4-P3		P3-P2			
		(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)	(nr)	(ratio)
1996	0	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
	I	7.0	0.28	4.0	0.16	8.0	0.32	7.0	0.28	26.0	0.26
	II	4.0	0.16	14.0	0.56	8.0	0.32	10.0	0.40	36.0	0.36
	III	10.0	0.40	7.0	0.28	7.0	0.28	7.0	0.28	31.0	0.31
	IV	1.0	0.04	0.0	0.00	2.0	0.08	1.0	0.04	4.0	0.04
	V	3.0	0.12	0.0	0.00	0.0	0.00	0.0	0.00	3.0	0.03
	Total	25.0	1.00	25.0	1.00	25.0	1.00	25.0	1.00	100.0	1.00
2000	0	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
	I	7.0	0.28	4.0	0.16	8.0	0.32	7.0	0.28	26.0	0.26
	II	4.0	0.16	12.0	0.48	8.0	0.32	11.0	0.44	35.0	0.35
	III	10.0	0.40	7.0	0.28	7.0	0.28	5.0	0.20	29.0	0.29
	IV	1.0	0.04	0.0	0.00	2.0	0.08	1.0	0.04	4.0	0.04
	V	3.0	0.12	2.0	0.08	0.0	0.00	1.0	0.04	6.0	0.06
	Total	25.0	1.00	25.0	1.00	25.0	1.00	25.0	1.00	100.0	1.00
2002	0	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
	I	7.0	0.28	4.0	0.16	8.0	0.32	7.0	0.28	26.0	0.26
	II	4.0	0.16	12.0	0.48	8.0	0.32	11.0	0.44	35.0	0.35
	III	10.0	0.40	7.0	0.28	7.0	0.28	5.0	0.20	29.0	0.29
	IV	1.5	0.06	0.0	0.00	2.0	0.08	1.0	0.04	4.5	0.05
	V	2.5	0.10	2.0	0.08	0.0	0.00	1.0	0.04	5.5	0.06
	Total	25.0	1.00	25.0	1.00	25.0	1.00	25.0	1.00	100.0	1.00
2011	0	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
	I	5.0	0.20	4.0	0.16	8.0	0.32	5.0	0.20	22.0	0.22
	II	4.0	0.16	11.5	0.46	8.0	0.32	11.0	0.44	34.5	0.35
	III	7.0	0.28	6.0	0.24	7.0	0.28	5.5	0.22	25.5	0.26
	IV	1.0	0.04	0.0	0.00	2.0	0.08	1.0	0.04	4.0	0.04
	V	8.0	0.32	3.5	0.14	0.0	0.00	2.5	0.10	14.0	0.14
	Total	25.0	1.00	25.0	1.00	25.0	1.00	25.0	1.00	100.0	1.00

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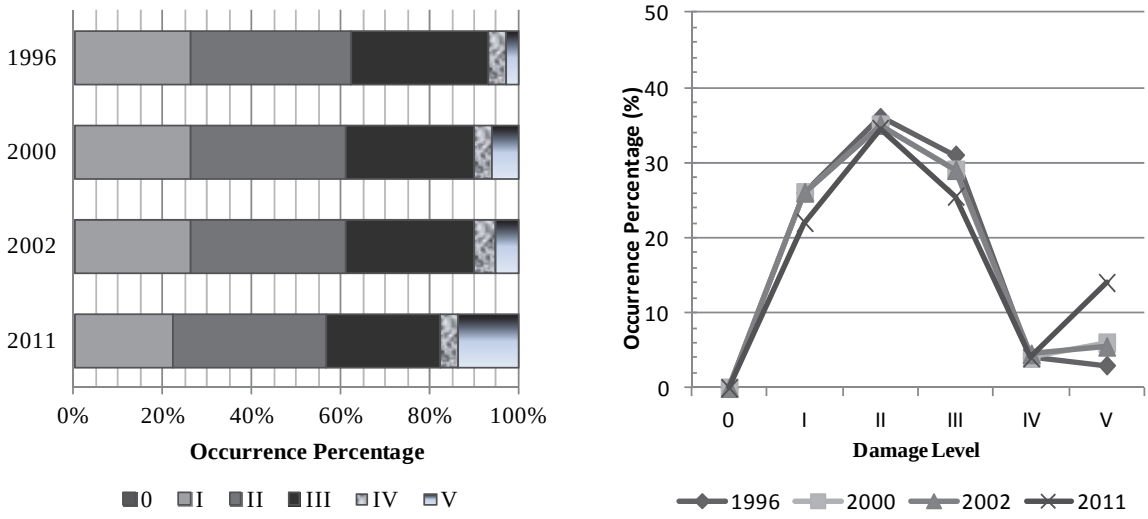

(i) Comparison of Occurrence Percentage

(ii) Transition of Damage Level

Prepared by Project Team

Figure 5.2-14 Transition of Occurrence Percentage and Damage Level (Access Bridge)

c) Non-Distractive Test

As a non-distractive test, the Project Team conducted a Schmidt Hammer test for the bottom flange of some P/C beams in order to estimate concrete strength. Table 5.2-15 shows a summary of the test results, which show that the estimated concrete strengths with correction of adjustment factors are within a range approximately between 60 and 75 N/mm^2 (600 and 760 kgf/cm^2) with an average of 67.4 N/mm^2 (687 kgf/cm^2). The results are different and bigger than those of the 1997 JICA Study (395 to 600 kgf/cm^2 over). It is commonly known that in the test, there is sometimes dispersion upon measurements depending on instruments, methods, the person who measures, concrete conditions, etc.

Assuming the original concrete design strength of P/C beams is 40 N/mm^2 generally adapted to long-span P/C beam, the expected actual strength is to be 52 N/mm^2 in consideration of a 30% additional rate in its design mix. Figure 5.2-15 (i) shows a comparison between measured strengths, the assumed design strength and expected actual strength. As seen in the figure, all the measured strengths are more than the expected strength upon the said assumption. Figure 5.2-15 (ii) illustrates the predicted/regressed strengths corresponding to each concrete age. The predicted strengths are estimated from the following equation *eq (1)* suggested by American Concrete Institute (ACI)[5].

$$(fc')_t = \frac{t}{a + \beta}(fc')_{28} \qquad \text{……eq(1)}$$

where,

$(f'c)_t$	:	Concrete compressive strength at any time t (N/mm^2)
t	:	Concrete age (day)
a, β	:	Coefficient factors, depending on cement type, concrete age etc. as specified in ACI 209R-92 (a=4.0 and β=0.85 simply applied in this examination)
$(f'c)_{28}$	:	28 days- concrete compressive strength (N/mm^2)

[5] American Concrete Institute (ACI), (1997), Prediction of Creep, Shrinkage, and Temperature Effects in Concrete Structures, ACI 209R-92

Table 5.2-15 Results of Schmidt Hammer Test at Old Jetty

Test No.	Location		Ave.	Adjustment		Corrected	Estimated Compressive Strength	
	Pier Nos.	Beam No.	Rebound	+90°	Wet	Rebound	(kgf/cm^2)	(N/mm^2)
1	A9 - A8	13	64	-2.3	+5	+67	683	66.9
2	A9 - A8	10	67	-2.3	+5	+70	722	70.8
3	A8 - A7	2	60	-2.3	+5	+63	631	61.8
4	A8 - A7	5	65	-2.3	+5	+68	696	68.2
5	A8 - A7	9	64	-2.3	+5	+67	683	66.9
6	A8 - A7	12	67	-2.3	+5	+70	722	70.8
7	A7 - A6	2	62	-2.3	+5	+65	657	64.4
8	A7 - A6	5	67	-2.3	+5	+70	722	70.8
9	A7 - A6	6	68	-2.3	+5	+71	735	72.0
10	A7 - A6	9	64	-2.3	+5	+67	683	66.9
11	A7 - A6	11	66	-2.3	+5	+69	709	69.5
12	A7 - A6	13	63	-2.3	+5	+66	670	65.7
13	A7 - A6	14	70	-2.3	+5	+73	761	74.6
14	A6 - A5	2	65	-2.3	+5	+68	696	68.2
15	A6 - A5	14	67	-2.3	+5	+70	722	70.8
16	A5 - A4	2	66	-2.3	+5	+69	709	69.5
17	A5 - A4	3	67	-2.3	+5	+70	722	70.8
18	A5 - A4	4	64	-2.3	+5	+67	683	66.9
19	A5 - A4	5	62	-2.3	+5	+65	657	64.4
20	A5 - A4	12	62	-2.3	+5	+65	657	64.4
21	A5 - A4	13	65	-2.3	+5	+68	696	68.2
22	A5 - A4	14	63	-2.3	+5	+66	670	65.7
23	A4 - A3	11	67	-2.3	+5	+70	722	70.8
24	A4 - A3	13	69	-2.3	+5	+72	748	73.3
25	A4 - A3	14	67	-2.3	+5	+70	722	70.8
26	A3 - A2	12	58	-2.3	+5	+61	605	59.3
27	A3 - A2	14	68	-2.3	+5	+71	735	72.0
28	A2 - A1	1	62	-2.3	+5	+65	657	64.4
29	A2 - A1	2	66	-2.3	+5	+69	709	69.5
30	P6 - P5	2	59	-2.3	+5	+62	618	60.6
31	P6 - P5	3	61	-2.3	+5	+64	644	63.1
32	P6 - P5	4	60	-2.3	+5	+63	631	61.8
33	P6 - P5	5	58	-2.3	+5	+61	605	59.3
34	P5 - P4	4	63	-2.3	+5	+66	670	65.7
35	P3 - P2	5	66	-2.3	+5	+69	709	69.5
36	P3 - P2	4	64	-2.3	+5	+67	683	66.9
						Average	687	67.4

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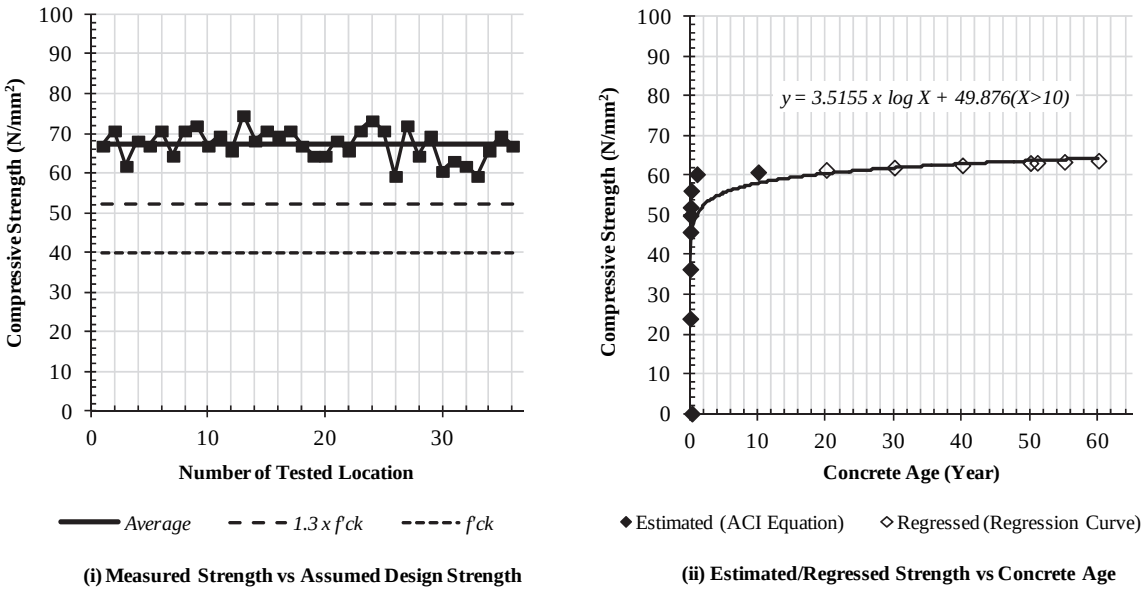


(i) Measured Strength vs Assumed Design Strength **(ii) Estimated/Regressed Strength vs Concrete Age**

Prepared by Project Team

Figure 5.2-15 Comparison of Concrete Strengths with Concrete Age

Upon computation of the equation, the said 52 N/mm^2 applies to 28 days concrete compressive strength. Also, the regressed strengths are specified from a regression curve based on the predicted strength given from the equation. Accordingly, the measured strength is more than the predicted strength in the comparison. However, it is quite possible that the measured strength is of repaired materials and not real strength of the P/C beam concrete.

6) Numerical Analyses

a) Prediction of Chloride Ion Infiltration

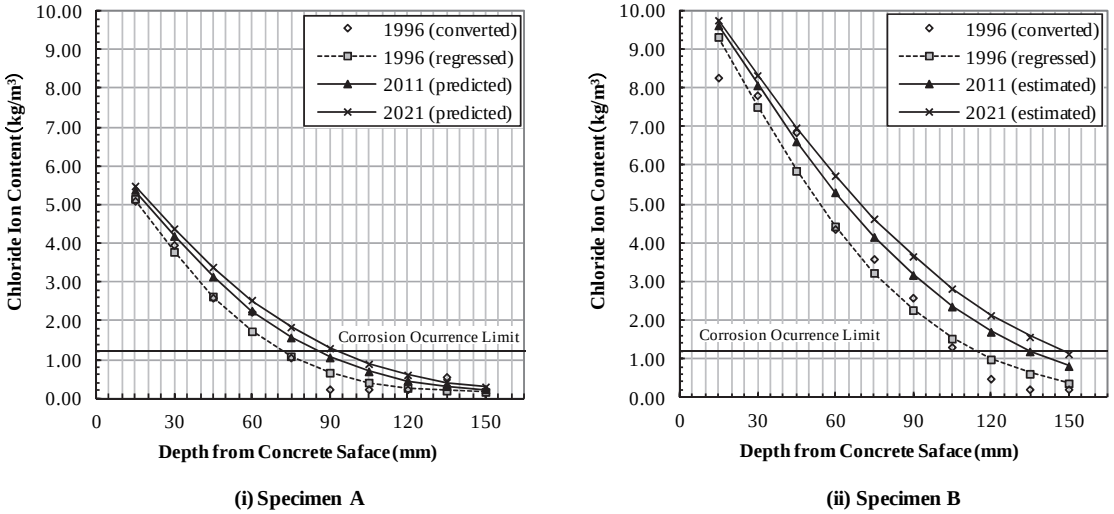
It is commonly recognized that the infiltration rate of chloride ions inside a concrete structure fits Fick's diffusion law. A chloride iron for unselected distance and time is given by the following equation eq (2):

$$C(x,t) = C_0\left(1 - erf\left(\frac{0.1x}{2\sqrt{D_{ap}t}}\right)\right) \qquad \text{……eq(2)}$$

where,

$C(x,t)$	:	Chloride ion content at distance x and time t (kg/m^3)
C_o	:	Chloride ion content at concrete surface (kg/m^3)
x	:	Distance from concrete surface (mm)
D_{ap}	:	Apparent diffusion coefficient (cm^2/year)
t	:	Duration from commencement of use and inspection (year)
erf	:	Error function, $erf(s) = \frac{2}{\sqrt{\pi}}\int_0^s e^{-\eta^2} d\eta$

If distribution data of concrete chloride content at the same point are obtained from site inspection, and C_o and D_{ap} are resultantly specified suitably finding a good regression curve fitting the obtained data, C can be estimated at unselected t and x from approximation of the data calculated from the said equation. Figure 5.2-16 shows the predicted chloride ion contents for 2011 and 2021 based on the results obtained from the actual test conducted in the 1997 JICA Study. The data obtained in 1996 was converted to the same units for comparison and the regression curves are shown as dotted lines with square makers. The shown "Corrosion Occurrence Limit" is 1.2 kg/m³, commonly specified in Japanese technical standards[6]. The applied test results of Specimens A and B are respectively located on the landside face of the bottom flange of P/C beam No.11 to diaphragm D6 between pier Nos. A6 and A5, and on the landside face of the bottom flange of P/C beam No. 12 near diaphragm D1 between pier No. A3 and A2.



(i) Specimen A **(ii) Specimen B**

Prepared by Project Team

Figure 5.2-16 Predicted Chloride Ion Content (Specimens A&B)

[6] Japan Society of Civil Engineers (JSCE), (2007), Standard Specifications for Concrete Structures, "Design"

As shown in Figure 5.2-15 (i) Specimen A, the depth from concrete surface indicates about 87 mm (2011) and 95 mm (2021) against 75 mm (1996) at 1.2 kg/m³ chloride ion content, and the differences of 8 mm (2011) and 20 mm (2021) from the data in 1996 respectively mean progression of infiltration of chloride ion from the condition in 1996. Although the actual concrete cover thickness from rebar installment is not certain due to the fact that no detailed as-built drawings remain, assuming the cover thickness is 50 mm based on PAS information obtained through actual repair works, it is predicted that the corrosion reaction has already reached the stirrup at present and will remain near the first P/C cable layer in 2021.

As seen in Figure 5.2-15 (ii) Specimen B, the depth from concrete surface indicates about 135 mm (2011) and 148 mm (2021) against 115 mm (1996) at 1.2 kg/m³ chloride ion content, and the differences of 20 mm (2011) and 33 mm (2021) from the data in 1996 respectively mean progression of the infiltration of chloride ion from the condition in 1996. It is apparent that Specimen B is in a more serious condition than Specimen A. As above, it is assumed that the corrosion reaction has already reached the first P/C cable layer at present and will be adjacent to the second layer in 2021.

b) Presumed Allowable Loading Conditions

A structural analysis was carried out in the 1997 JICA Study Report. The analysis concluded that the P/C beam without the first P/C cable layer could be durable up to 9 kN/m^2 (0.9 tf/m^2) uniformed load, compared to the original P/C beam durable for 15 kN/m^2 (1.5 tf/m^2) uniform load equivalent to T-20 vehicle load. This analysis provides more some cases that have lost P/C cables based on the results of the predicted chloride ion infiltration.

The approach of the analysis is to establish the prerequisites in consideration of the same conditions used in the analysis in the 1997 JICA Study, to first reprise same two (2) cases of the previous analysis, and to execute structural computations for finding allowable loading conditions for a further four (4) assumed cases.

The following are the prerequisites of the analysis:

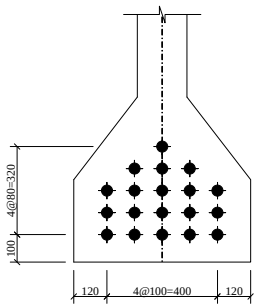
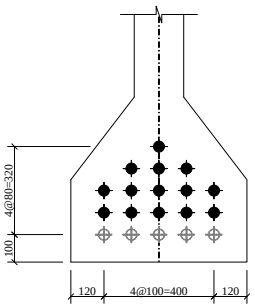
- Repetition cases conducted at the beginning to match the 1997 JICA Study
- Same dimensions of P/C beam applied
- No other developments considered except for malfunction of P/C cables
- Same material properties of concrete and P/C cable accordingly used in the 1997 JICA Study confirmed through repetition cases
- Stress checking verified for concrete bending compression stress at the top flange, P/Cable tensile stress at the bottom flange, and factor of safety at rupture of P/C beam section.

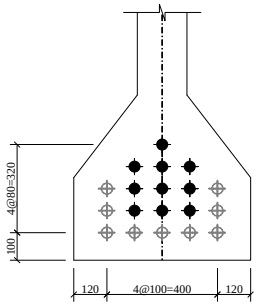
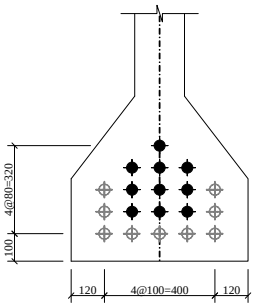
Selected cases are as follows (refer to typical sections in Table 5.2-16):

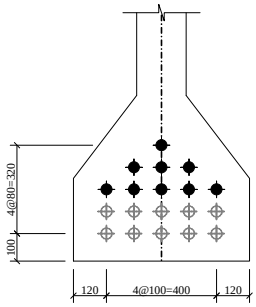
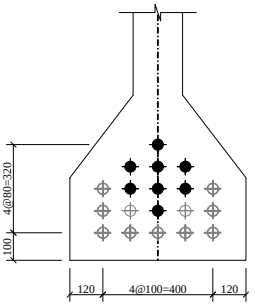
- **Case A**: checking stress at 15 kN/m^2 (1.5 tf/m^2) uniform load (equivalent to T-20 vehicle load) on the original structural conditions assumed without any damage
- **Case B**: checking stress at 9 kN/m^2 (0.9 tf/m^2) uniform load consequently obtained in 1997 JICA Study on the condition of all the bottom layer of P/C cables broken (5 cables broken)
- **Case C**: checking stress at 9 kN/m^2 (0.9 tf/m^2) uniform load on the condition of all outer P/C cables broken (9 cables broken)
- **Case D**: finding allowable loading condition with satisfaction for stress checking on the condition of all outer cables broken (9 cables broken) the same as Case C
- **Case E**: finding allowable loading condition with satisfaction for stress checking on the condition of bottom two P/C cable layers broken (10 cables broken)
- **Case F**: finding allowable loading condition with satisfaction for stress checking on the condition of bottom two P/C cable layers and outer side cables broken (11 cables broken)

Table 5.2-16 describes the summary of the structural analysis of the above-mentioned cases. Each case is explicated as follows:

Table 5.2-16 Summary of Structural Analysis

Case	A					B				
Typical Section (Bottom Flange)										
Loading Condition (except for Dead Load)	Uniform Load (approx. T-20 equivalent)		q	tf/m²	1.50	Uniform Load (calculated backward)		q	tf/m²	0.90
				kN/m²	15.00				kN/m²	9.00
Stress Checking	Concrete	Allowable Bending Compression Stress	σca	N/mm²	14.00	Concrete	Allowable Bending Compression Stress	σca	N/mm²	14.00
		Bending Compression Stress	σc	N/mm²	13.67 < σca OK		Bending Compression Stress	σc	N/mm²	12.53 < σca OK
	PC Cable	Allowable Tensile Stress	σpa	N/mm²	900.00	PC Cable	Allowable Tensile Stress	σpa	N/mm²	900.00
		Tensile Stress	σp	N/mm²	664.72 < σpa OK		Tensile Stress	σp	N/mm²	725.42 < σpa OK
	Resisting Bending Moment at Rupture		Mr	kN·m	22,911.81	Resisting Bending Moment at Rupture		Mr	kN·m	17,526.82
	Ultimate Bending Moment		Mu	kN·m	18,127.23	Ultimate Bending Moment		Mu	kN·m	14,198.19
	Factor of Safety (=Mr/Mu)		Fs	-	1.26 > 1 OK	Factor of Safety (=Mr/Mu)		Fs	-	1.23 > 1 OK
Remark	* Original design same assumed on 1997 JICA Study Report * Satisfactory durable for 1.5 tf/m² (15 kN/m²) uniform load without any loss of PC cables					* Satisfactory durable for 0.9 tf/m² (9 kN/m²) uniform load, in case five (5) PC cables at the bottom layer are cut by corrosive reaction on the shown cable arrangement				

Case	C					D				
Typical Section (Bottom Flange)										
Loading Condition (except for Dead Load)	Uniform Load (apply same uniform load of Case B)		q	tf/m²	0.90	Uniform Load (calculated backward)		q	tf/m²	0.50
				kN/m²	9.00				kN/m²	5.00
Stress Checking	Concrete	Allowable Bending Compression Stress	σca	N/mm²	14.00	Concrete	Allowable Bending Compression Stress	σca	N/mm²	14.00
		Bending Compression Stress	σc	N/mm²	14.83 > σca NG		Bending Compression Stress	σc	N/mm²	12.25 < σca OK
	PC Cable	Allowable Tensile Stress	σpa	N/mm²	900.00	PC Cable	Allowable Tensile Stress	σpa	N/mm²	900.00
		Tensile Stress	σp	N/mm²	987.70 > σpa NG		Tensile Stress	σp	N/mm²	858.16 < σpa OK
	Resisting Bending Moment at Rupture		Mr	kN·m	12,590.98	Resisting Bending Moment at Rupture		Mr	kN·m	12,590.98
	Ultimate Bending Moment		Mu	kN·m	14,198.19	Ultimate Bending Moment		Mu	kN·m	12,282.12
	Factor of Safety (=Mr/Mu)		Fs	-	0.89 < 1 NG	Factor of Safety (=Mr/Mu)		Fs	-	1.03 > 1 OK
Remark	* Not durable for 0.9 tf/m² (9 kN/m²) uniform load, in case nine (9) PC cables at the bottom and both sides layers are cut by corrosive reaction on the shown cable arrangement					* Satisfactory durable for 0.5 tf/m² (5 kN/m²) uniform load, in case nine (9) PC cables at the bottom and both sides layers are cut by corrosive reaction on the shown cable arrangement				

Case	E					F				
Typical Section (Bottom Flange)										
Loading Condition (except for Dead Load)	Uniform Load (calculated backward)		q	tf/m²	0.20	-		q	tf/m²	-
				kN/m²	2.00				kN/m²	-
Stress Checking	Concrete	Allowable Bending Compression Stress	σca	N/mm²	14.00	Concrete	Allowable Bending Compression Stress	σca	N/mm²	14.00
		Bending Compression Stress	σc	N/mm²	11.15 < σca OK		Bending Compression Stress	σc	N/mm²	10.38 < σca OK
	PC Cable	Allowable Tensile Stress	σpa	N/mm²	900.00	PC Cable	Allowable Tensile Stress	σpa	N/mm²	900.00
		Tensile Stress	σp	N/mm²	842.33 < σpa OK		Tensile Stress	σp	N/mm²	871.59 < σpa OK
	Resisting Bending Moment at Rupture		Mr	kN·m	11,207.14	Resisting Bending Moment at Rupture		Mr	kN·m	10,020.48
	Ultimate Bending Moment		Mu	kN·m	10,845.07	Ultimate Bending Moment		Mu	kN·m	9,887.03
	Factor of Safety (=Mr/Mu)		Fs	-	1.03 > 1 OK	Factor of Safety (=Mr/Mu)		Fs	-	1.01 > 1 OK
Remark	* Satisfactory durable for 0.2 tf/m² (2 kN/m²) uniform load, in case ten (10) PC cables at the bottom two layers are cut by corrosive reaction on the shown cable arrangement					* Satisfactory durable for dead load only, in case ten (11) PC cables are cut by corrosive reaction on the shown cable arrangement				

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Case A: concrete bending stress and P/C tensile stress are respectively 13.67 and 664.72 N/mm^2 within both the allowable stresses, and the factor of safety at rupture is 1.26. This case is therefore satisfactorily durable for 15 kN/m^2 (1.5 tf/m^2) uniform load (no P/C cables broken). It is presumed that this reappears for the same case in the 1997 JICA Study, which was possibly the original loading condition equivalent as assumed.

Case B: concrete bending stress and P/C tensile stress are respectively 12.53 and 725.42 N/mm^2 within both the allowable stresses, and the factor of safety at rupture is 1.23. This case is therefore satisfactorily durable for 9 kN/m^2 (0.9 tf/m^2) uniform load (all bottom 5 P/C cables broken). It is presumed that this also reappears for the same case in the 1997 JICA Study.

Case C: concrete bending stress and P/C tensile stress are respectively 14.83 and 987.70 N/mm^2 beyond both the allowable stresses, and the factor of safety at rupture is 0.89. This case is therefore not durable for 9 kN/m^2 (0.9 tf/m^2) uniform load (all bottom 5 P/C cables and both-sides 4 P/C cables broken). It is apparent that the loading condition is to be smaller than the applied at least on the condition of the P/C cables.

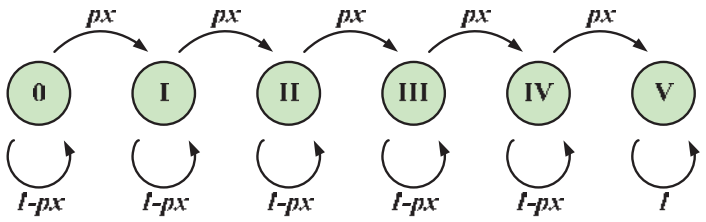
Case D: found allowable loading condition is 5 kN/m^2 (0.5 tf/m^2) uniform load with the same conditions of Case C (all bottom 5 P/C cables and both-sides 4 P/C cables broken), which is satisfactory to stress checking that concrete bending stress and P/C tensile stress are respectively 12.25 and 858.16 N/mm^2 within both the allowable stresses, and the factor of safety at rupture is 1.03. If the actual chloride ion infiltration has progressed as predicted, this case is most likely to reflect the actual cable conditions.

Case E: found allowable loading condition is 2 kN/m^2 (0.2 tf/m^2) uniform load with the condition of 10 P/C cables broken in all the bottom two layers, which is satisfactory to stress checking that concrete bending stress and P/C tensile stress are respectively 11.15 and 842.33 N/mm^2 within both the allowable stresses, and the factor of safety at rupture is 1.03. This case is more progressive than Case D.

Case F: no allowable loading condition is found with the condition of 11 P/C cables broken as shown. Concrete bending stress and P/C tensile stress are respectively 10.38 and 871.59 N/mm^2 within both the allowable stresses, and the factor of safety at rupture is 1.01. This case means the other 8 P/C cables are able to bear the dead weight of the P/C beam. This is the worst cable condition with danger for actual use.

c) Prediction of Damage/Deterioration Levels of P/C Beams (Main Pier)

As a method for predicting the progress of damage/deterioration of structures, it is well known to apply a Markov Chain, which is a mathematical probability model, in which a process starts in one of state and changes successively from one state to another by adopting two concepts of "state" and "transition." It is possible to predict the damage/deterioration progress with definition of transition probability *px* by using the results of judgment for damage level of P/C beams (Grades 0, I, II, III, IV and V) as specified. Figure 5.2-17 illustrates a conceptual model of the Markov Chain transition for the results of the judgment.



Source: A Technical Maintenance Manual of Port Facilities in Japan modified by Project Team

Figure 5.2-17 Markov Chain Transition Model for Damage/Deterioration Levels of P/C Beams

One damage level of member transits to the next level of the member, if certain time elapses from the present, and the rest not to be transited remains at the same level of the member. This transition of deterioration is simultaneously arisen to all the members and finally converges on Grade V without any progress after this grade. In this model, the deterioration gradually progresses following the transition mentioned above. Assuming all the members are judged as Grade 0 at the initial stage, the following determinant equation is given:

$$\begin{bmatrix} V \\ IV \\ III \\ II \\ I \\ 0 \end{bmatrix} = \begin{bmatrix} 1-px & 0 & 0 & 0 & 0 & 0 \\ px & 1-px & 0 & 0 & 0 & 0 \\ 0 & px & 1-px & 0 & 0 & 0 \\ 0 & 0 & px & 1-px & 0 & 0 \\ 0 & 0 & 0 & px & 1-px & 0 \\ 0 & 0 & 0 & 0 & px & 1 \end{bmatrix}^{t} \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad \text{……eq (3)}$$

where,

px : Transition Probability (specified as constant)

t : Elapsed Time (year)

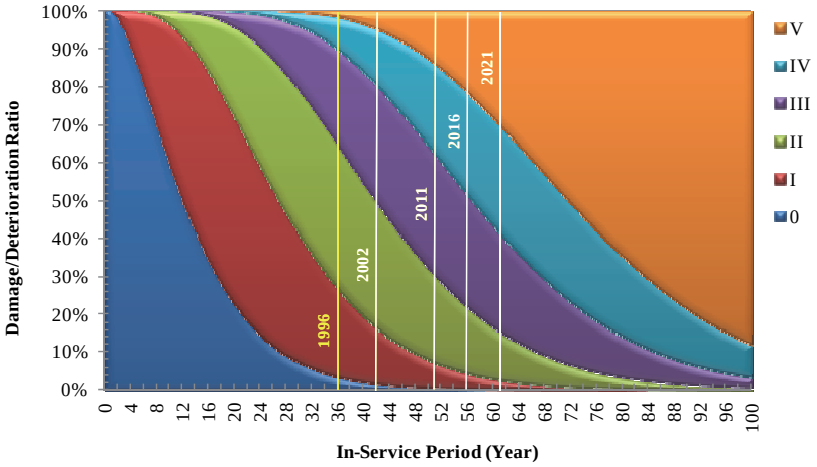
The above formula indicates a state for a deterioration level with a Markov Chain Model. In the actual calculation, several trials are required in changing split numbers fractionated of damage/deterioration level grading, and a transition probability is resultantly given at better correspondence between the actual and the computed ratios in the grading at the target base year. Applying the transition probability found, the calculation of eq (3) gives all the damage/deterioration ratios for target duration, which would be a prediction of distributed damage/deterioration ratios in the assumed transition process.

In this trial analysis, the prediction is only conducted for the main pier, because the Markov Chain Model requires certain statistical samples and the samples for the access bridge are not good enough for evaluation of the results.

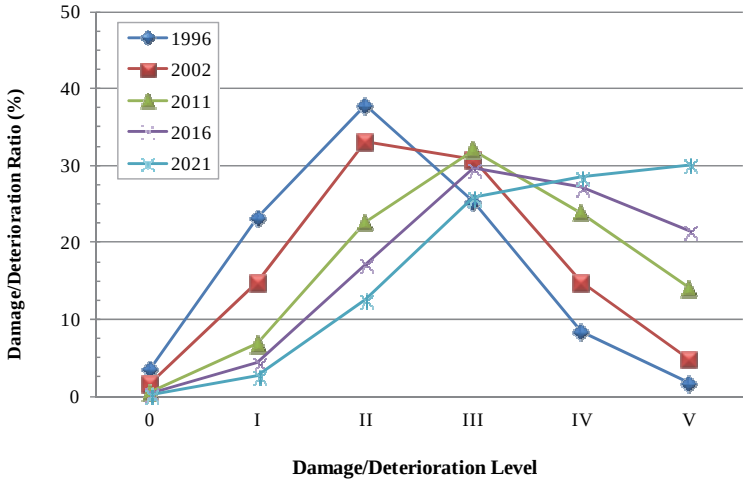
The base year of the prediction is set as 1996 for the trial calculation of eq (3) and its graded ratios are applied as the actual data introduced in Table 5.2-13. Through several trials aforementioned, an optimal correspondence of the damage/deterioration ratios in 1996 is consequently given at two (2) split numbers of the grading and the transition probability is obtained as 0.134. By applying the transition probability, the calculation of eq (3) provides a distribution of all the damage/deterioration ratios for in-service period assumed from 0 to 100 years.

Figure 5.2-18 presents a predicted damage/deterioration progress of P/C beams by the Markov Chain Model, which comprise i) distribution of damage/deterioration ratio by in-service period, ii) a comparison of damage/deterioration transition progress and iii) a comparison between the actual damage/deterioration ratio and the ratio predicted by the Markov Chain Model.

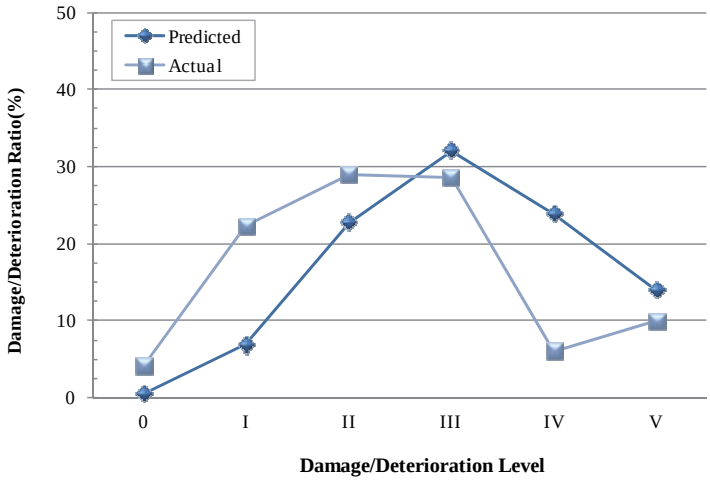
As seen in the first figure i), it is apparent that shown damage/deterioration ratios are different in the years 1996, 2002, 2011, 2016 and 2021. In particular, the figure shows a trend that the percentages of Grades 0, I and II are smaller and those of Grades IV and V are bigger as the in-service period becomes incresed. The second figure ii) suggests a similar trend in that the peaks of the distribution clearly stay at Grade II up to 2002 but tend to shift to Grade III after 2011 with a decrease in Grades 0, I and II and an increase in Grades IV and V. The third figure iii) implies inconformity between the actual and the predicted distribution of damage/deterioration ratios in 2011. This inconformity shows that damage/deterioration transition process is possibly delayed because Grades I and II are still dominant and the trend is similar to that predicted in 2002. It is also noted that certain patch and maintenance works and load restrictions that have been implemented by PAS may be connected to the delay of the transition process.



i) Distribution of Damage/Deterioration Ratio by In-Service Period



ii) Comparison of Damage/Deterioration Process



iii) Predicted Deterioration Ratio vs Actual Deterioration Ratio (2011)

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Figure 5.2-18 Predicted Damage/Deterioration Progress of P/C Beams (Main Pier)

d) Presumed Structural Performance Degradation of Main Pier

Moreover, the results of the prediction of the Markov Chain Model which was obtained in c) enable conducting further examination for structural performance degradation. Takahashi et al.[7] suggests a method for establishment of a structural performance curve.

The approach of the examination is specified as below:

A1) Estimate an optimal transition probability of the Markov Chain Model based on data gathered through a structural diagnosis survey

A2) Predict damage/deterioration ratios for each structure by year adopting the optimal transition probability

A3) Establish a weight rating for each grading and estimate general rating by year through multiplication of the damage/deterioration ratios and corresponding weight rating

A4) Assume a structural performance index by in-service period equal to the general rating by year

A5) Draw a structural performance curve by plotting the structural performance index corresponding to in-service period.

The following are the prerequisites of the examination:

- Use the results of the prediction of damage/deterioration ratios by year with an optimal transition probability of 0.134, which was obtained in former subsection 3) and corresponds to the results of A1) and A2).
- Apply an assumed weight rating for Grades 0=100, I=99, II=98, III=95, IV=80, V=0, as the suggested rating for standard pier-type structure as referred to in the paper.
- Define "Serviceability Limit State (SLS)" at 80% of the structural performance index and "Ultimate Limit State (ULS)" at 60% of the structural performance index as suggested in the papers issued by Takahashi and Yokota et al.[8].

Upon the above approach and prerequisites, Figure 5.2-19 illustrates presumed structural performance degradation at the main pier and Table 5.2-17 shows a summary of the estimate of structural performance index by in-service period. As presented in both the figure and table, some observations of the results are provided as follows:

- Gradual declination of structural performance index (SPI) started after 20 years (year 1980)
- The declination of SPI is steeper after 35-40 years (years 1995-2000)
- Assumed Serviceability Limit State (SLS) falls at 49 years (year 2009)
- Assumed Ultimate Limit State (ULS) appears at about 62 years (year 2022).

The above observations give the specific limit in-service period for the both SLS and ULS upon examination. Although the results may not fit the actual conditions of the main pier and there may not be enough reliable samples for discussion of this matter, the observations indicate a possible perspective that might happen in view of some aspects. It is to be mentioned at least that the structural performance index is already steeply declining beyond SLS.

[7] Takahashi, Yokota and Iwanami: "Formulation of Asset Management for Port Facilities –Determination of Structural Performance Degradation and Trial Application", Research Report of National Institute for Land and Infrastructure Management, Japan, No. 29 (2006)

[8] Yokota, Takahashi and Nishizono: "Research on Lifecycle Management of Port Facilities", Ministry of Land, Infrastructure, Transport and Tourism (MLIT) Research Report Conference, (2007), <http://www.mlit.go.jp/chosahokoku/h17giken/program/kadai/pdf/shitei/shi1-04.pdf>

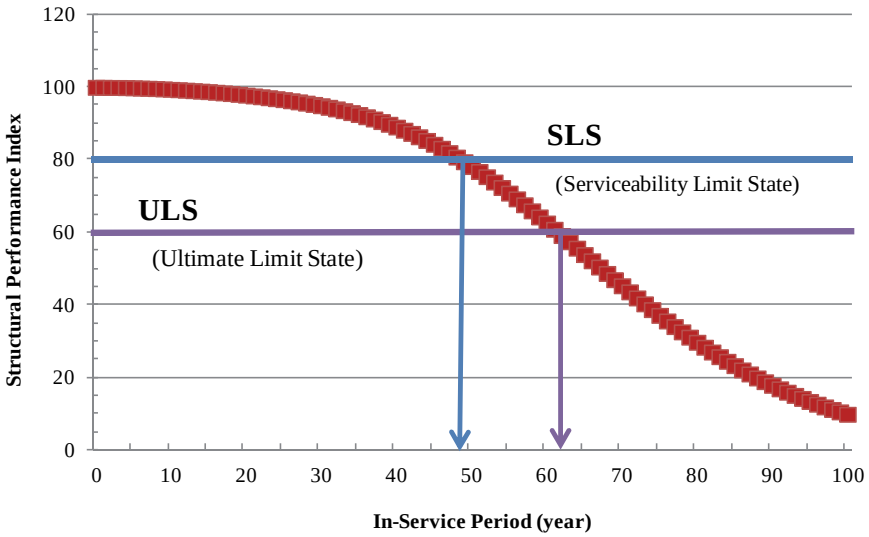

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Figure 5.2-19 Presumed Structural Performance Degradation (Main Pier)

Table 5.2-17 Summary of Estimate of Structural Performance Index (Main Pier)

In-service Period (year)	Year	px = 0.134 Damage/Deterioration Ratio (%)						Weighted Rating (%)						Structural Performance Index (%)
		0	I	II	III	IV	V	0	I	II	III	IV	V	
		0	I	II	III	IV	V	100	99	95	90	80	0	
0	1960	1.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	100.00
1	1961	1.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	100.00
2	1962	0.98	0.02	0.00	0.00	0.00	0.00	98.19	1.79	0.00	0.00	0.00	0.00	99.98
3	1963	0.95	0.05	0.00	0.00	0.00	0.00	95.06	4.89	0.00	0.00	0.00	0.00	99.95
4	1964	0.91	0.09	0.00	0.00	0.00	0.00	90.99	8.88	0.03	0.00	0.00	0.00	99.91
5	1965	0.86	0.14	0.00	0.00	0.00	0.00	86.30	13.42	0.14	0.00	0.00	0.00	99.86
6	1966	0.81	0.18	0.00	0.00	0.00	0.00	81.23	18.20	0.37	0.00	0.00	0.00	99.80
7	1967	0.76	0.23	0.01	0.00	0.00	0.00	75.96	23.00	0.77	0.00	0.00	0.00	99.73
8	1968	0.71	0.28	0.01	0.00	0.00	0.00	70.63	27.63	1.37	0.01	0.00	0.00	99.65
9	1969	0.65	0.32	0.02	0.00	0.00	0.00	65.37	31.96	2.20	0.03	0.00	0.00	99.56
10	1970	0.60	0.36	0.03	0.00	0.00	0.00	60.24	35.89	3.26	0.07	0.00	0.00	99.46
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
20	1980	0.23	0.49	0.24	0.04	0.00	0.00	22.86	48.84	22.36	3.58	0.23	0.00	97.86
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
30	1990	0.07	0.34	0.38	0.17	0.04	0.00	7.43	33.44	36.02	15.14	2.88	0.00	94.92
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
36	1996	0.04	0.23	0.38	0.25	0.08	0.02	3.64	22.94	35.91	22.69	6.74	0.00	91.91
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
40	2000	0.02	0.17	0.35	0.29	0.13	0.04	2.23	17.13	33.21	26.43	10.06	0.00	89.06
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
42	2002	0.02	0.15	0.33	0.31	0.15	0.05	1.75	14.66	31.36	27.74	11.82	0.00	87.32
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
49	2009	0.01	0.08	0.25	0.32	0.22	0.11	0.73	8.15	23.75	29.22	17.68	0.00	79.53
50	2010	0.01	0.08	0.24	0.32	0.23	0.13	0.64	7.45	22.63	29.07	18.40	0.00	78.20
51	2011	0.01	0.07	0.23	0.32	0.24	0.14	0.56	6.82	21.53	28.83	19.08	0.00	76.82
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
56	2016	0.00	0.04	0.17	0.30	0.27	0.21	0.30	4.29	16.34	26.65	21.69	0.00	69.27
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
60	2020	0.00	0.03	0.13	0.27	0.28	0.28	0.18	2.92	12.75	24.03	22.75	0.00	62.63
61	2021	0.00	0.03	0.13	0.26	0.29	0.30	0.16	2.65	11.94	23.30	22.87	0.00	60.91
62	2022	0.00	0.02	0.12	0.25	0.29	0.32	0.14	2.40	11.17	22.55	22.93	0.00	59.19
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
70	2030	0.00	0.01	0.07	0.18	0.27	0.47	0.05	1.06	6.30	16.34	21.60	0.00	45.35
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
80	2040	0.00	0.00	0.03	0.11	0.21	0.65	0.01	0.36	2.82	9.64	16.95	0.00	29.80
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
90	2050	0.00	0.00	0.01	0.06	0.14	0.79	0.00	0.12	1.18	5.11	11.51	0.00	17.92
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
100	2060	0.00	0.00	0.00	0.03	0.09	0.88	0.00	0.04	0.46	2.49	6.99	0.00	9.97

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7) Conclusions

The preliminary assessment is conducted from six (6) aspects including chronology, previous reports, repair records, use records, field inspections and numerical analyses as aforementioned. Those aspects consequently imply some key important points to highlight the current status of the Old Jetty. Focusing on the key points, conclusions for the preliminary assessment are summarized as follows:

- **Repair methods that have been taken seem to be effective in mitigating some damage/deterioration. However, the methods are not fully appropriate for actual structural conditions regarding the progressive damage/deterioration process.**

  Chronologically, major repair works were done on the fender system and asphalt pavement after 1997. Aside from the said major repair works, PAS has periodically carried out regular repair works at their own expense especially for P/C beams by using the methods established from suggestion especially in the 1995-1997 ADB Project. However, it is not necessarily mentioned that the methods match the actual structural conditions of the P/C beams upon the field observation.

- **Although repair works, load and operational restrictions enforcement are carried out by PAS, the Old Jetty still has significant damage/deterioration in the fender system, P/C beams and abutting beams. In particular, the damage for P/C beams is seriously progressing.**

  The Old Jetty berths 1-2 standard 10,000 DWT general cargo vessels a week, which is a small frequency, but accumulated invisible impacts may accumulatively affect the existing structures deteriorated during berthing and loading/unloading operations. Also, recently, PAS has restricted use of the Old Jetty for loading/unloading activities as much as possible to minimize the impact on damaged structures based on the recommendation of the 1997 JICA Study.

  Visual inspections found three significant damaged/deteriorated facilities in the Old Jetty including the fender system, P/C beams (superstructure), and abutting beam (foundation). In particular, the P/C beams that have comparative data for their damage levels show progressive damage/deterioration, of which, a proportion of the damaged Grades III, IV and V have increased.

- **Certain chloride ion infiltrations presumed require loading restrictions on the existing P/C beams in the progressive damage/deterioration process. Also, structural performance of the main pier of the Old Jetty is beyond SLS at present and has a possibility to reach ULS in the near future.**

  Upon numerical analyses, the predicted chloride ion infiltrations in 2011 and 2021 respectively deepen up to 87-135 and 95-148 mm and those resultantly bring loading restrictions presumed on the affected existing P/C beams respectively to 5 kN/m^2 (0.5 tf/m^2) and 0-2 kN/m^2 (0-0.2 tf/m^2) uniform loads based on a structural analysis. Damage/deterioration predicted by the Markov Chain Model suggests their progressive transition process; however, the actual transition process seems to be delayed in 2011 probably due to a reason that the existing repair works have been conducted and loading restriction is strictly enforced by PAS. Also, further examination using the results of the predicted damage/deterioration ratios by Markov Chain Model reveals an undeniable speculation that the main pier of the Old Jetty is already beyond the Serviceability Limit State (SLS) with steep declination and may reach the Ultimate Limit State (ULS) within/after 10 years.

(4) Recommendations

The conclusions aforementioned through the preliminary assessment may only represent an extreme situation assumed at localized portions of the Old Jetty and the beginning of the actual destruction may be anticipated to gradually and partially occur at the damaged/deteriorated P/C beams,

because the superstructure made of the P/C beams is composed of lattice beam groups and the actual damage/deterioration distributions are not uniformed. Since mooring facilities may lack for accommodating passenger boats, Ro-Ro vessels or other vessels possible for breaking when cargo vessels simultaneously call at Sihanoukville Port, it is suggested that the Old Jetty is to be maximally utilized to the extent possible on well-restricted use and implementation of reasonable and effective repairs and reinforcements in consideration of mitigation and suspension of damage/deterioration, and possible life extension. Considering the above, the following are countermeasures to be considered:

1) Definition of required role & function of the Old Jetty

It is important in vie w of port administration that role and function of the Old Jetty is defined and opportunely updated with harmonization of those of other port facilities, based on the actual performance, capacity and durability of the facility that is properly evaluated.

Generally, maximization of efficient utilization of quays for any port activities is a common role of port administration. However, each port facility has each restriction from the accommodative vessel type and dimensions, also the capacity and durability. In particular, the capacity and durability are absolutely lowering after commencement of use, so maintenance, repair and reinforcement are required accordingly.

It is therefore necessary to carefully undertake the utilization of the Jetty by defining the role and function once again, since the Jetty is over 50 years in-service period and is not suitably enough to have such maintenance, repair and reinforcement as consequently concluded in the preliminary assessment. Also, updating the role and function undoubtedly needs for the unavoidable situation that the capacity and durability are still lowering even certain maintenance, repair and reinforcement are carried out.

In view of asset management of port facilities, the above consideration is essential for not only efficient facility management with optimized running cost but also enhancement of comprehensive capacity of Sihanoukville Port.

2) Urgent Implementation of detailed structural diagnosis survey for the Old Jetty

A detailed structural survey was carried out for the Old Jetty only in the 1995-1997 ADB Project and some various investigations/analyses of the P/C beams were conducted in the 1997 JICA Study. All the relevant information based substantially comes from the Project and Study executed more than 15 years ago. It is apparent that the conducted preliminary assessment highly relies on the previous information even though some field investigations and numerical analyses have been newly incorporated. In fact, the assessment of the structural capacity and durability should be comprehensively concluded by gathering more accurate and current information. In order to specify locations, characteristics, causes, and concretized effective countermeasures for damage/deterioration of the P/C beams and concrete encasements and foundation such as abutting beams and caissons including other associated facilities, the Old Jetty urgently requires the following detailed structural diagnosis survey, but not limited to:

- Visual inspection with application of standard criteria defined for damage/deterioration classification including hammering test for concrete structure and underwater survey for caisson structures
- Displacement measurement by survey instrument
- Non-distractive tests using instruments such as a fiber-optic gyroscope for detailed observation at inaccessible location(s) and portion(s), electric/magnetic utilization for presumption of location, diameter and cover thickness of reinforcement and of water content in concrete, elastic/magnetic waves for gathering information of strength, cracks, exfoliation, internal void of concrete and of loading records affected to structure(s), and electrochemical characteristics for supposition of steel corrosion state and rate in concrete
- Partial distraction test for confirmation of the property and deterioration state of concrete and reinforcement, e.g. coring test

- Verification test for evaluation of deteriorative factors of such as salt damage, chemical attack and alkali aggregate reaction, etc.

3) Application of more suitable repair/reinforcement methods

a) Fender System

The fender system is one of the facilities with important functions of the Old Jetty to absorb berthing energy. In particular, the system has the role of minimizing horizontal impact forces on the existing P/C beams. If the function does not work well, all the energy is distributed to the P/C beams, which could be a cause of damage of the beams. Through field inspections as previously presented, some rubber fenders are apparently cracked and damaged resulted from repeated compression/decompression and/or incidental twists at vessel berthing, and damage/deterioration caused by ultraviolet and higher temperature occurred. Also, some H-beam piled frame structures in the system are deformed by accidental vessel strikes. The both disturbances happened are remarkably dominant to the offshore side due to frequency of larger vessel berthing. In addition, the P/C beams are not durable for berthing force horizontally affected from a rectangular direction without consideration of it design, so restoring the fender system is further minimizing damage/deterioration to the P/C beams. In several available options, the following two (2) measures are suggested:

- Replacement of some damaged/deteriorated rubber fenders on the offshore side with the unused better-conditioned fenders installed on the inshore side as an urgent measure.
- Possible relocation of the fender system to be re-installed on the line of the foundation where abutting beams and caissons are located to minimize the impact of berthing force on the P/C beams damaged and deteriorated. In case some fender system requires between the caisson foundations, the system is to be preferably self-standing type for example without touching the P/C beams as much as possible.

b) P/C beams and other concrete structures

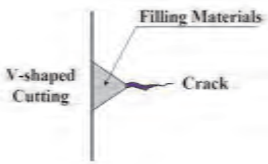
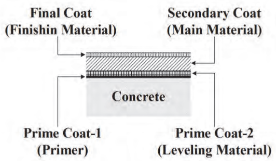
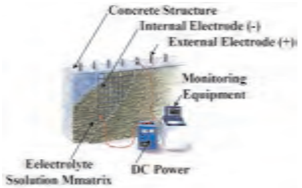
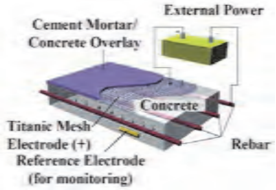
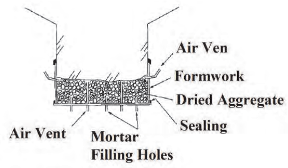
P/C beams installed on abutting beams supported by concrete caisson foundations is the major structural members of the Old Jetty. Depending on the necessary role and function of the Jetty, the P/C beams and other concrete structures require not only repair but also reinforcement works, in order to secure mitigation and suspension of the damage/deterioration and possible life expansion.

Table 5.2-16 shows applicable repair methods for the P/C beams and other concrete structures including abutting beams and caisson foundations. The table introduces five (5) types of repair methods including “crack repair,” “surface coating,” “desalination,” “cathodic protection” and “sectional restoration” applicable for all the concrete structures, and each advantage and disadvantage, etc. The list includes some repair methods for salt damage which is the most critical deteriorative factor observed for the P/C beams and other concrete structures in the splash zone. The repair could be done as single or combined applications, if necessary.

Table 5.2-19 provides the suggested optimal concrete repair timing for port facilities considering lifecycle cost as suggested by Fukute[9] and Figure 5.2-20 designates the relationship among deterioration states and grades, and reserved performance. As referred to in Figures 5.2-12 and 5.2-14, 75-80% of damage/deterioration of the P/C beams at both the main pier and access bridge are of Grades II, III, IV and V in 2011, and Figure 5.2-20 indicates that the situation in 2011 is already categorized with advanced, accelerated and deteriorated processes.

[9] Fukute: “Study on Selection of Maintenance and Repair/Reinforcement for Deterioration of Port Facilities with Consideration of Asset Management”, Research & Development Report of Service Center of Port Engineering (SCOPE), (2006), <http://www.scopenet.or.jp/main/research/pdf/fukute_houkoku.pdf>

Table 5.2-18 Applicable Repair Methods of P/C Beams and Other Concrete Structures

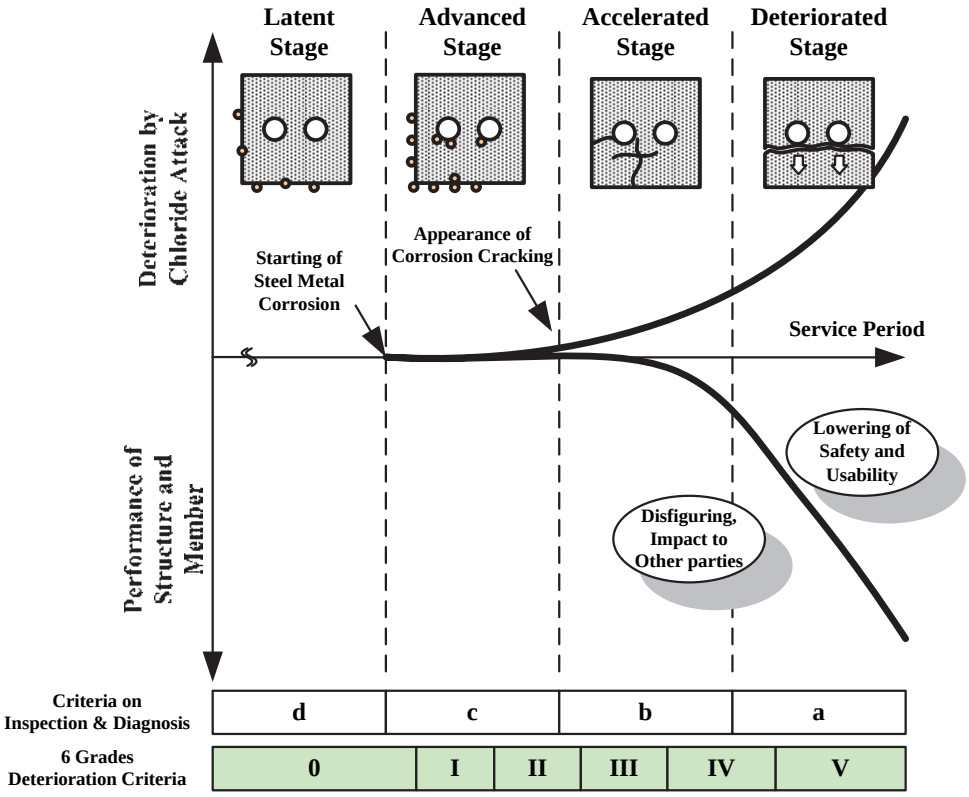
ITEM \ TYPE	CRACK REPAIR	SURFACE COATING	DESALINATION	CATHODIC PROTECTION	SECTIONAL RESTORATION
IMAGE PHOTOGRAPH					
CONCEPTUAL DRAWING					
PURPOSE	* Waterproof, * Restoration of durability	* Control of rebar corrosion progress with decreasing infiltration of chloride ion and oxygen	* Extraction of chloride ion inside concrete by electric potential gradient	* Suspension of corrosion reaction by passing protective current	* Restoration of damaged concrete section including anticorrosive coating to rebar, and replacement by and addition of new rebar
METHOD	① Inject epoxy resin, ② V-shaped cutting and apply epoxy resin or mortar	① Coat concrete surface with polymer, resin or rubber materials	① Attach electrolyte solution matrix to concrete surface, ② Connect lead wire to rebar of concrete and wire-mesh respectively, ③ Apply electric current to the circuit	① Install titanic mesh electrode, ② Place cement mortar or concrete overlay, ③ Connect positive and negative wires to External Power, ④ Apply electric current to the circuit	① Chip all damaged and saline concrete portions, ② Blasting and coating rebar or, Recondition by new rebar, ③ Apply restoration materials such as epoxy mortar&resin, polymer concrete etc.
CHARACTERISTIC	○ Easy/quick application to minor crack, ○ Less disturbance to the actual operation	○ Certain preventive coating secured, ○ Easy application, ○ Less disturbance to the actual operation	○ Certain desalination expected, ○ Less duration of passing current than cathodic protection, ○ Minimal disturbance to the actual operation	○ Most reliable method to suspend corrosion process, ○ Many experiences recorded, ○ Applicable to saline concrete containing much chloride ion	○ Able to directly remove deterioration part(s) of saline concrete, ○ Certain protection to be expected for entering chloride ion, ○ Original section(s) secured without deficiency
	× Not applicable to deteriorated/structural cracks, × Additional crack may be arisen around the repaired cracks, × Appearance highlighted by the repaired method	× Possible diffusion of chloride iron inside coated concrete surface, × Weakness for damage and scratch	× Not applicable to saline concrete with much chloride ion & rebar corrosion, × Possible re-supply of chloride ion remained inside concrete	× Costs to be increased by passing external power/changing anode metals	× Possible re-supply of chloride ion remained inside concrete, × Possible occurrence of "Micro-cell Corrosion"
APPLICATION	* Initial crack caused by temperature, dry and shrinkage etc.	* Saline concrete surface	* Saline concrete surface	* Saline concrete member	* Damaged and saline concrete member
MAINTENANCE	* Confirmation of other crack(s) around the repaired portion(s)	* Re-touching partially	* Coating required after desalination process and monitoring chloride ion content	* Passing external power continuously and changing anode materials periodically	* Periodical visual inspection required with monitoring of infiltration of chloride ion etc.
DURABILITY	* Limitedly and partially secured only at new concrete structure	* Limitedly and partially secured only up to latent stages of deterioration	* Limitedly and partially secured with combination to other method of repair such as coating	* Secured for suspension of progressive corrosion of rebar inside concrete structure(s)	* Secured for restoration of section of structural member(s), but it is not reinforcement of structural member(s)

Prepared by Project Team

Table 5.2-19 Practical Concrete Repair Application for Port Facilities

Repair Type	Deterioration Process					Remark
	Newly Constructed	Latent	Advanced	Accelerated	Deteriorated	
Crack Repair	○	High Risk for Re-deterioration				Re-diffusion of chloride ion
Surface Coating	○	○				
Desalination + Surface Coating	-	○	○			
Cathodic Protection	○	○	○	○	○	Control of Protective Current
Sectional Restoration	Not Economical		○	○	○	Micro-cell Corrosion

Source: Fukute (Study on Selection of Maintenance & Repair/Reinforcement for Deterioration of Port Facilities)



Source: Technical Maintenance Manual of Port Facilities in Japan

Figure 5.2-20 Relation among Deterioration States &Grades, and Reserved Performance

According to Table 5.2-19, the present situation is limited to selecting the applicable repair methods of the P/C beams from only “desalination + surface coating,” “cathodic protection” and “sectional restoration.” In this situation, it is therefore suggested that the selected methods are to be carefully applied to the relevant concrete members (single or combinational application), based on examination of each damage/deterioration state and progress through a detailed structural diagnosis survey.

Table 5.2-20 shows applicable reinforcement methods for the P/C beams. As seen in the table, four (4) methods including “steel/textile bonding,” “replacement,” “pre-stressing” and “additional supporting” are suggested. Selection of the methods completely depends on the required role and function of the Old Jetty, considering the performance and durability. Generally, the “steel/textile

bonding" method is easier to apply and cheaper than other options, but it can be durable only for additional loads on the pier and is not a complete alternative for cut P/C cables. The "replacement" method is quite simple and assures full capacity and durability, but the cost is high since it would be necessary to demolish existing P/C beams, fabricate new P/C beams, and mobilize equipment for new beam installation. The "pre-stressing" method is a simple and effective for securing the capacity and durability, but needs concrete durability for the stressing on the outer side of the P/C beams and involves certain cost implications for new cabling and making fixing points. The "additional supporting" method is structurally effective to minimize bending moment of the P/C beams, but has difficulty in providing a foundation for the supports among the existing concrete caissons.

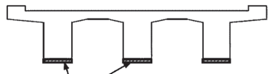
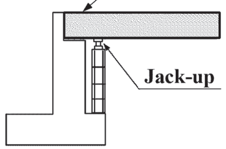
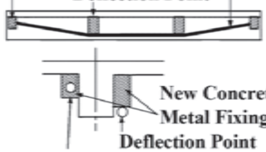
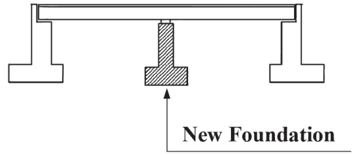
For selecting the repair methods, sufficient information based on a detailed structural diagnosis survey is required. However, although information is limited at this time, it would seem the "replacement," "pre-stressing" and "additional support" methods are practically applicable and accordingly recommendable.

4) Scoping on alternative facilities for succeeding role and function of the Old Jetty

The Old Jetty can not be used indefinitely even if PAS conducts restricted operation and implements the technical countermeasures as suggested. A certain perspective is required to provide alternative facilities for successful establishment of the role and function depending on the development policy of Sihanoukville Port.

If other berthing facilities can accommodate all vessels expected to berth at the Old Jetty with large enough dimensions and capacity, a new alternative is not necessary. However, if not, the new alternative is to be duly required and *t*hen provided prior to the final operation of the Old Jetty.

Table 5.2-20 Applicable Reinforcement Methods of P/C Beams

ITEM\TYPE	STEEL/TEXTILE BONDING	REPLACEMENT	PRE-STRESSING	ADDITIONAL SUPPORTING
IMAGE PHOTOGRAPH				
CONCEPTUAL DRAWING				
PURPOSE	* Strengthening load resistance capacity by additional reinforcement material(s)	* Restoring load resistance capacity by new structural member(s)	* Reinforcing P/C beam(s) by external pre-stressing PC cables	* Mitigating bending moment of the existing P/C beam(s) by additional support(s)
METHOD	① Clean up concrete surface, ② Apply epoxy resin to surface, ③ Attached reinforcement materials such as steel plate, textile sheet at bottom and both side of beam	① Remove the existing P/C beam(s), ② Rehabilitate support and damaged abutting beam(s), ③ Fabricate new P/C beam(s), ④ Install new P/C beam(s)	① Reinforce the both edges of P/C beam(s), ② Install necessary fixings at anchorage and turning points, ③ Install and tension PC cables upon design required	① Driving H-shaped piles between the existing caisson foundations, ② Uplift the existing P/C beam(s) to release tension of the existing PC cables alive, ③ Install new abutting beams on the new piles with necessary supports
CHARACTERISTIC	○ Flexible application to concrete surface, ○ Easy supply of reinforcement materials, ○ Less disturbance to the actual operation	○ Certain securement of structural stability, ○ Easy installation of new PC beam(s), ○ Flexible adjustment to required design loads be considered	○ Certain securement of structural stability, ○ Easy installation of external PC cables, ○ Flexible adjustment to required design loads be considered	○ Mitigation of bending moment for the existing beam(s), ○ Less impact to the existing structure(s), ○ Minimal disturbance to the actual operation
	× Limited effect to reinforce concrete. member, × Possible damage to original member, × Difficulty in bonding of reinforcement materials to the entire beam(s)	× Large-scaled disturbance to the actual operation, × Possible impact to the existing caissons, × Higher costs my be required	× Medium-scaled disturbance to the actual operation, × Difficulty in application of pre-stressing, × Concrete repair to be concurrently required	× Additional reinforcement required at upper side of the existing beam(s), × Possible damage to P/C beams by H-pile driving, × Difficulty of lifting the existing beam(s)
APPLICATION	* Additional load resistance limited	* Full load resistance depending on target utilization to be determined	* Full load resistance depending on target utilization to be determined	* Restricted load resistance depending on allowable structural durability
MAINTENANCE	* Corrosion protection required for steel repair materials	* Not significantly required due to new member(s) installed	* Certain corrosion protection required for PC cables	* Corrosion protection required for H-shaped piles as well as P/C beams concurrently
DURABILITY	* Limitedly secured only for increasing additional live load	* Secured for long period, depending on durability of the existing caissons	* Secured for certain period, depending on durability of the existing P/C beams and caissons	* Upgrading structurally with distributing critical load conditions

Prepared by Project Team

5.2.3 Capacity of existing port facilities

(1) Container terminal

As discussed in Chapter 4, the handling capacity of the existing container terminal is 500,000 TEU per year on the condition that the concentration of vessels arrival on a particular day of a week will be alleviated with increased container handling volume. Increase of capacity of cargo handling equipment including introduction of new QGCs is also a precondition of the estimated handling capacity.

(2) Bulk terminal

The handling capacity of the bulk terminal which is to be constructed by the Multi-purpose Terminal Development Project is estimated to be 2,160 thousand tons per year as shown in the table below.

Table 5.2-21 Estimated handling capacity of the bulk terminal (under construction)

Commodity	Maximum Handling Volume	Vessel Size	Number of Ships	Handling Efficiency	Gang	Working Hours	Berth-Day	Berth Occupancy Ratio
	tons/yr	DWT	Vessels/yr	ton/hr		hr/day	day	
Woodchips	1,400,000	50,000	28	280	4	20	63	68%
Rice	600,000	10,000	60	48	4	20	156	
Wheat	148,000	10,000	15	112	4	12.5	26	
Sugar	9,000	7,000	1	48	4	12.5	4	
Total	2,157,000		104				249	

Source: PAS

(3) Cruise terminal

It can be assessed that Sihanoukville Port doesn't have a cruise terminal with necessary functions because there is no passenger building in the port. Furthermore, the old jetty which cruise vessels mainly use is severely deteriorated and its physical functions cannot be maintained in the target year.

Therefore, the Project Team evaluates that the capacity of cruise terminal in the target year is zero.