5.7 Port Planning

5.7.1 Aim of Port Planning

In this section, an optimum port layout plan is proposed taking into account the assumed design cargo volume, required berth length and yard space estimated in the previous section.

5.7.2 Port Dimensions

The basic port dimensions assumed in the previous section is as follows.

- Berth Length: 164m (2 berths)
- Cargo Yard: 3 ha

Other dimensions for the port are estimated as follows.

(1) Water Depth of Berth

Table 5.43 shows the water depth of the river channel along the Ayeyarwady and Chindwin Rivers during the dry season. It appears that the water depth upstream is shallower than it is downstream. The water depth at the Mandalay Port is 1.5m. The design depth of the berth is assumed at -2.0m considering the channel depth and some additional spare depth.

Table 5.43 Water Depth of the River Channel during Dry Season

Ayeyarwady River

Waterway Section			Water Depth
Hinthada	~	Pyay	5 ' 6 " (1.68m)
Pyay	~	Mandalay	5 ' 0 " (1.52m)
Mandalay	~	Kathar	4 ' 0 " (1.22m)
Kathar	~	Bamaw	3 ' 9 " (1.14m)
Sinbo	~	Myitkyina	2 ' 0 " (0.61m)

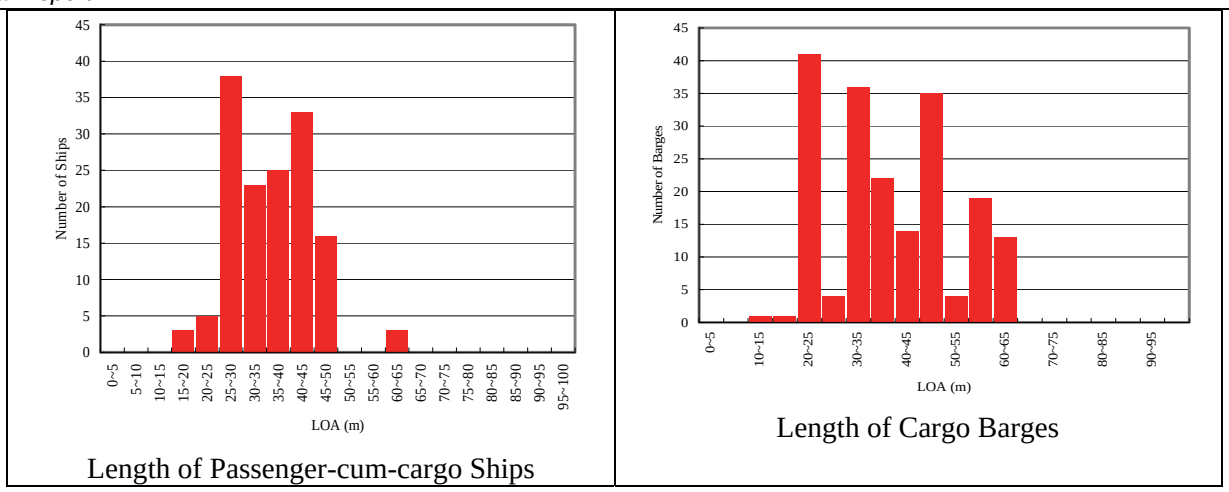
Cindwin River

Waterway Section			Water Depth
Chindwin	~	Monywa	3 ' 0 " (0.91m)
Monywa	~	Kalewa	3 ' 3 " (0.99m)
Kalewa	~	Homali	3 ' 0 " (0.91m)
Homali	~	Khamti	2 ' 6 " (0.76m)

Source: IWT

(2) Berth Length

The following Figure shows the number of ships owned by IWT for each group of ship length (LOA). The average length of passenger-cum-cargo ships is 36m, and the average length of cargo barges is 40m. The maximum length of barges is 64m. From these data, the berth length is designed at 82m for one berth, and two berths are planned for initial development.



Length of Passenger-cum-cargo Ships

Length of Cargo Barges

Source: IWT

Figure 5.68 Number of Ships Distribution for each Ship Length (IWT owned)

(3) Apron Width

Apron width is designed taking into account the following space for quay-crane, truck running lane, and cargo handling space. The conventional apron width is in the range of 15 ~ 20m according to the existing ports. In the case of Mandalay, design width is proposed to be wider at 20m because both handling by manual labor and by equipment will be mixed in the same apron space.

Truck running lane 4m
Truck lane for cargo operation 3m
Space for quay-crane ..... 6 ~ 8m
Cargo handling space ..... 5 m
(Total)..... 20m

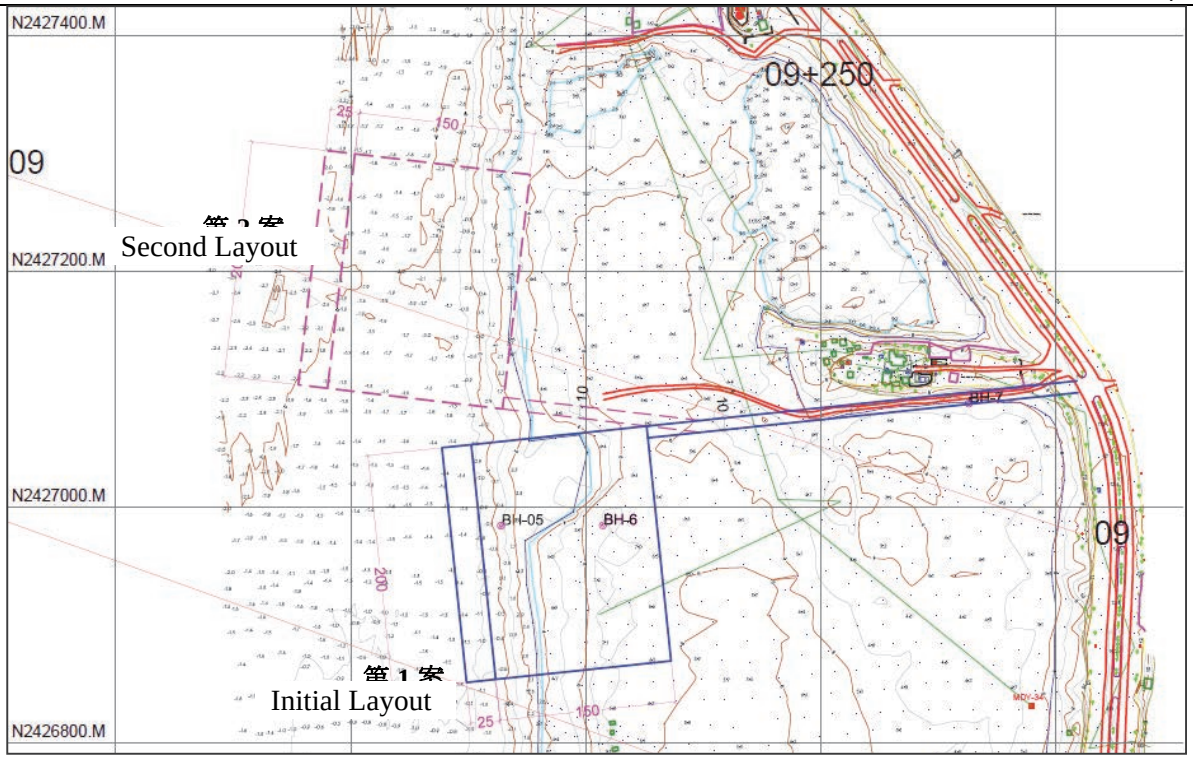
5.7.3 Layout of Berth and Cargo Yard

For this study, information on the water depth and topographic survey data was very limited during the study for a suitable port location. The layout plan for the jetty and cargo yard was re-considered after receiving precise survey records.

The initial plot plan for the study of a suitable port location is shown in Figure 5.69. This plan requires dredging in front of the berth as the location is shallow. In addition, maintenance dredging might be required due to seasonal changes in the riverbed.

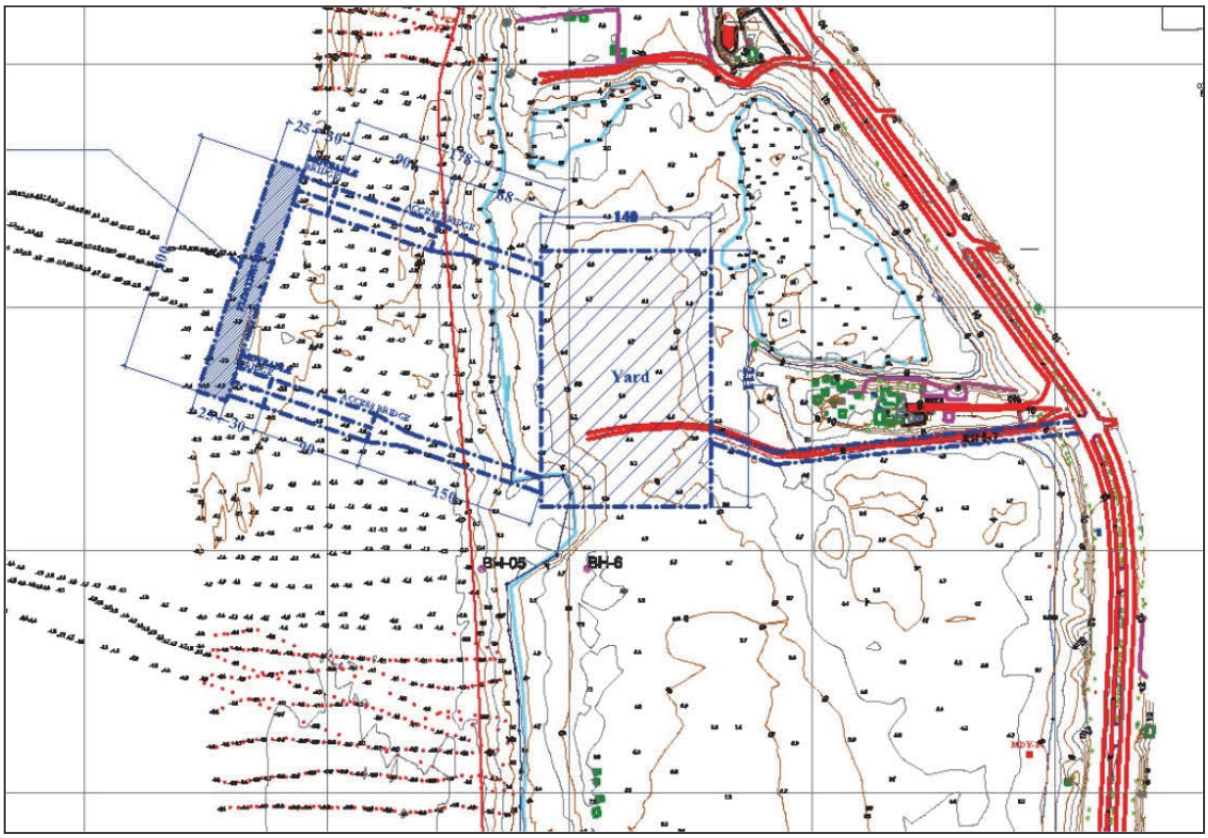
The second layout plan shown in Figure 5.69 is the modified plan so that the berth location should be moved to the place where riverbed is nearly -2.0m. Referring to the records of the river flow survey, the berth face line is adjusted to the same direction as the river flow. The plan will provide an advantage for reducing the risk of the initial and maintenance dredging. However, the plan has a disadvantage regarding construction costs because the depth at the cargo yard reclamation is not shallow. Mandalay port has an 8m water depth difference between the dry and rainy season, thus the reclamation height shall be more than 10m, which makes the reclamation volume very large.

The final proposed layout plan is shown in Figure 5.70 which plots the reclamation yard on higher land, in which access bridges connect the berth and the cargo yard. The plan has the advantage of reducing the risk of dredging and reducing construction costs for reclamation.



Source: The Study Team

Figure 5.69 Initial and Second Layout plan for the Study



Source: The Study Team

Figure 5.70 Final Proposed Layout Plan

5.7.4 Future Expansion Plan

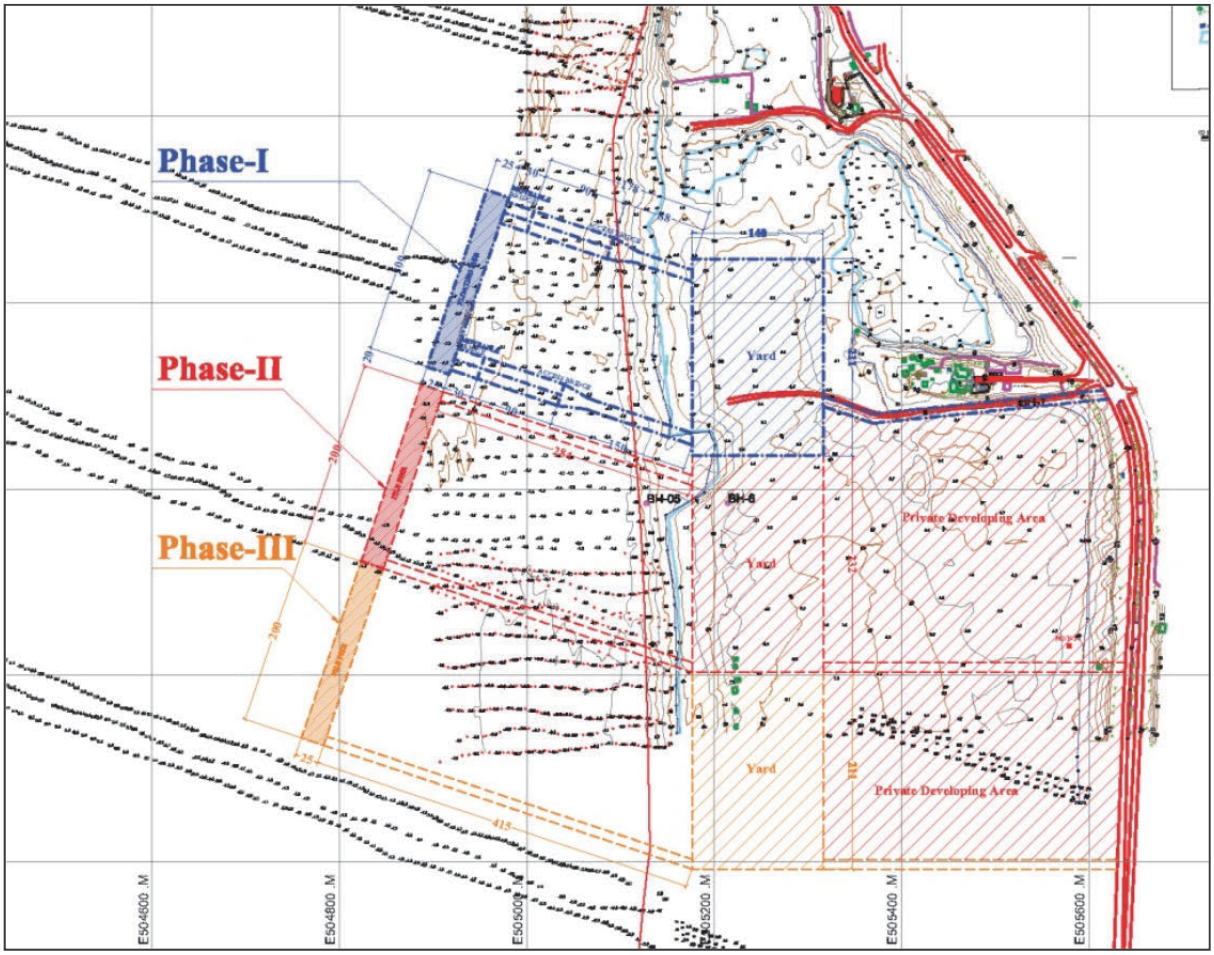
In this study, the initial development of Mandalay Port is proposed to have the capacity of handling 240,000 tons of cargo per year. If it is assumed that in the future the modernization of the port cargo operation will proceed and more equipment is utilized for cargo operation, the expansion plan will be required as roughly estimated as shown in Table 5.44.

Table 5.44 Future Development Perspective (Conceptual)

Development Phase	Development Period	Port Capacity
Initial Phase Developoment	2016~2017	240,000 ton/year
Second Phase Development	2021~2022	500,000 ton/year
Third Phase Development	2027~2028	850,000 ton/year

Source: The Study Team

Figure 5.71 shows the further development layout plan (conceptual). This shows the port terminal will be expanded southward where a wider flat space of riverside is available.



Source: The Study Team

Figure 5.71 Future Expansion Plan (Conceptual)

5.8 Riverbed Deformation and Countermeasures

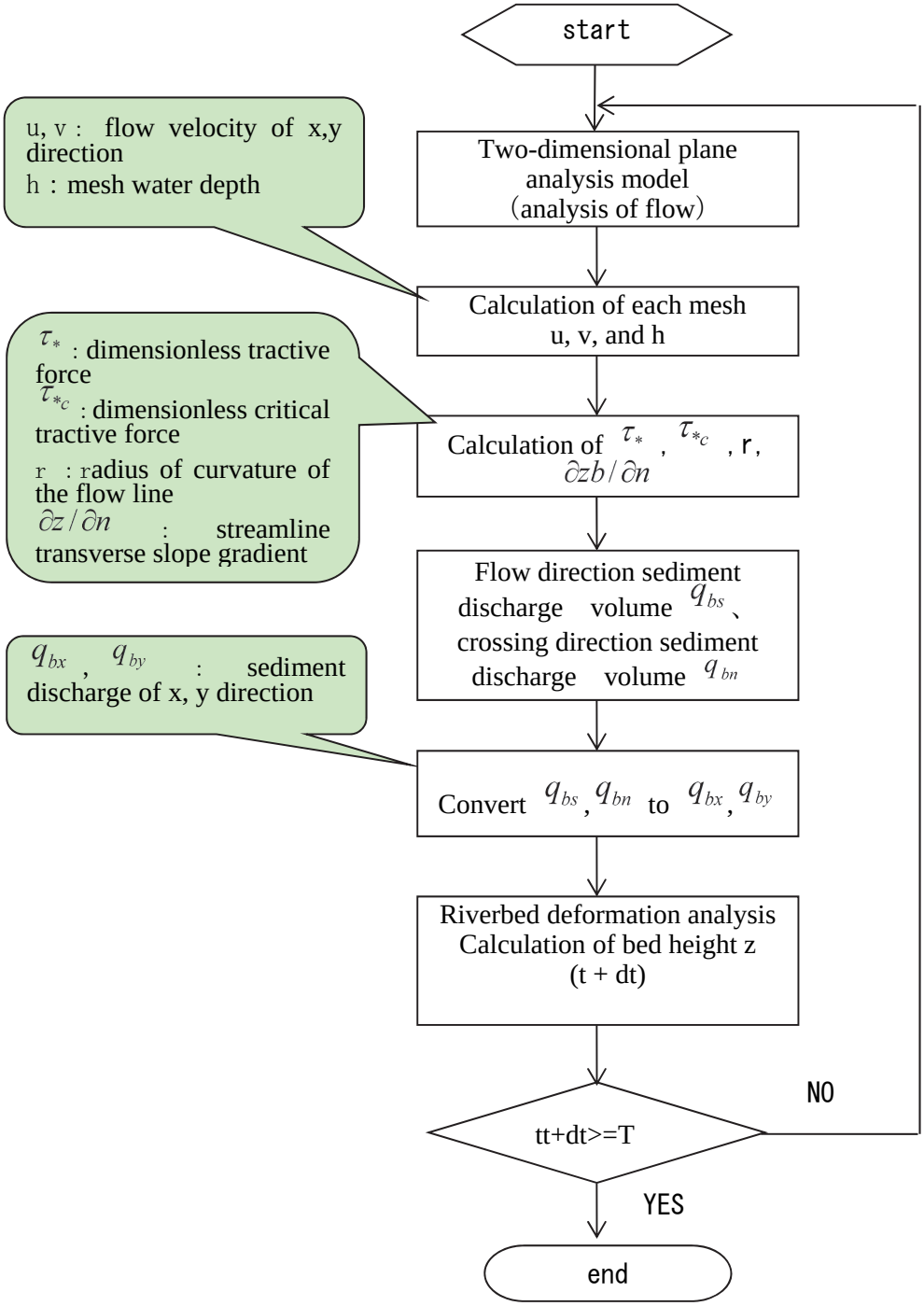
The difference in the water level of the Ayeyarwady River between the rainy season and the dry season is 8m, which is fairly large. Therefore, the flow velocity is also significantly different in the dry season than in the rainy season.

To check the status of sediment deposition at the projected of river port site and to select the type of structures to be used, it is desirable to grasp the situation of the bed deformation velocity in the flood season when the external force is at its largest.

In this section, after river flow analysis, riverbed deformation will be predicted, and a countermeasure against sedimentation will be discussed.

5.8.1 Flow Study and Analysis Purpose

In the riverbed deformation analysis, the two-dimensional plane analysis model, capable of representing flow planar, was used. This is to identify the trends of flow direction, velocity, and sand sediment accumulation, by the layout of facilities such as a jetty groyne.



Source: the Study Team

Figure 5.72 Flow Diagram of Bed Deformation Analysis

5.8.2 Organizing Analysis Condition

The list below shows the conditions of numerical analysis.

Table 5.45 Analysis Conditions

Items	Contents
Analytical method	two-dimensional plane river bed deformation analysis
Basic equations of flow	Accumulation conservation equation of flow （continuity equation） Two-dimensional plane shallow-water flow equation （equation of motion）
Basic equations of riverbed deformation	Accumulation of sand sediment conservation equation（continuity equation） Equation of Ashida and Michiue （Longitudinal direction sand bed load volume equation） Equation of Hasegawa （crossing direction sand bed load volume equation）
Area analyzed	18km upstream area from Ayeyaiwady bridge (Yadanabon)
River channel cross-section	Crossing survey results（1km pitch or 250m pitch）
Roughness coefficient	Low-flow channel 0.030　Flood channel 0.045
The upstream end flow rate conditions	Flow rate Hydro of 51days （2004/7/10～2004/8/29） （Water observatory record　Peak discharge 25468m^3/s）
The downstream end water level conditions	Conversion water level of 51days（2004/7/10～2004/8/29） （Water observatory record　Peak water level 70.684m）
Representative particle size	dm＝0.4mm（60% Grain size）
Computation time interval	
Structures to be modeled	yard、groyne Under water structure is treated as an inhabitation to cross-sectional area.

Source: the Study Team

5.8.3 Analysis Results

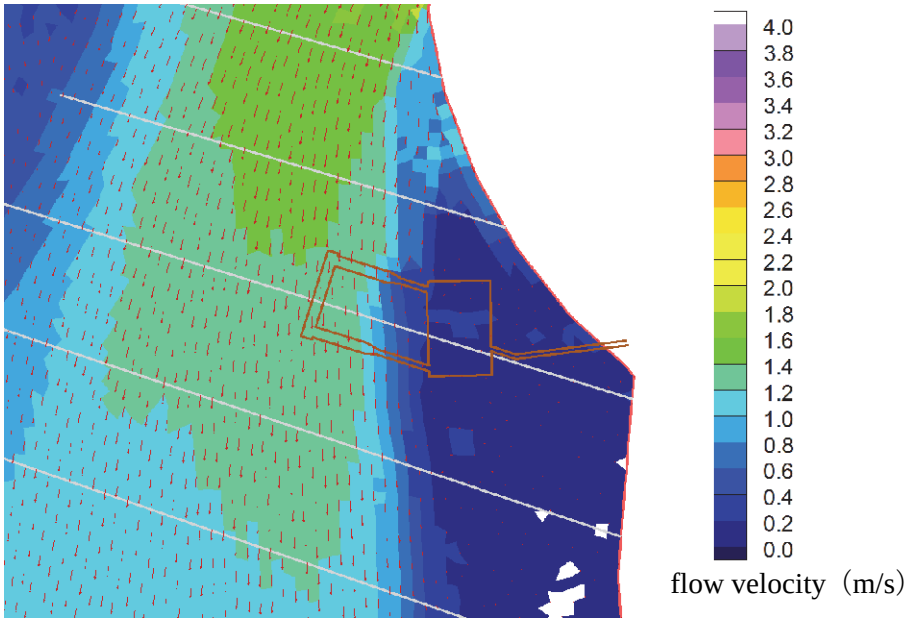
The riverbed deformation analysis and flow analysis were carried out for the following cases.

CASE1	without groyne	To check flow velocity distribution and sand sediment transport conditions of the present channel
CASE2	with groyne	Based on the analysis results of current river channel, the shape of the groyne that is capable of sand sediment control was studied.

(1) CASE1：without groyne

When there is a difference in the sand sediment carried away downstream and sand sediment coming in from upstream by the flow, the riverbed height is increased or decreased. This sand sediment discharge affects tractive force and the flow direction vector. Sand sediment is greatly moved when the tractive force is increased and water level becomes high, and sand sediment is accumulated when the tractive force is reduced and water level is low.

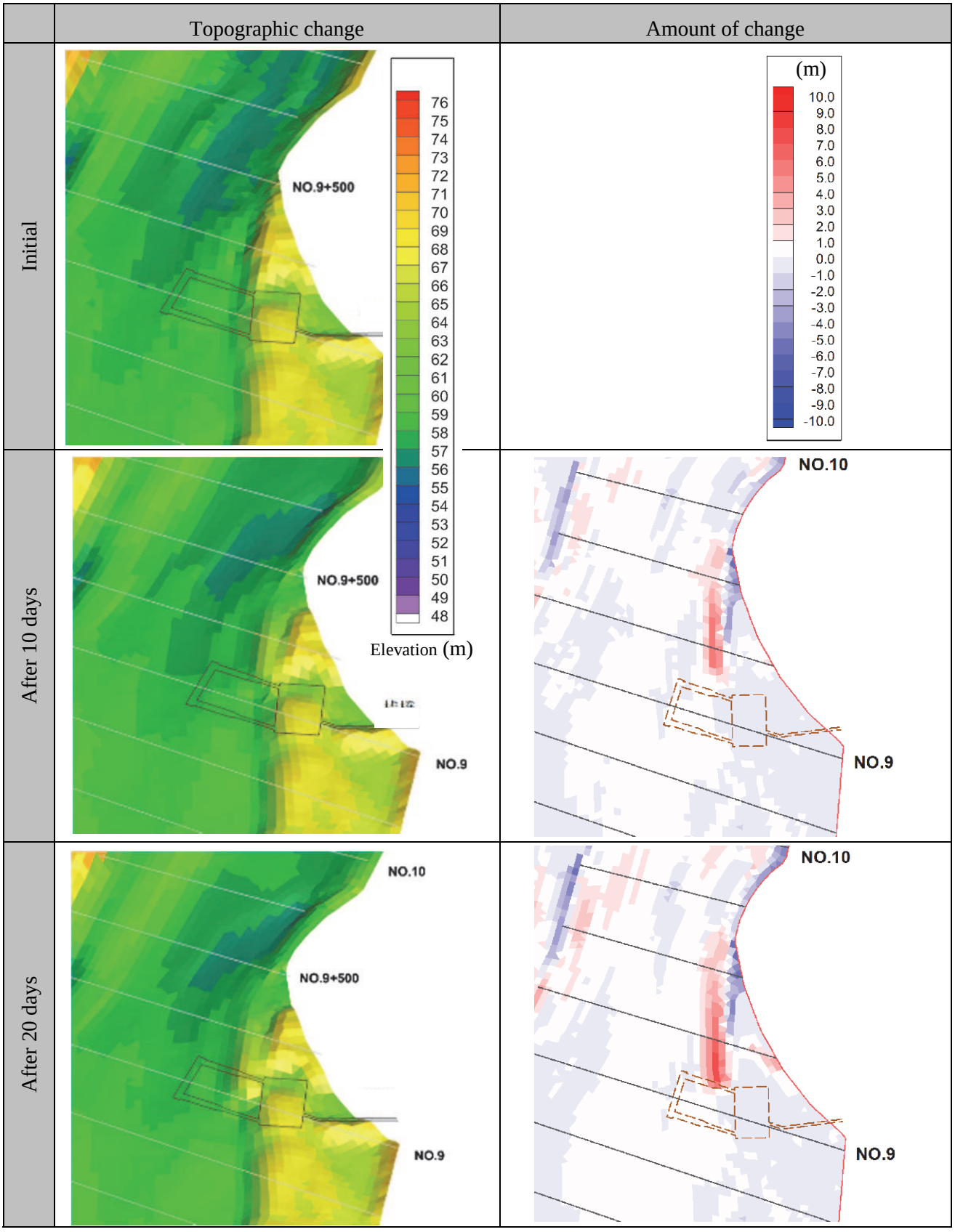
Figure 5.73 shows a flow velocity distribution diagram of the peak flow rate obtained by flow analysis. At the Mandalay port project site where the flow path width is widened, the flow velocity begins to fall. Maximum Flow velocity of the present river in the Mandalay port project site is estimated to be about 1.4m/s.



Source: the Study Team

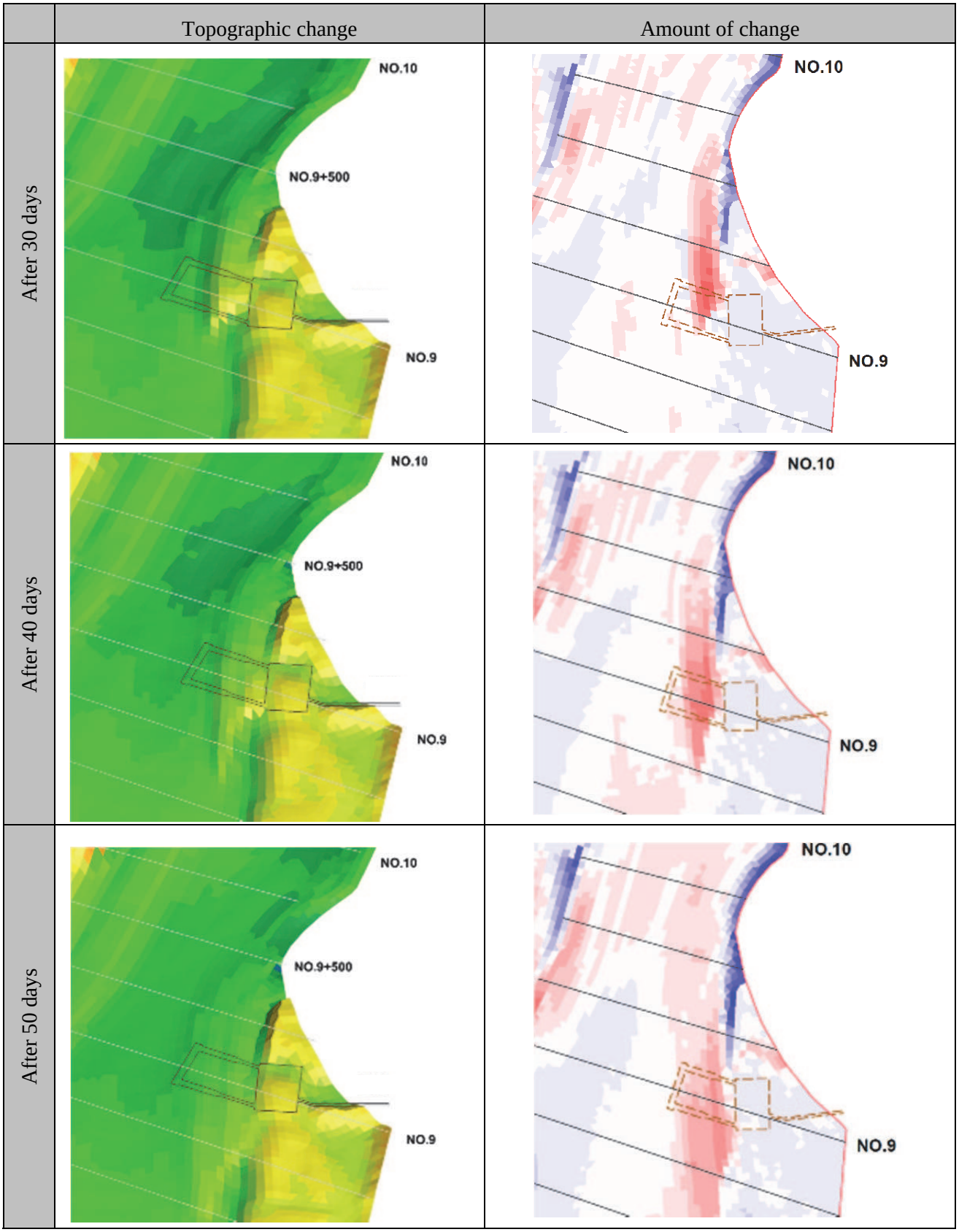
Figure 5.73 Flow Velocity Distribution Diagram of Current River Channel

The result of the riverbed deformation analysis shows a trend that sand sediment is moved in the flow velocity vector direction. Sand sediment is accumulated about 1 ~ 2m in the floating dock projected(on planned) point. Because it is the point where the tractive force (flow velocity) is reduced, it is an area where sand sediment from upstream tends to deposit.



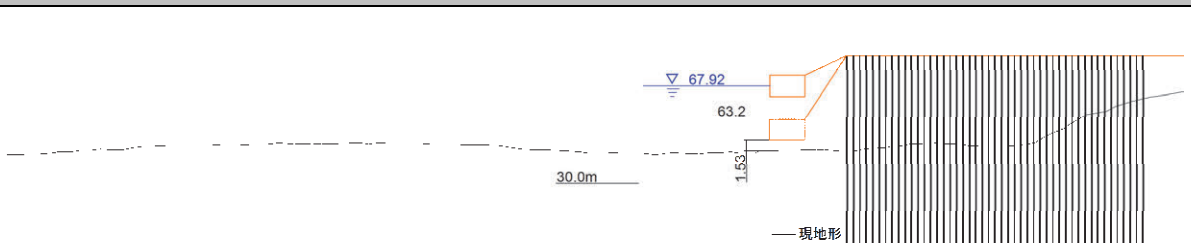
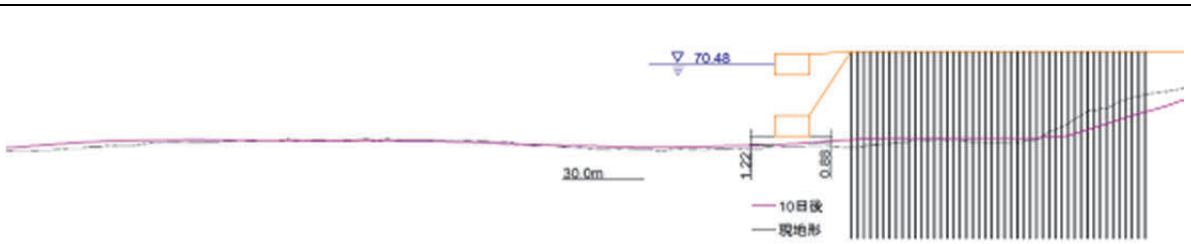
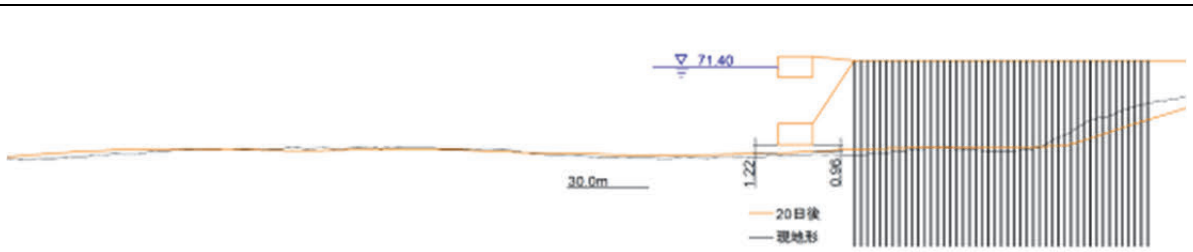
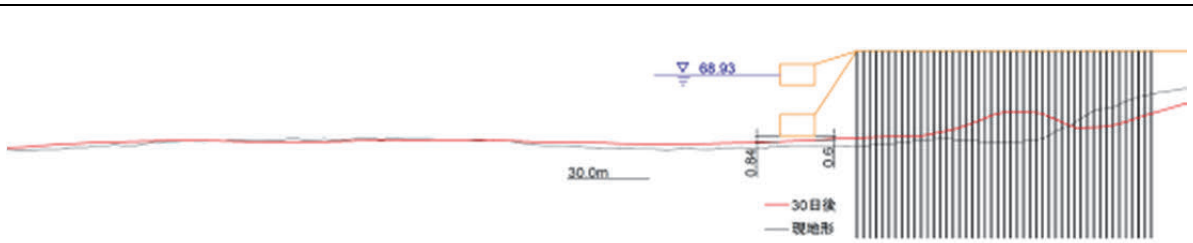
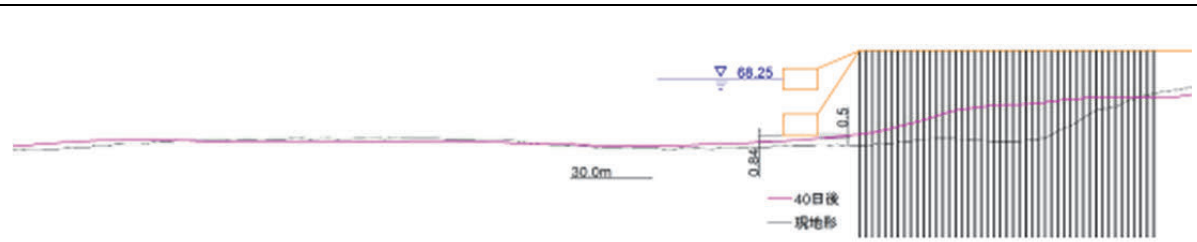
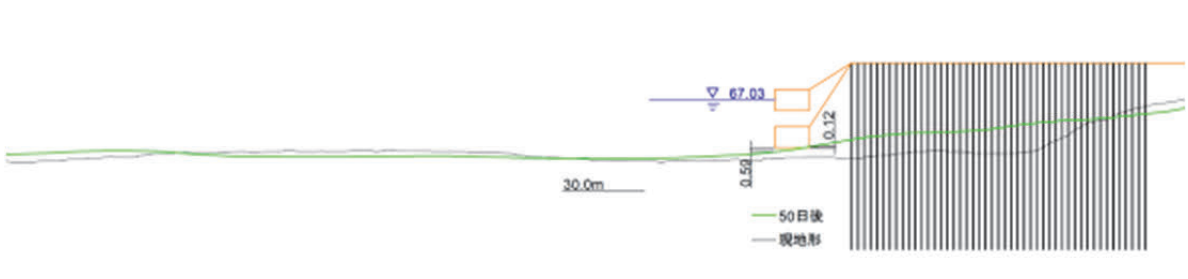
Source: the Study Team

Figure 5.74 Analysis of the Current River Channel (1)



Source: the Study Team

Figure 5.75 Analysis of the Current River Channel (2)

	Accumulation situation Cross SectionV/H=1/5
Initial	
After 10 days	
After 20 days	
After 30 days	
After 40 days	
After 50 days	

Source: the Study Team

Figure 5.76 Analysis of the Current River Channel (3)

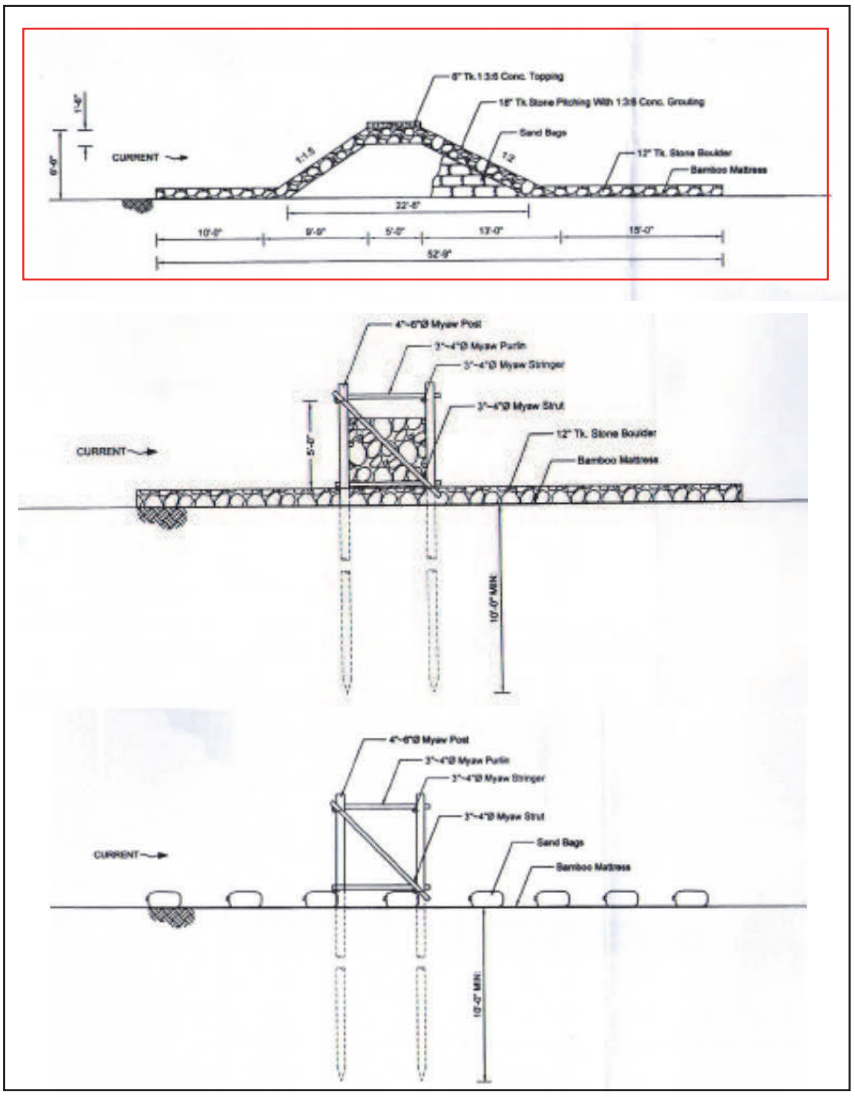
(2) Consideration of Anti -sand Sediment Measures by Groyne

Tendency to accumulate sand sedimentation was observed at the port project site, and the use of a groyne was studied to control the conditions of sand sediment accumulation and water flow direction.

【Structure of groyne】

The purpose of a groyne installation is to prevent sand accumulation from the front of the groyne to floating docks downstream. It is necessary to have an effect of splashing water and sand sediment splashes, so a non-overflow, opaque type groyne was applied.

As for the best choice in the structure of the groyne, a stone tension type (opaque type), was selected. This type is among the types which DWIR installs on the Ayeyarwady River.

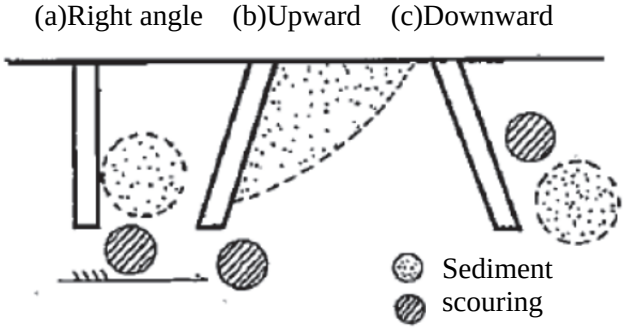


Source: Data received from DWIR

Figure 5.77 Types of Groyne, Installed in Ayeyarwady

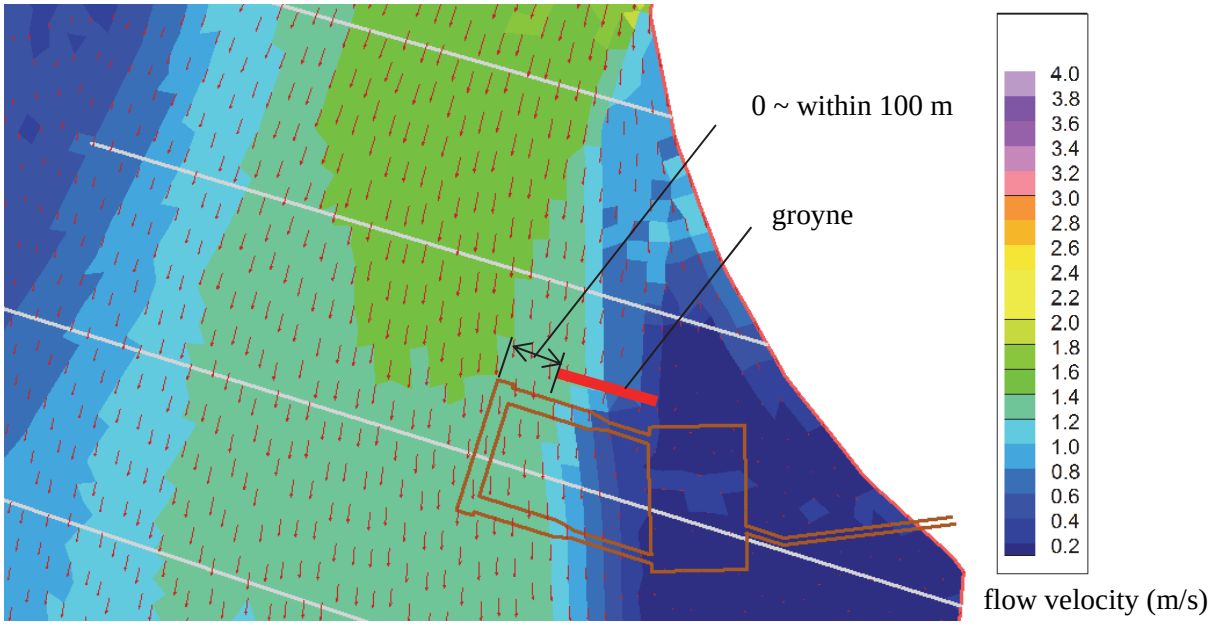
【Orientation of the Groyne】

The figure below shows examples of the installation direction of groynes. By placing the groyne in an upward direction against the running water, it is possible to make scouring at the groyne head larger. However, sand sediment on the downstream side of the groyne will be dominant. Based on the effect of groynes like this, the groyne was placed in an upward direction to the running water (parallel to the pier direction) to hinder sand sediment around the projected floating platform (to encourage scouring at the top of the groyne). And in order to have a splashed water effect and sand sediment bouncing effect, the head of the groyne is set to near-100m from the floating platform, where flow rate starts to decrease.



Source: the Study Team

Figure 5.78 Orientation of groynes

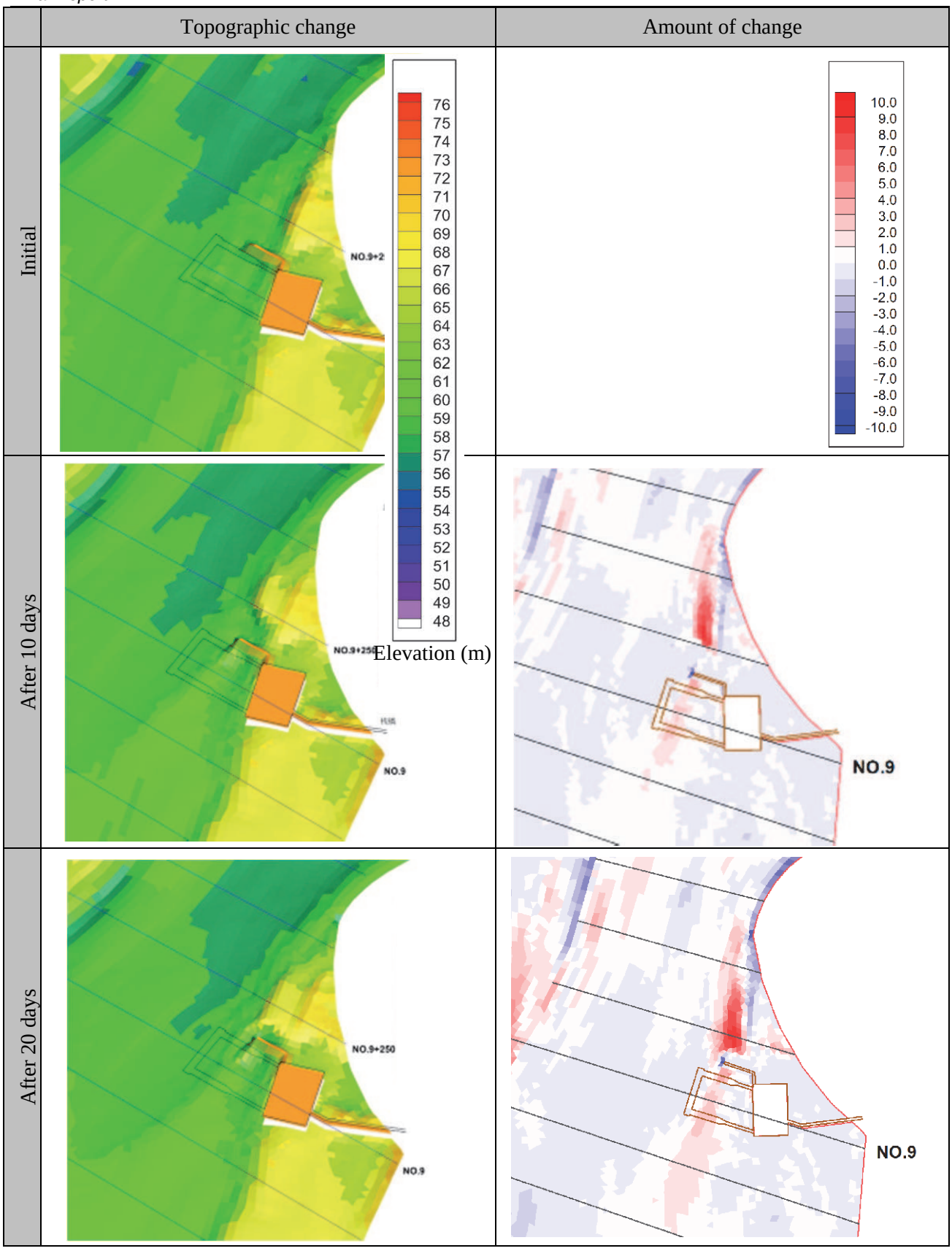


Source: the Study Team

Figure 5.79 Orientation of the Groyne

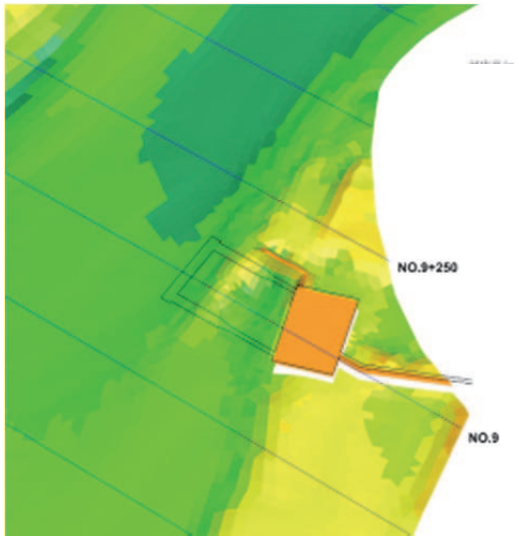
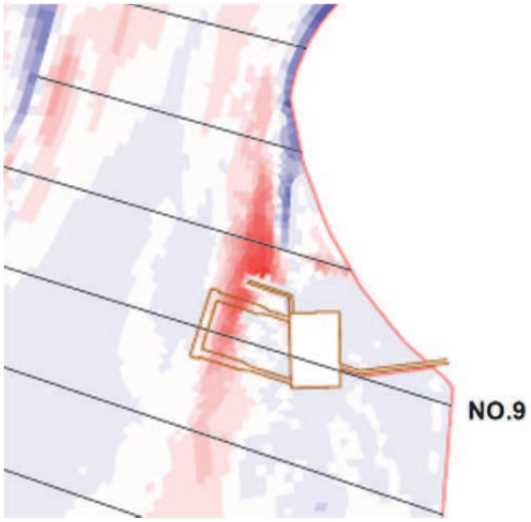
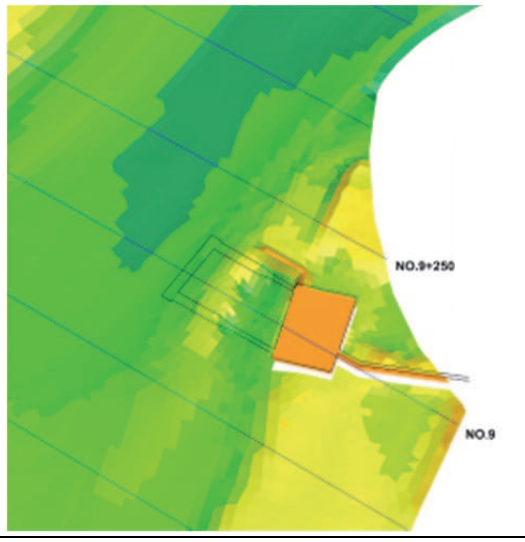
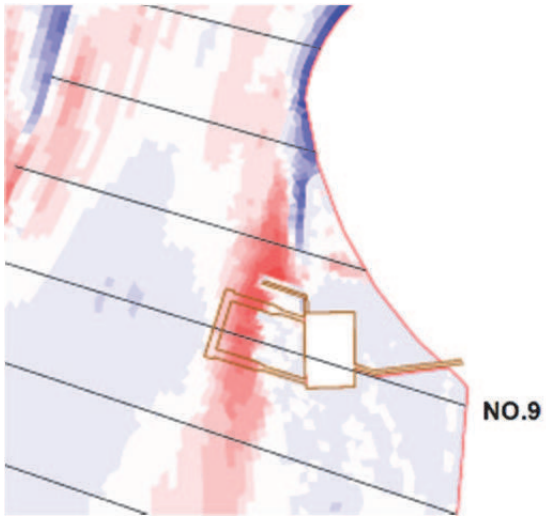
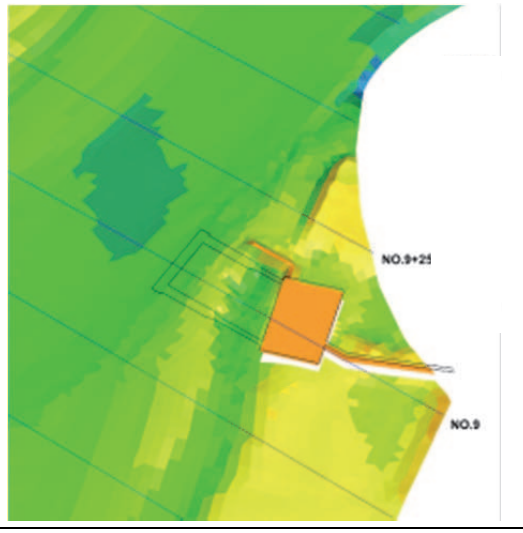
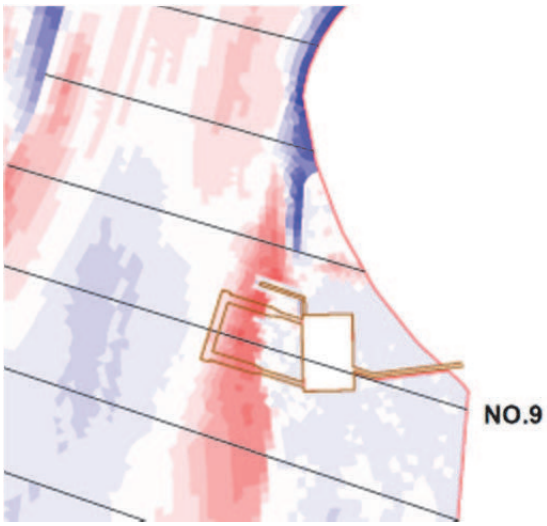
As a result of the analysis, until sand sediment comes from upstream, the flow velocity is accelerated around the groyne head, and the riverbed around the head of the groyne and downstream of the groyne, and the scoured sand sediment is accumulated on the downstream side of the groyne (up to 20 days). Then, sand sediment comes from upstream and passes the head of the groyne (30 days later), and finally sand sediment is accumulated downstream of the groyne.

In addition, results of the analysis of the other cases show sand sediment accumulation on the riverbed around floating pontoon becomes bigger as the head of groyne is extended to the outside bank side.



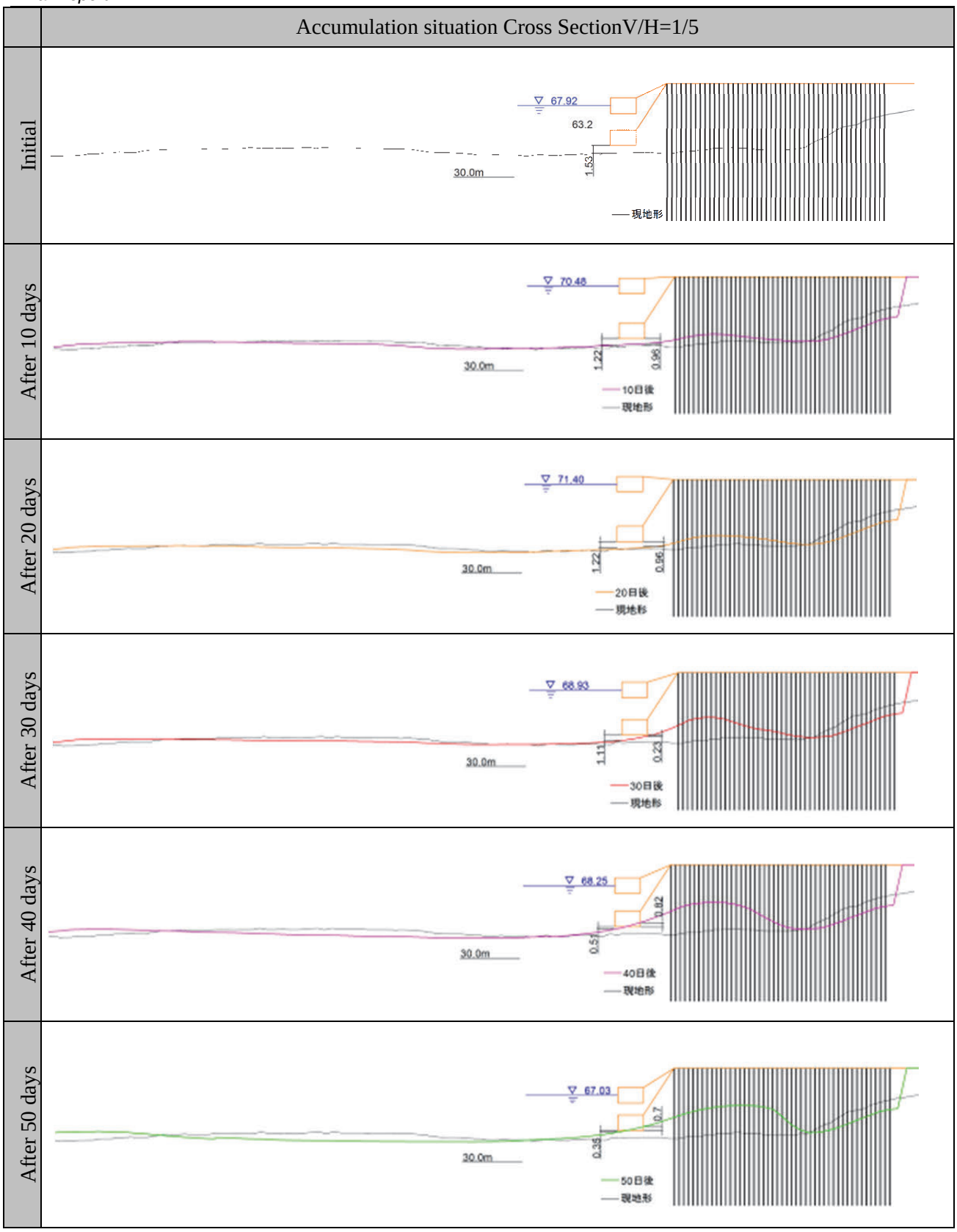
Source: the Study Team

Figure 5.80 Analysis of the Case of Installing a Groyne (1)

	Topographic change	Amount of change
After 30 days		
After 40 days		
After 50 days		

Source: the Study Team

Figure 5.81 Analysis of the Case with a Groyne (2)



Source: the Study Team

Figure 5.82 Analysis of the Case of Installing a Groyne (3)

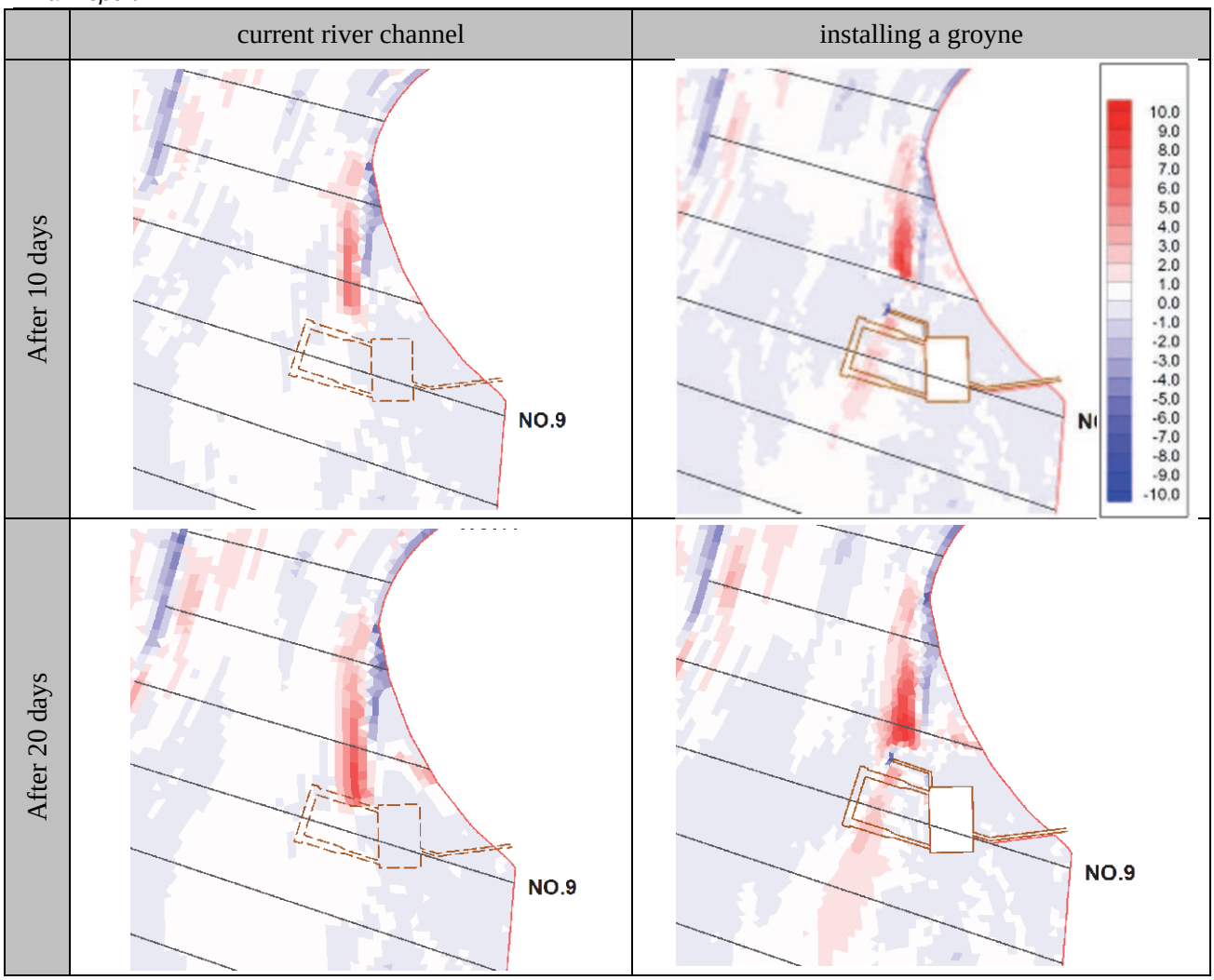
5.8.4 Discussion of Analysis Results

(1) Comparison of Analysis Results

The results of the analysis for flow velocity distribution and topographic change amount were compared for the current river channel case and with groyne case.

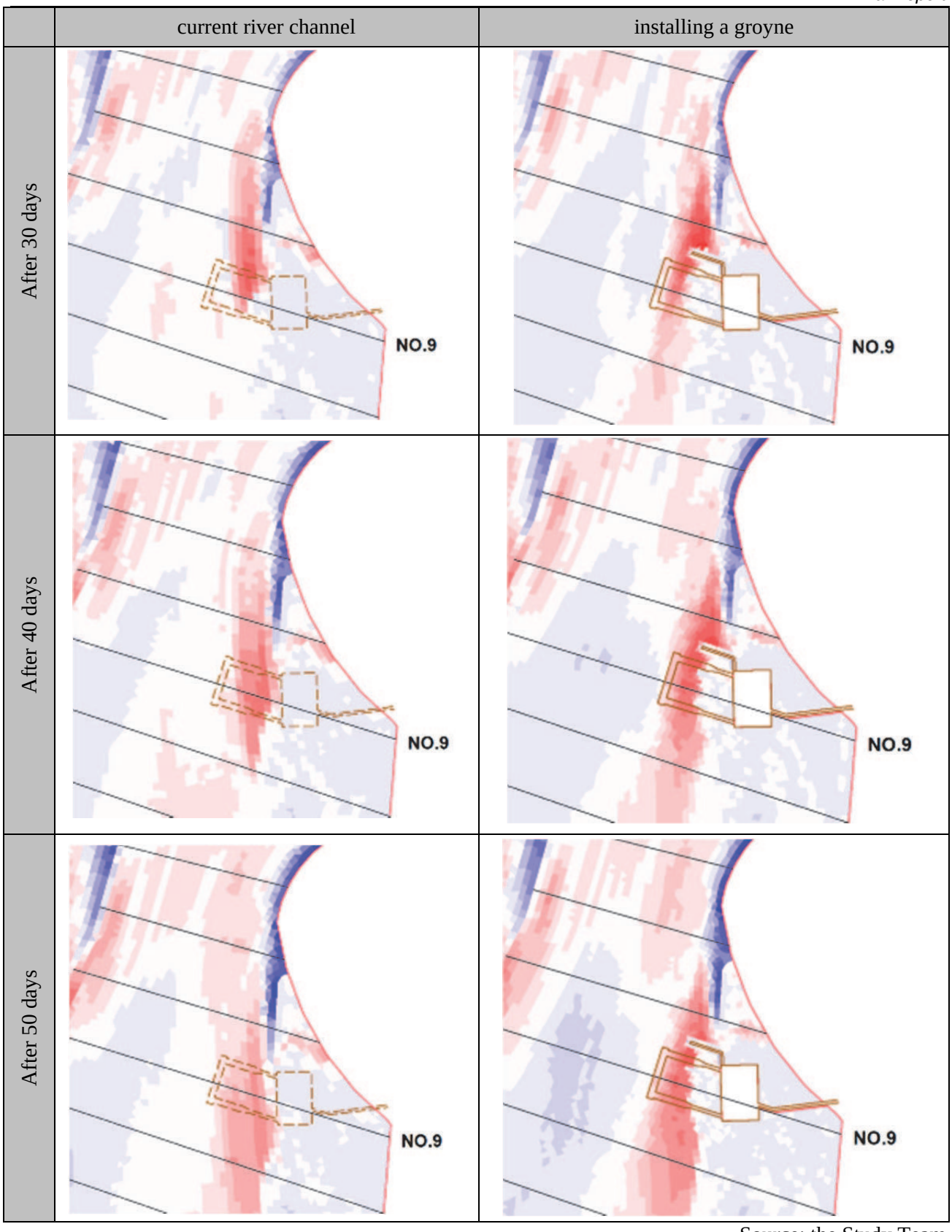
For the accumulation conditions of sand sediment, the effect of installation of the groyne can be observed until sands pass through the head of the groyne, but after the sand sediment has passed through the head of the groyne, the sand sediment condition is almost the same as without the groyne case.

For flow velocity distribution, flow is accelerated slightly, because the mainstream flow moves to the center of the river by the effect of the groyne, and the riverbed is scoured from the current river channel condition. But the flow velocity distribution trend is almost the same as the analysis of the current river channel. It should be noted that the above analysis is only for a flood of 50 days (one flood). Sand sediment is accumulated and flows downstream if water level rises occur again and again. However, it is considered that sand sediment on the downstream side of the groyne will stay as the flow velocity gets slower. When applying the floating pontoon type of structure, it will be necessary to dredge sand sediment under the floating structure, or to dredge sand sediment upstream of the groyne, reducing sand sediment to the floating pontoon.



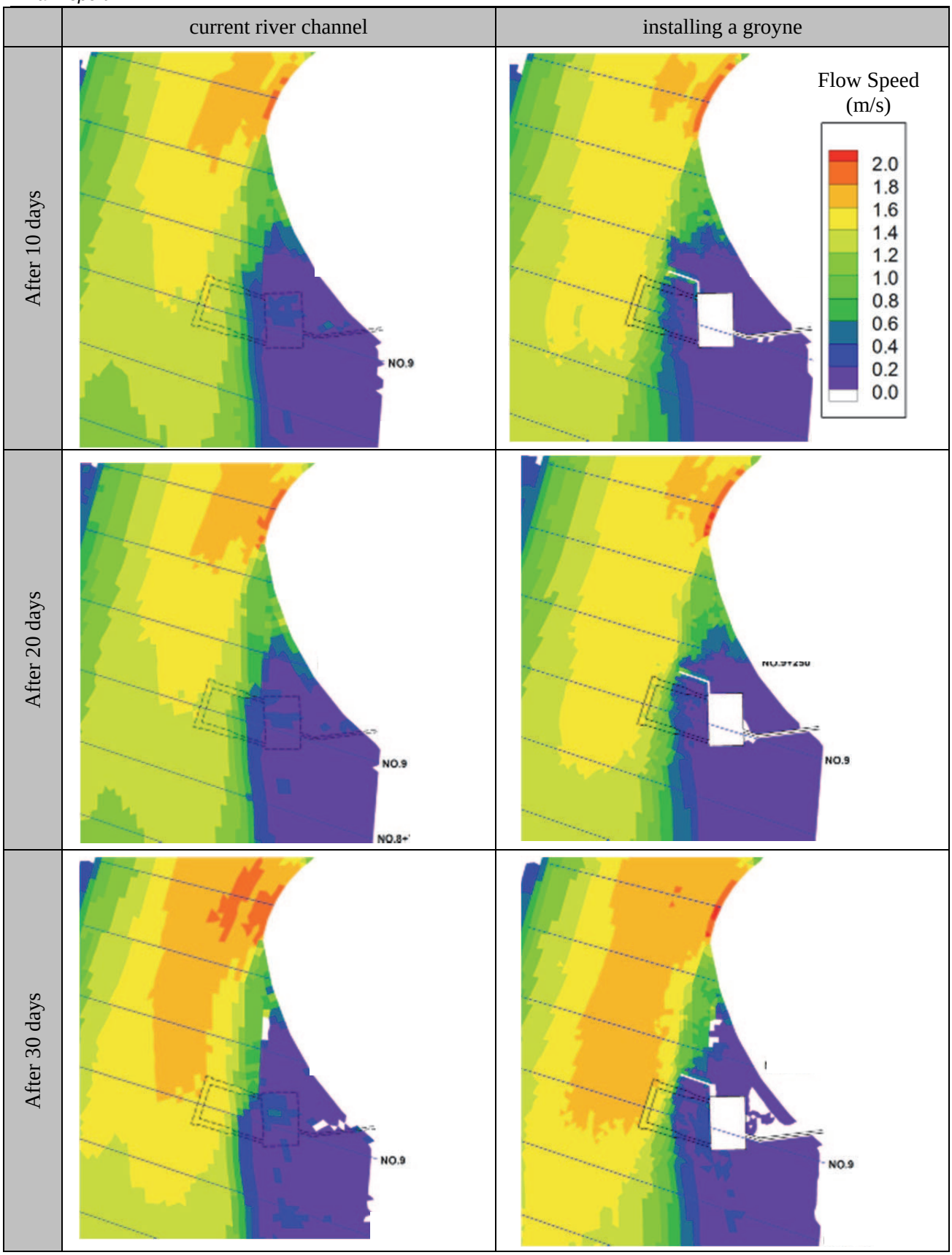
Source: the Study Team

Figure 5.83 Comparison of Topographic Change Amount (1)



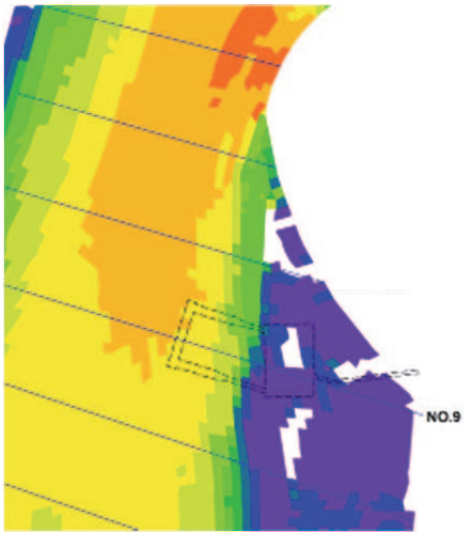
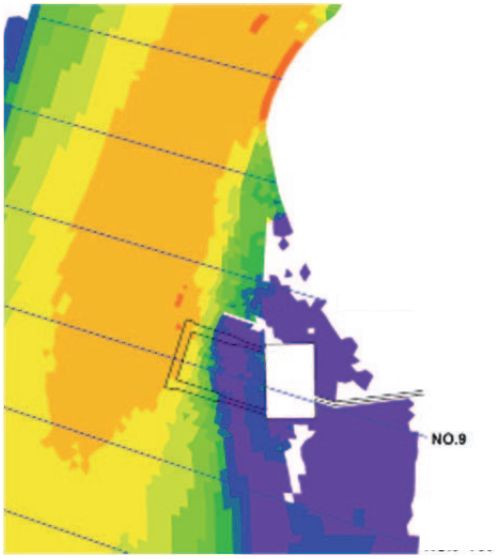
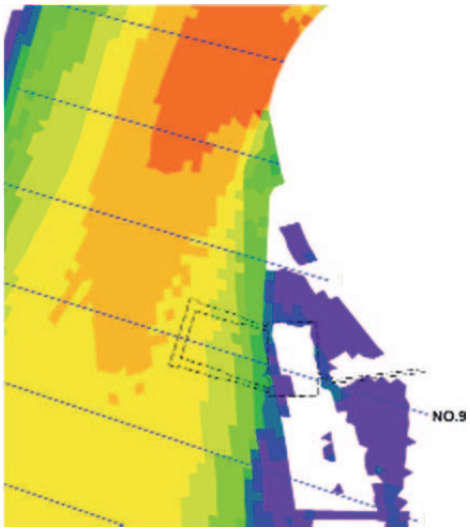
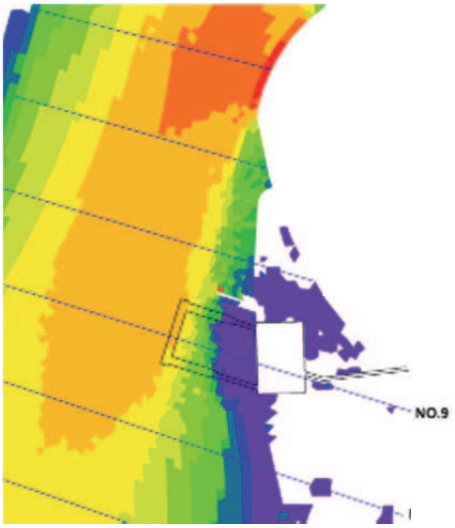
Source: the Study Team

Figure 5.84 Comparison of Topographic Change Amount (2)



Source: the Study Team

Figure 5.85 Comparison of Flow Velocity Distribution (1)

	current river channel	installing a groyne
After 40 days		
After 50 days		

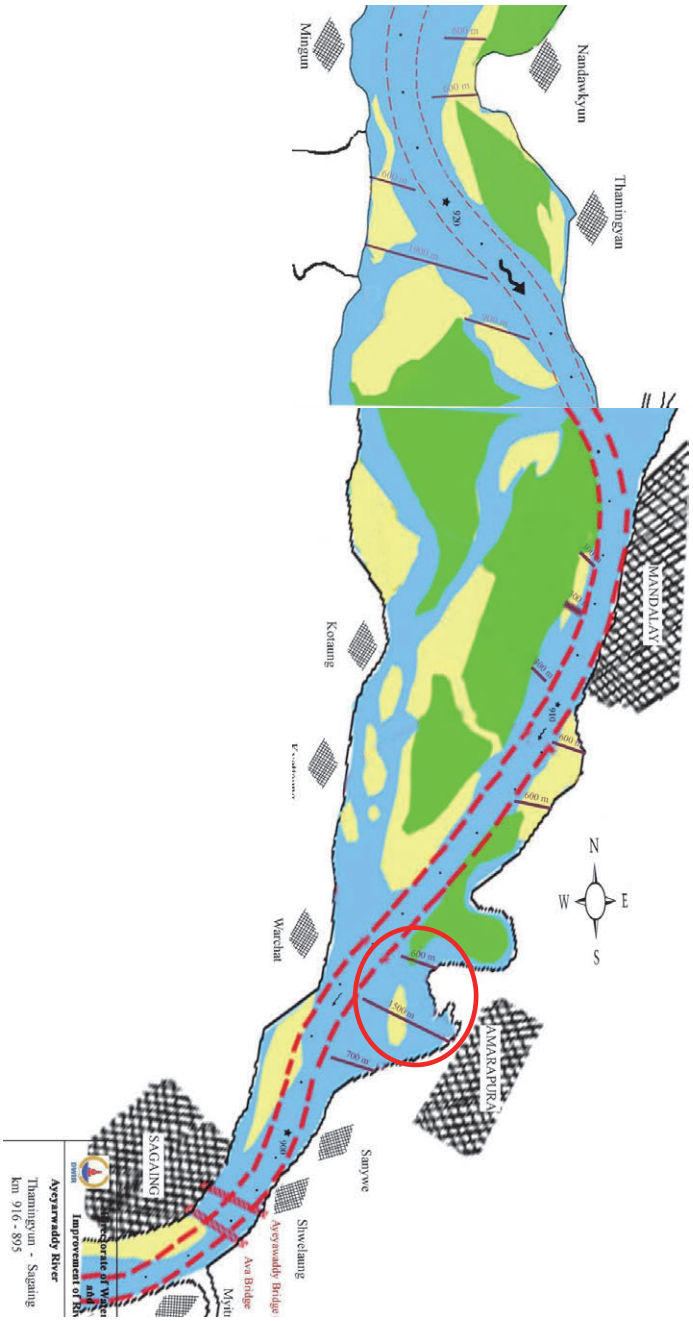
Source: the Study Team

Figure 5.86 Comparison of Flow Velocity Distribution (2)

(2) About Groyne DWIR to plan

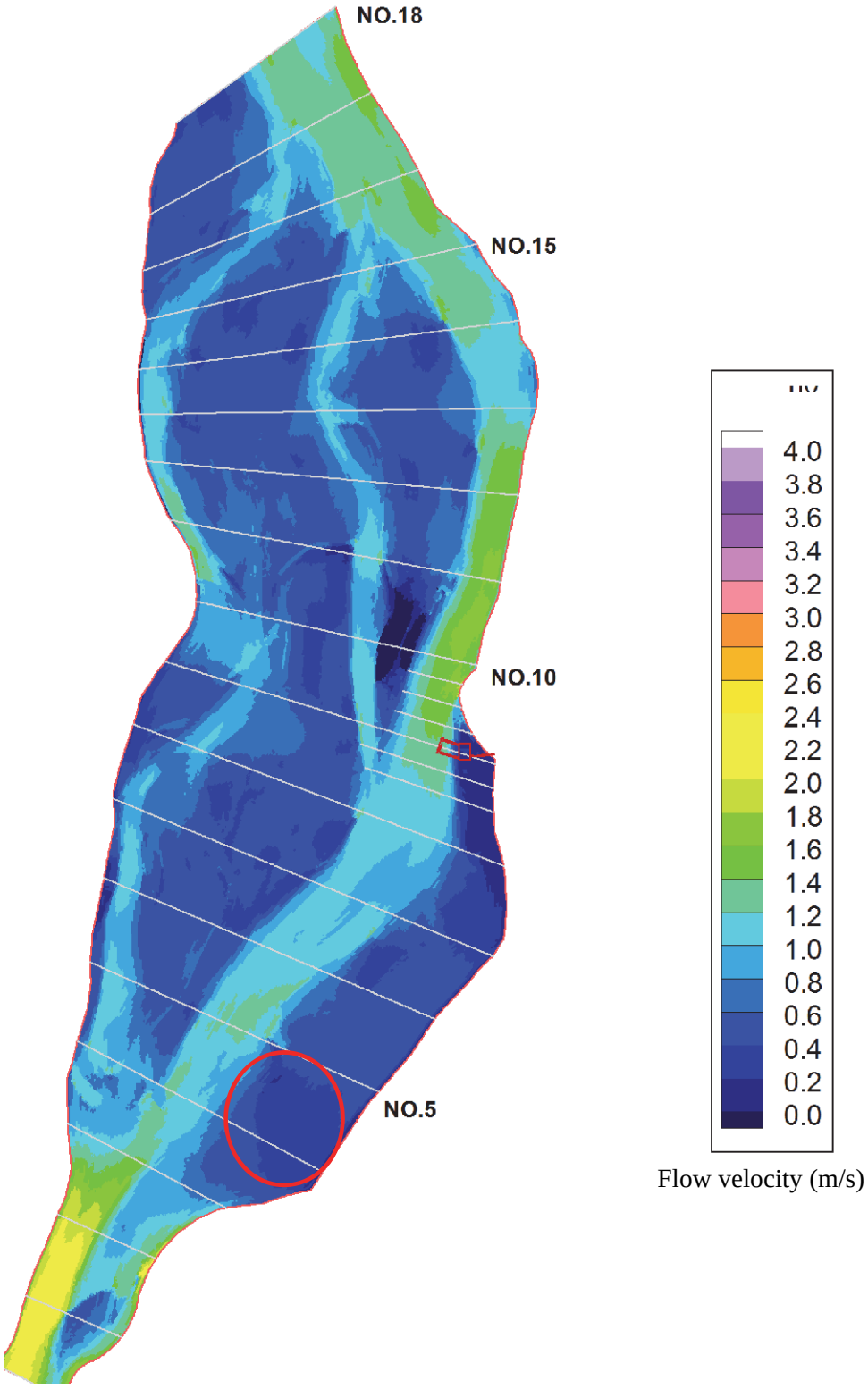
DWIR will plan the groyne and will consider the secure route. However, if the groyne is loacated at the red point, the effect of the flow rate will be small because the flow rate in a flood is less at that point.

Also, a groyne at that point can be used with the dry season low-flow channel, which will eliminate the need to build a flood channel, which in turn will reduce the cost.



Source: Provided drawings from DWIR

Figure 5.87 Groyne DWIR to Plan



Source: the Study Team

Figure 5.88 Flow Velocity Distribution Diagram of Current River Channel (Subject section)

5.9 Preliminary Design of Port Facilities

5.9.1 Outline of Project Site

(1) Outline of River

1) Flow Regime Analysis

The forecast of the riverbed variation was conducted by the 2-dimentional horizontal flow riverbed variation analysis model as the forecast analysis method. The analysis model was facilitated based on the topographic information, the flow velocity and the natural riverbed soil materials survey, and analyzed under the condition of the water level variation of maximum flood duration (50 days) in the past 10 years.

In the results of the analysis, the riverbed soil moved along the direction of the flow velocity vector, and the soil tended to accumulate in 1.0m to 2.0m of thickness in the planning project site of the pier. The project site has the tendency of the sedimentation of soil from upstream, because the flow velocity slows in the project site area.

2) Water Depth

Based on the hydrographic survey, the water depth in the pier location is 1.9m to 2.7m. In the case for the construction of a floating pier, if the draft of floating structure pier is 1.3m to 1.5m, the clearances between the floating bottom and the riverbed are 0.4m to 1.4m. However, if sedimentation of 1.0m to 2.0m thick materializes, the floating pier will be at risk for touching the bottom in the dry season.

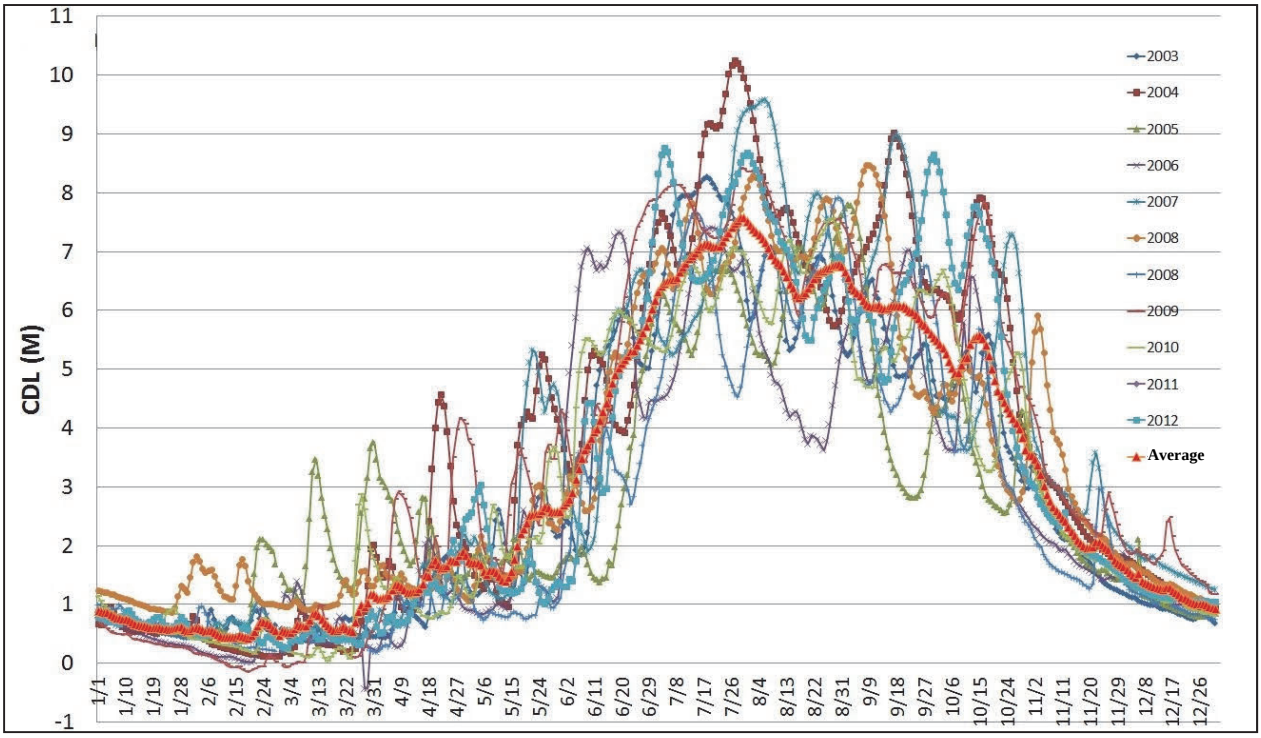
3) Water Level

Based on the existing DWIR water level records in the past 45 years and the DWIR's standard in the Mandalay Area, the H.W.L and L.W.L in the project site will be used as follows:

H.W.L (High Water Level) +71.6m (CDL 10.3m)

L.W.L (Low Water Level) +61.3m (CDL 0.0m)

Moreover, based on the daily water level record in the past 10 years, 60.874m (CDL-0.423m) in elevation has existed, therefore, this figure was also considered for the design.



Source: DWIR

Figure 5.89 Daily Water Level Variation (2003 to 2012)

(2) Velocity of the Water Flow:

Based on the survey for velocity of the water flow in the Ayeyarwaddy River, the design velocity is assumed as follows:

- The velocity of the flow downstream: 3.9 knot (2.0m/s)

Waves will not be considered as the project site is on the river bank.

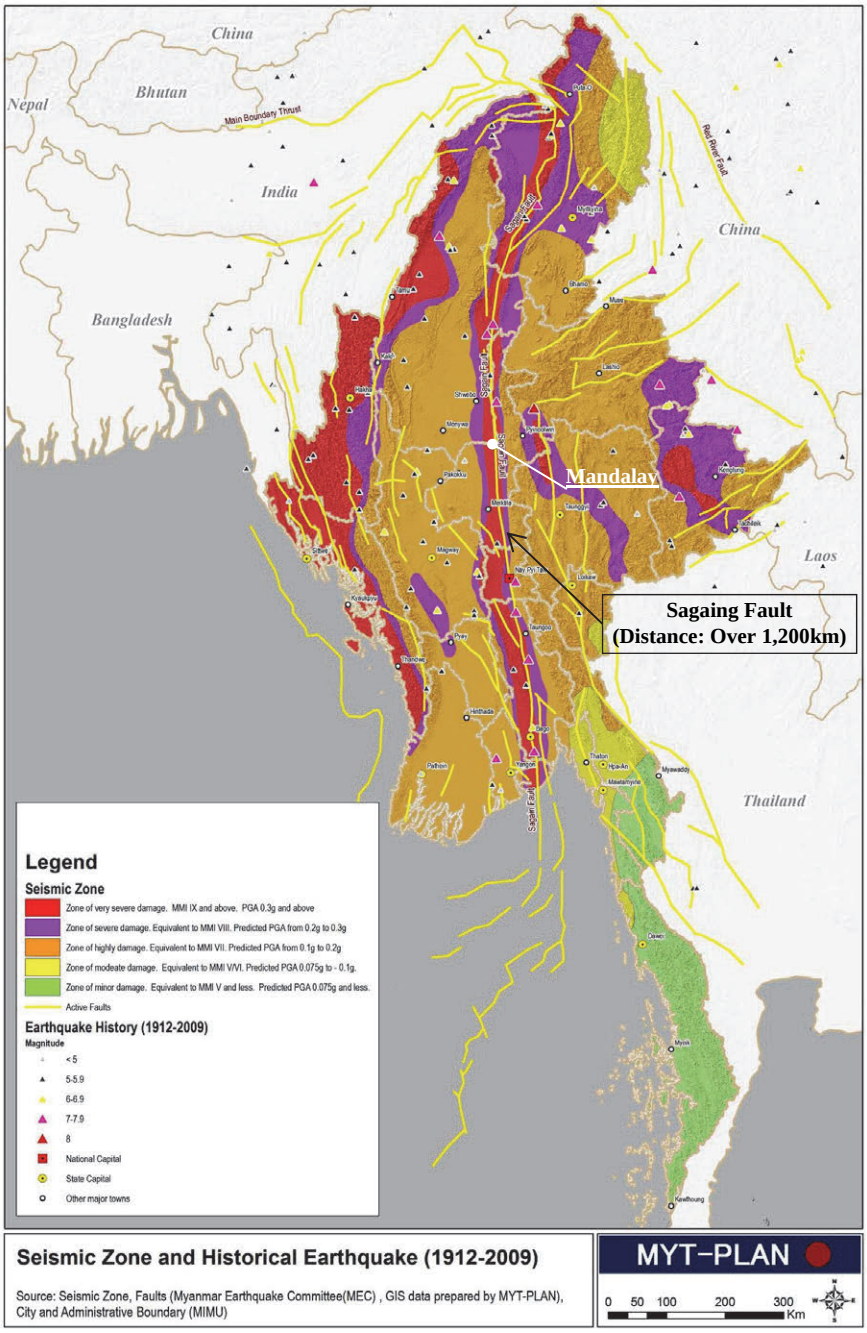
(3) Earthquake Forces:

The Sagaing Fault is a major fault in Myanmar, and passes through Mandalay in a north-south direction. The Sagaing Fault has experienced many damaging earthquakes of magnitude 7 class.

Based on the Seismic Zone Map of Myanmar, the Mandalay area is the most severe damage of seismic intensity area in the 5 seismic zones. Therefore, based on seismic intensity in Mandalay, the earthquake forces in design are considered as follows.

Horizontal earthquake forces: kh = 0.18

Vertical earthquake forces: kv=0.00

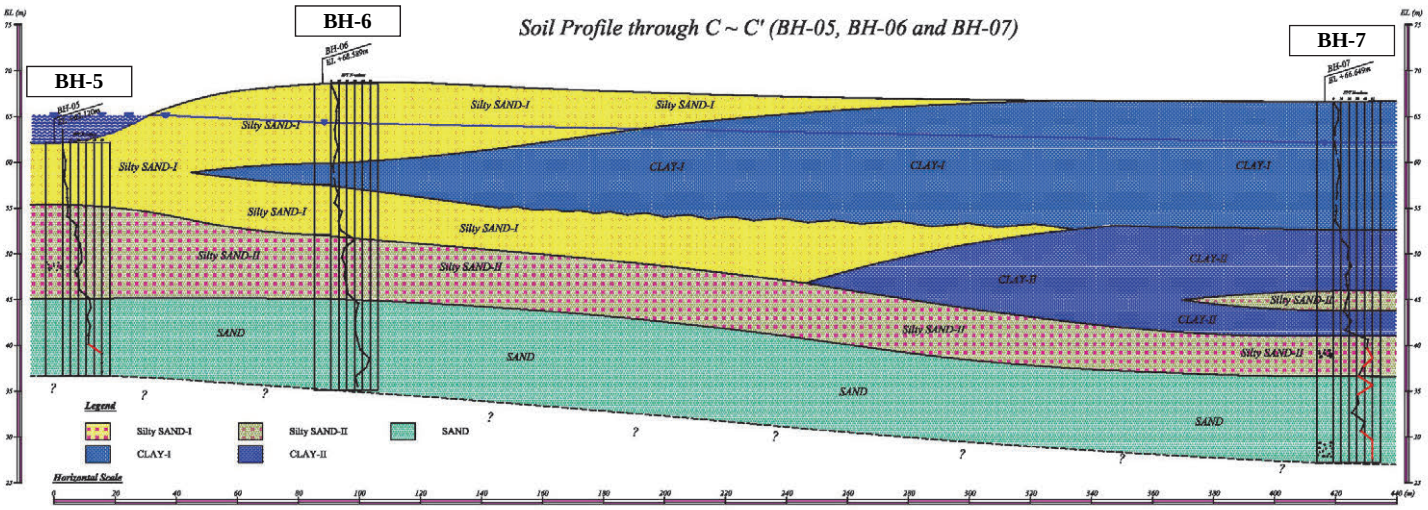


Source: MEC, MYT-PLAN and MIMU

Figure 5.90 Seismic Zone Map of Myanmar

(4) Soil Condition:

The JICA Study Team conducted 3 Borings in the project site area. There are silty sand and sand layers in the BH-5 strata, and silty sand and sand layers, including thinly layered, clay in BH-6 strata. However, there are clay, silty sand and sand layers in BH-7 strata



Source: Geotechnical Survey Report (conducted by JICA Study Team in Aug 2013)

Figure 5.91 Soil Profile (BH-05, BH-06 and BH-07)

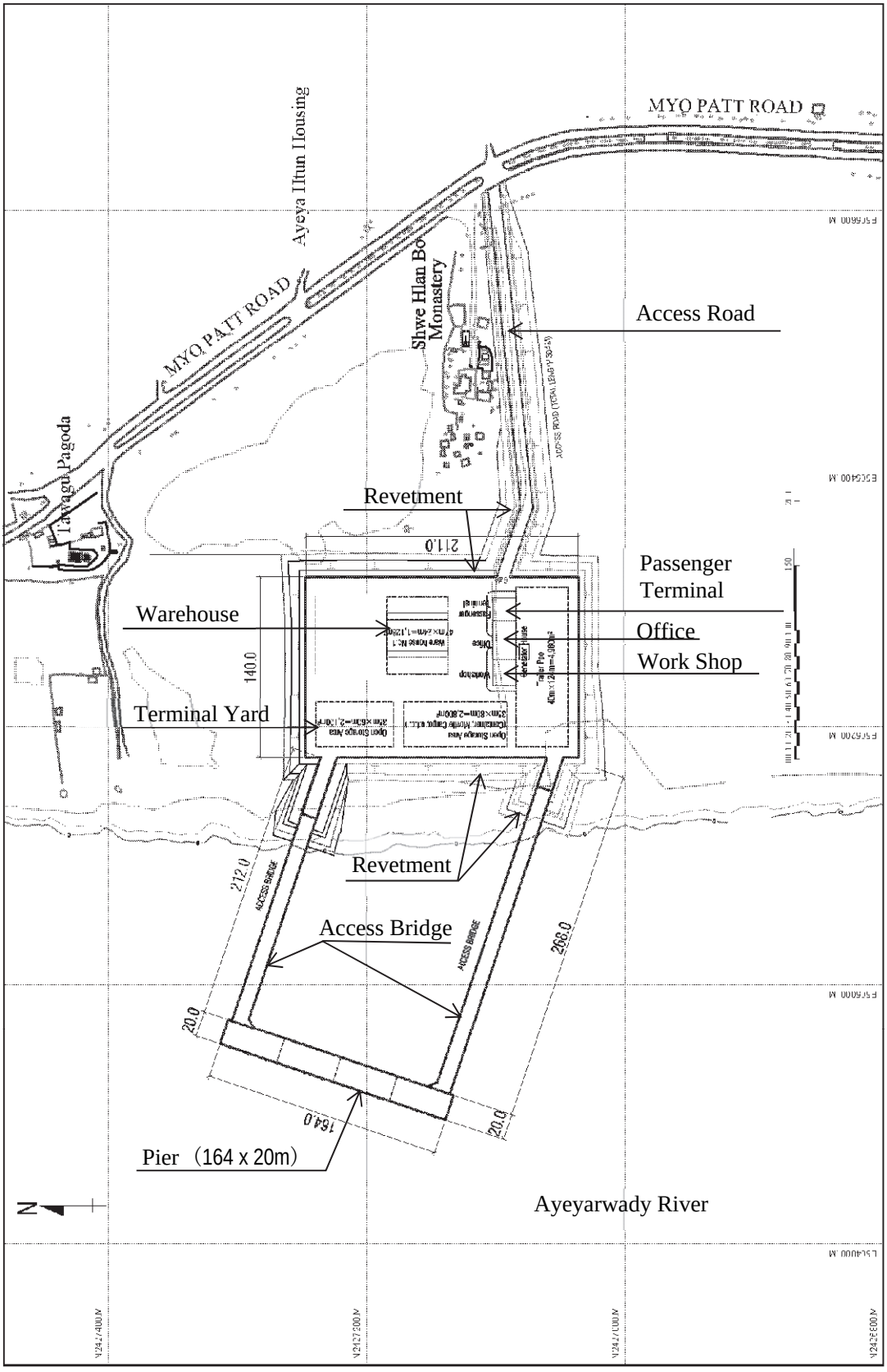
Table 5.46 Summary of the Results of BH-05 to BH-07

Boring No.	Elevation	N-Value	Description of Strata
BH-No. 5	CDL+0.8m to -5.9m	N<7	Very loose to loose silty sand
	CDL-5.9m to -16.2m	7<N<17	Loose to medium dense silty sand
	CDL-16.2m to -25.0m	17>N>50	Dense sand
BH-No. 6	CDL+7.3m to -1.4m	N<9	Loose silty sand
	CDL-1.4m to -3.7m	3<N<5	Soft to firm clay
	CDL-3.7m to -9.2m	5<N<14	Loose to medium dense silty sand
	CDL-9.2m to -16.2m	14<N<30	Medium dunce silty sand
	CDL-16.2m to -26.1m	31<N<49	dense sand
BH-No. 7	CDL+5.3m to -8.7m	N<9	Firm to soft clay
	CDL-8.7m to -15.3m	9<N<23	Stiff to very stiff clay
	CDL-15.3m to -17.5m	14<N<20	Medium dense silty sand
	CDL-17.5m to -20.3m	14<N<23	Stiff to very stiff clay
	CDL-20.3m to -24.7m	32<N<50	dense silty sand
	CDL-24.7m to -34.1m	29<N<50	Medium dense to dense sand

Source: Geotechnical Survey Report (conducted by JICA Study Team in Aug 2013)

5.9.2 Layout Plan

Port facilities should be planned to facilitate smooth cargo handling operation to easily store, transport and carry in and take out, and for the vessels to accommodate the port facilities safely and smoothly. The layout based on the port planning is as shown in Figure 5.92.



Source: JICA Study Team

Figure 5.92 Layout Plan of Mandalay Port

5.9.3 Selection of Pier Structure

Based on the analysis of handling cargo in Mandalay, both manpower and mechanical cargo handling will be mixed in the beginning of cargo operation in the new Mandalay Port. Based on the actual applied river pier sample of the large tidal differences, the adaptability for the new Mandalay Port was evaluated in the following 4 samples:

1) **Multi-level deck pier:** The pier was designed as multi-level deck type. The upper deck is utilized in the high water level season and the lower deck is utilized in the low water level season. The upper and lower pier is connected with a sloping road. This type of pier has been selected for the Kaladan River project in Myanmar and it is under construction.

2) **Ramp pie**r: The pier was designed as a ramped berth. The cargo is handled with cranes and others on the ramped berth. This type of pier was built for the Vientiane Port in Laos and is under operation.

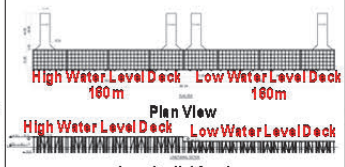
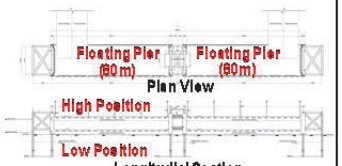
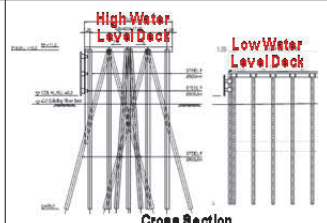
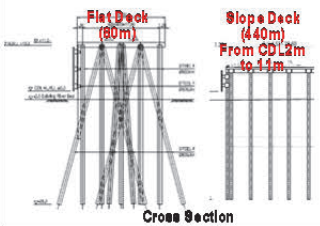
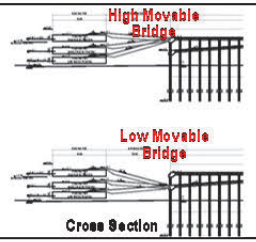
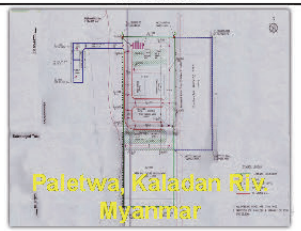
3) **Piled pier:** The pier was designed as a very general berth structure, as no flood position of berth apron in the high water level season. For example, the pier was built for the Phnom Penh Port in Cambodia and it is under operation.

4) **Floating pier:** The pier was designed as the floating structure so that the berth apron will move up-and-down in response to changes in the water level. The pier was built for the Jambi Port in Indonesia and it is under operation.

The Multi-level deck and the Ramp pier are suitable for handling a small volume of cargo, however, in Mandalay, it is estimated that the volume of cargo will be more than 400,000 tons/year, therefore those port facilities are not suitable for the Mandalay Port. The merit of the floating pier is the workability of both manual and mechanized cargo handling operations, and the floating pier is suitable in the transition period from the manual cargo operation to the mechanized cargo operation. However, the piled pier is suitable for mechanical cargo handling, if it becomes widely used.

In the case of a floating pier as the berth structure, because of the shallow of water depth and the river bed seasonal water level variation at the proposed installation location of the pier, the floating pier will be at risk for touching the bottom in the dry season.

Table 5.47 Berth Structure Comparison

	Pile Pier (High & Low Water Level Deck)	Ramp Pier	Piled Pier	Floating Pier (Steel)
Plan View and Longitudial Section				
Cross Section				
Applicable Case				
Characteristics	• The crown heights of the berth are two kinds of heigh as high and middle water levels.	• It is possible to change vessels' mooring positions depending on the water level.	• The crown height of the berth is constant.	• As the floating mooring facilities changes its elevation depending on the river level, it is possible to maintain a certain berth height and length.
Merits	• Based of water level, two kinds of deol can be selected. • Less influence to the berth structure. • Less disturbance to the flow of the river.	• This structure allows vessels to change their positions depending on the water level. • Embankment and disembankment of passengers can be easier and safety. •Both mecharized and manual cargo handling are possible	• Construction can be proceeded quickly than others. • Construction will not be affected much by the changing of water level. • Less disturbance to the flow of the river. • Least construction cost among other types.	• Effective cargo handling operation because of the constant deck posion on verious water leveling •Both mecharized and manual cargo handling are possible. • Embankment and disembankment of passengers can be easier and safety. • Less disturbance to the flow of the river.
Demerits	•In the case of high water level, the middle water level berth goes under the river water. Therefore, cost-effect performance is very bad.	•As this is a ramp type structure, it is necessary to build a long berth to provide adequate usable space. • It is also necessary to handle cargo operation on a slope deck.	•The elevation difference between the berth top and the mooring vessel's deck become greater during the low water level period, and it is inconvinient for cargo handling and embankment and disembankment of passengers.Therefore, flat and step structure under deck is necessary in the middle and low level..	•Preliminary investment cost is expensive than the other structures. •The floating pier will be at risk for reaching the bottom in the dry season because of the shallow of water depth and the river bed seasonable water level variation in the pier's installation location
Cargo Handling of IWT Vessels	•In the haigh and middle leveling, all IWT vessel can be accomodated and handling in this struture. But in other leveling only for IWT cargo vessels and barge can be accomodated.	• All IWT vessels can be accomodated and can be nomal cargo handling and embankment and disembankment of passengers in this berth in verious river water levels.	• Basicaly, this structure can be operated for IWT cargo ship and barge by mecharized cargo handling. For manual cargo handling like IWT passenger & cargo mixing vessel, flat and step structure under deck is necessary in the middle and low level..	• All IWT vessels can be accomodated and can be nomal cargo handling and embankment and disembankment of passengers in this berth in verious river water levels.
Construction Period	Approx. 21 months	Approx. 30 months	Approx. 10 months	Approx. 8 months
Construction Cost	Approx. 11 million USD	Approx. 17 million USD	Approx. 8.5 million USD	Approx. 17.5 million USD (in case manufactured in Japan then inport)
Maintenance Cost	Annual Maintenance Necessary	Annual Maintenance Necessary	Annual Maintenance Necessary	Annual Maintenance Necessary
Evaluation	△	△	◎	○

Source: JICA Study Team

(1) Preliminary Design

1) Design Condition

The design conditions for the piled pier are listed as follows:

a) Metrological and Hydrographic Condition				
i) Tides		HWL：＋10.3m		
		LWL＝CDL：±0m		
ii) Current Velocity		3.9knot/s（2.0m/s）		
iii) Design seismic coefficient		Horizontal design coefficient：kh＝0.18g		
		Vertical design coefficient ：kv=0.00g		
b) Subsoil Condition		Subsoil profile at BH-5 and BH-6 are used as reference. Apply following soil condition for the whole area of New Berth.		
	Soil Layer	Soil	N-value	φ（°）
	Riverbed-2m～-6m	Silty Sand	5	22
	-6m～-17m	Silty Sand	20	30
	-17m～-25m	Sand	30	33
	deeper than -25m	Dense Sand	More than 50	39
c) Design Vessels (maximum vessel size)		2,000DWT(75m in length, 15 in breadth, 2m in draft)		
d) Surcharge of Apron		Uniform Load: 20kN/m2		
e) Cargo Handling Equipment		Fork Lift: Lifting Capacity: 3 ton		
		Truck Crane: Lifting Capacity: 50 ton & 100 ton		

2) Fixed Pier

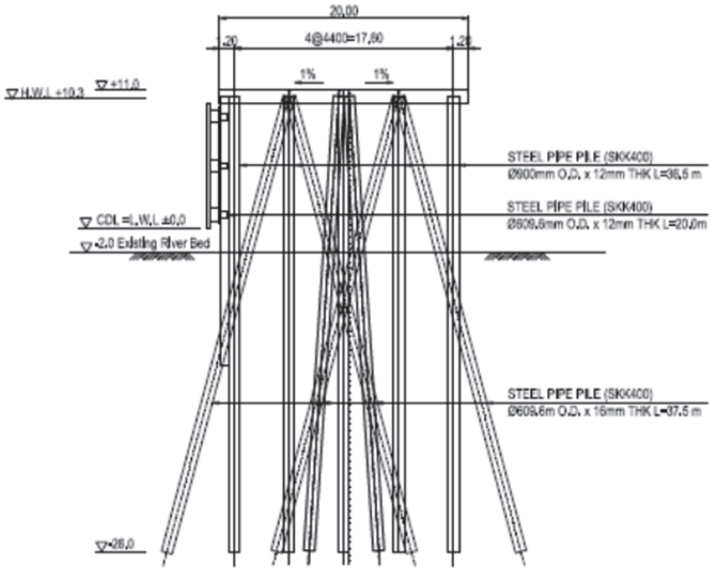
Soil from upstream tends to accumulate at the proposed project site. In order to avoid this, a piled pier is the best choice for the project because sedimentation will not build up under its structure.

The Mandalay area is prone to severe damage from seismic activity. A large horizontal force could impact the berth in an earthquake. Also, the velocity of the river flow is very fast (3.9 knot/sec) and it would influence the day-to-day moving of the berth. Therefore, the piled pier on coupled raking piles was selected for resisting seismic actions and the force of the river flow. The coupled raking piles should be laid out to resist the horizontal force and horizontal displacement is smaller for the vertical piles.

The main components of the upper structure will be reinforced concrete (RC), slab and girder deck. The steel pipe piles are foundation piles that are 800mm dia. with 16mm wall thickness including the consideration of liquefied sandy ground. The geometry of the berth is as follows.

- Water depth : -2.0m
- Berth Cope-line Height : +11.0m
- Apron Width : 20m
- Berth Length : 164m

Also, in order to operate the berth at night for handling cargo, a lighting system is planned for the berth. Moreover, a water supply and fire hydrant system is planned for the mooring vessels.

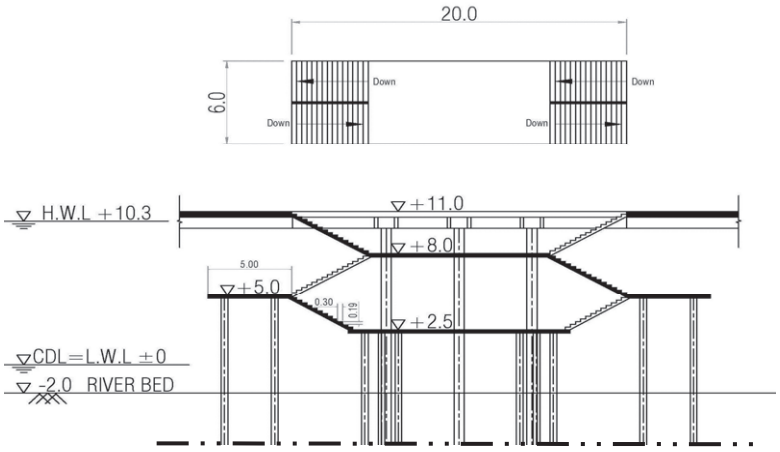


Source: JICA Study Team

Figure 5.93 Section of Fixed Piled Pier

For the handling of cargo by manual labour, additional gentle steps and flat space structures are planned to be installed on part of the RC slab deck.

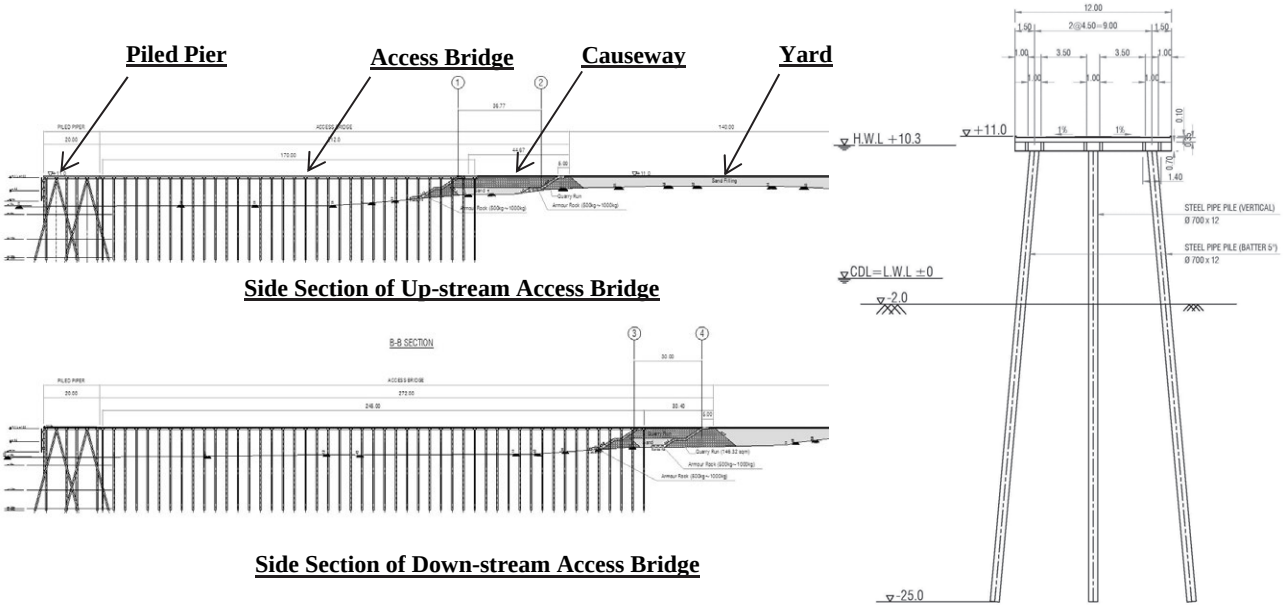
The layout of the gentle steps and the flat space structures in the berth is described as follows. The flat spaces of +2.5m, +5.0m and +8.0m level for various water levels is added under the apron of +11m level.



Source: JICA Study Team

Figure 5.94 Layout of Gentle Steps and Flat Spaces in the Berth

The access bridges to the piled pier are planned to be located on the upstream and downstream sides of the pier, and one-way traffic direction will be used for efficient and smoother transport. Concrete decks (width: 12m, top elevation: CDL=11.0m) are applied to the upper structure. If the vertical pipe pile is applied for the pier structure in case of seismic activity, the horizontal displacement is approx. 9cm in the uniformed load 20kN/m^2, therefore, the coupled raking piles is applied for the foundation structure.



Source: JICA Study Team

Figure 5.95 Steps and Flat Spaces in the Berth

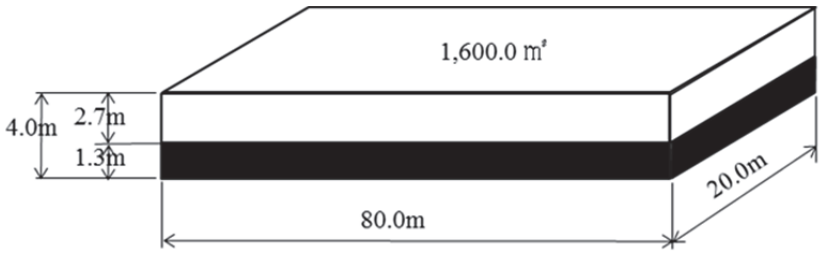
3) Floating Pier

The stability analyses are conducted for a PC hybrid structure, a RC hybrid structure and a steel structure in the assumption of the utilized condition. The following 5 cases are studied for the required freeboard.

Case 1	Planned freeboard shall be equivalent to the floating freeboard without the surcharge.
Case 2	The floating freeboard shall be more than 0m, and shall satisfy the stability analysis of the floating structure. For safety reasons, it is desirable that GM (distance (m) between the metacenter and the center of gravity in the case of full load) shall be more than 5% of the draft.
Case 3	In the condition of full surcharge, the freeboard of the floating structure shall be more than 0m and the stability condition of the floating shall be satisfied.
Case 4	In the center of the major axis of floating, in the condition of half surcharge, the slope of floating shall be less than 0.1(1/10) and the minimum freeboard shall be more than 0m.
Case 5	In the center of the minor axis of floating, in the condition of half surcharge, the slope of floating shall be less than 0.1(1/10) and the minimum freeboard shall be more than 0m.

It is not possible for less than 2m draft of a PC hybrid structure and a RC hybrid structure, in the results of the calculation for component material weight based on the required utilization and strength.

Only a floating steel structure is less than 2m of draft. And the basic dimensions of a floating steel structure that can satisfy the above stability calculation are as follows:

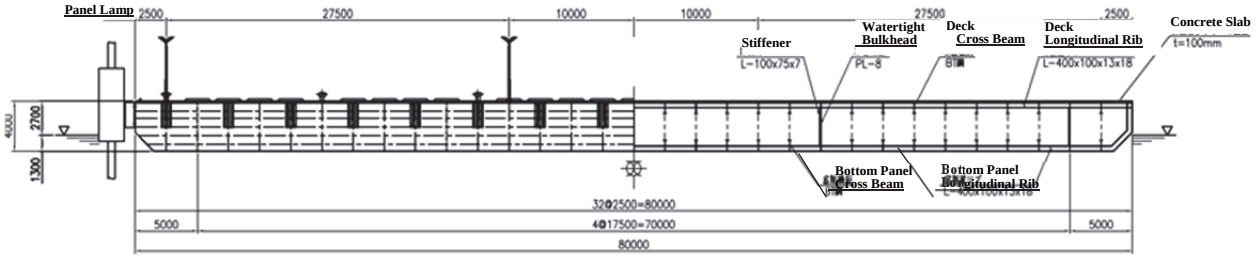


Length	L=	80.0 m	Freeboard	*f*=	2.7 m
Width	*B* =	20.0 m	Draft	*d*=	1.3 m
Distance	*D*=	4.0 m	Area	*A*=	1600.0 m^2

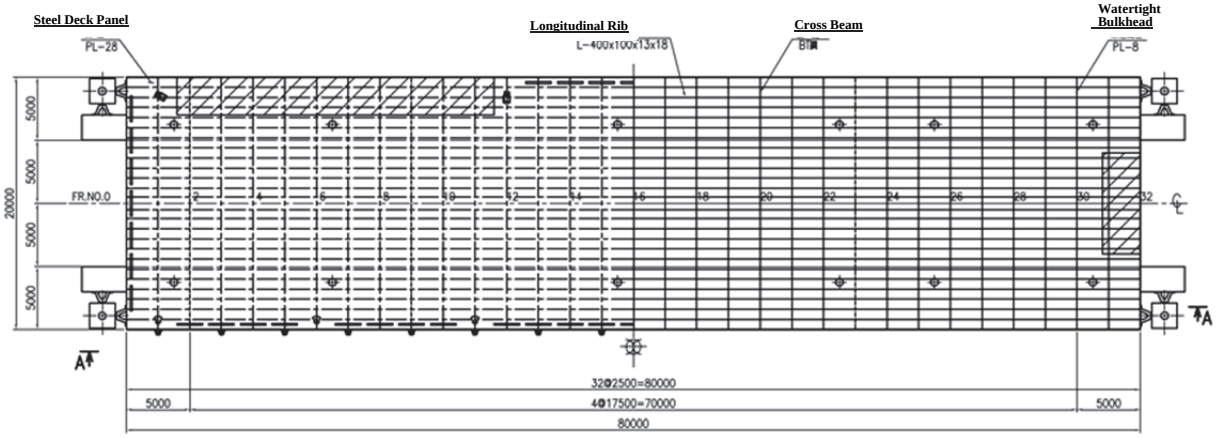
Source: JICA Study Team

Figure 5.96 Basic Dimension of Floating Structure (Steel)

The section of the above floating structure is as follows:



Front and Section Drawing



Plan and Section Drawing

Source: JICA Study Team

Figure 5.97 Section and Plan of Floating Structure (Steel)

Furthermore, if the steel floating structure is made in Japan, the floating depth during towing in the ocean should be 3.9m (excluding the floor concrete thickness) of the whole depth to assure section strength against assumed vertical bending moment, and the displaced weight has to arrange to 2m of freeboard with a large volume of ballast concrete, and consequently the draft is 2m.

Based on the hydrographic survey data, the water depth of the location for the floating pier installation is CD-1.9m to 2.8m. Even if the steel floating structure is used, the installation will be difficult because of the 2.0m of draft. Therefore, one of the countermeasures would be dredging at the installation area. However, based on the results of the flow regime analysis, it is highly possible that the dredged area will accumulate sedimentation of soil from upstream every rainy season. If the soil is accumulated under the

floating pier, it will be necessary to conduct maintenance dredging under the floating pier. It is possible to dredge in several methods, but the current agencies have no experience in this type of maintenance.

The list of the floating structure is described in the appendix 5.9.1. The construction costs of the three structures are the expenses of a floating structure manufactured in Japan and imported to Myanmar.

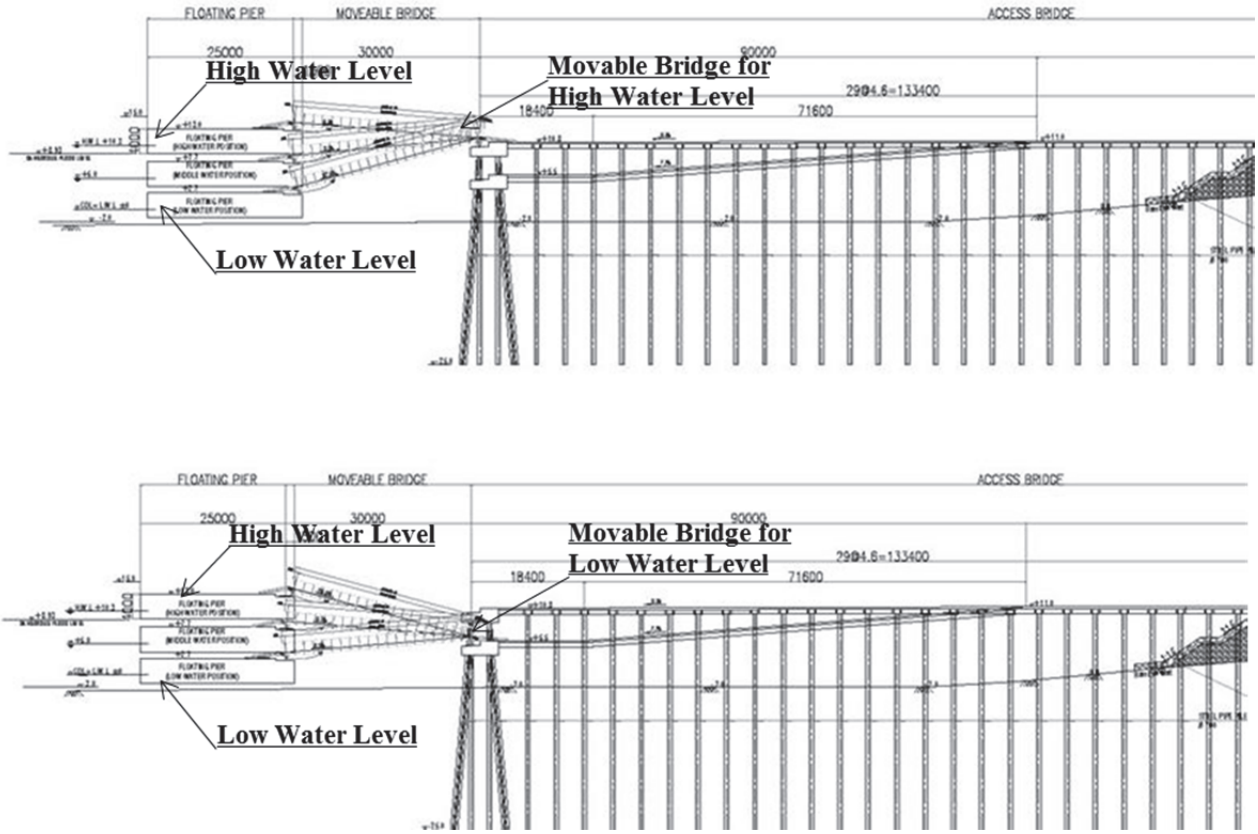
4) Movable Bridge and Access Bridge

The floating piers move up and down 10.3m because of water level differences. Therefore, in consideration of a required driving slope (less than 10%) for vehicles and equipment on the movable bridge, two types of movable bridges were designed, one is for a high water level and the other is for a low water level.

The design condition of movable bridge is as follows:

▪ Bridge Type	: Simple Girder Bridge with Plate Floor
▪ Beam Length	: Main Bridge: 31m
▪ Span Length	: Main Bridge: 30m
▪ Load	: Live Load, Truck Crane 37.7t (1 No.)
▪ Effective Width	: 8.0m
▪ Floorboard	: Steel Plate Deck t=12mm
▪ Pavement	: Asphalt Pavement t=50mm
▪ Longitudinal slope	: LWL=±0.0m~H.W.L=+10.3m
▪ Main Member Material	: SS400, SM490

The movable bridges are planned to be located upstream (2 sets) and downstream (2 sets) of the floating pier, and connect to the access bridges.



Source: JICA Study Team

Figure 5.98 Section of Movable Bridge

5.9.4 Cargo Yard and Revetment

(1) Cargo Yard

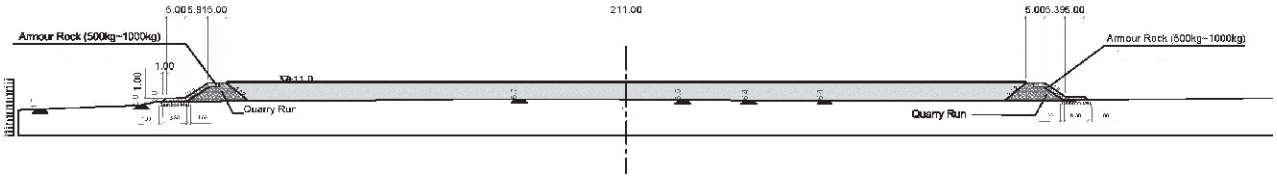
The pavements in the cargo yard are to be made of reinforced concrete (concrete thickness : 250mm、concrete top elevation: CDL=11.0m) with a high durability and easy maintenance. Filling soil materials in the cargo yard have to be select soil material which do not have a risk of liquefaction. Especially, the dredged sand from the Ayeyarwaddy River is sand of well graded particles, therefore, it has a risk of liquefaction.

(2) Revetment

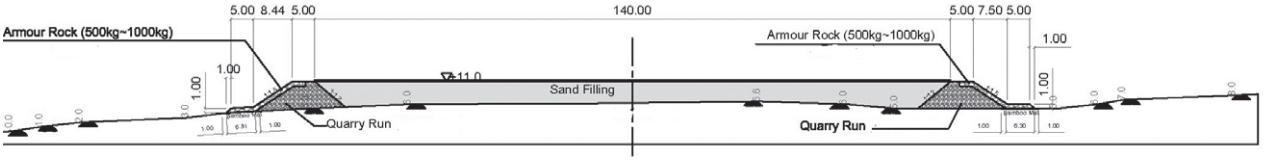
The required mass of armour rock to be stable against the water current was calculated using the Isbash's equation. The revetment around yard, including two causeways, has a total of thirteen corners. In general, strong currents occur locally near the corners, therefore the mass should be increased at least 1.5 times. Therefore, 500kg to 1,000kg of armour rock should be applied for the revetment. The armosr units thickness are more than 2 layers in general, therefore, 1.0m of thickness should be applied

(3) Design Section

The following sections are for cargo yard and revetment:



Typical Section of Yard (North to South)



Typical Section of Yard (West to East)

Source: JICA Study Team

Figure 5.99 Typical Section of Yard and Revetment

5.9.5 Access Road and Revetment

(1) Design Condition

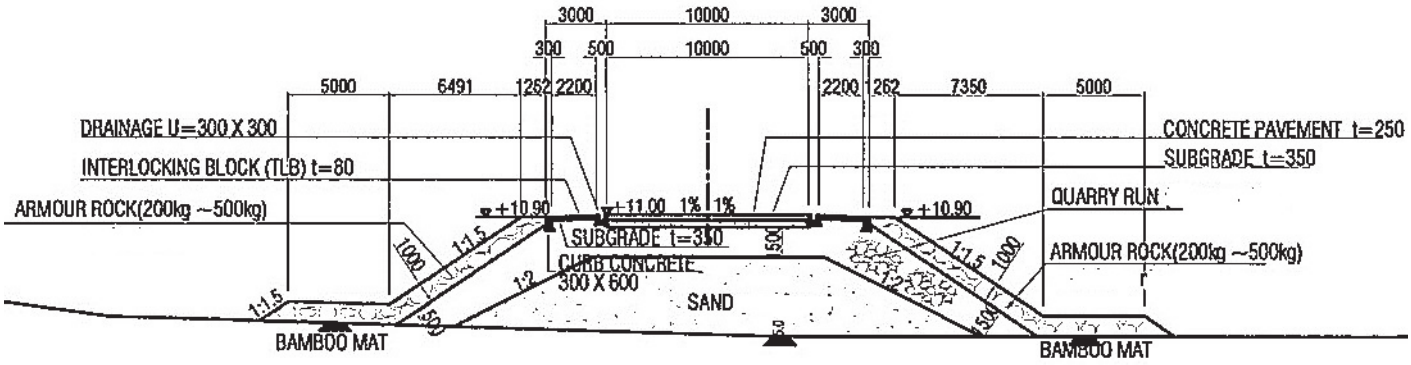
1) Access Road

Concrete pavements (width:10m, One-way 5m (road way: 3.5m and stopping lane: 1.5m, concrete thickness : 250mm、concrete top elevation: CDL=11.0m) are to be applied to the access road, and Interlocking Concrete Blok pavement (width: 2.2m in both sides) are to be used for pedestrian walkways.

2) Revetment

The revetment of the access road is not including the sharp corner and there is not a stronger current velocity behind the cargo yard. Based on the Isbash's equation, the required mass of armour rock was calculated as 200kg to 500kg.

In an economical view, the revetment structure consists of 3 layers: sand layer, quarry run layer, and then covered by armour rock. In the sub-soil condition BH-7, with unit weight load 1.0 t/m^2, in the calculation of circular sliding, the structure has the safety factor more than 1.2.



Source: JICA Study Team

Figure 5.100 Typical Section of Access Road and Revetment

5.10 Construction Plan and Cost Estimate

5.10.1 General Conditions of Site

(1) Location and Access

The proposed project is site is located around 4 – 5 km south from the center of the city of Mandalay. There is a paved road along the left bank of the Ayeyarwaddy River, connecting the city and the project site. All of the construction materials can be delivered to the project site easily by this city road.

(2) Rainfall

The average monthly rainfall and number of rainy days are shown in Table 5.48 and Table 5.49 respectively. The climate is clearly divided into a dry season (Dec – Apr) and a rainy season (May – Nov).

Table 5.48 Average Monthly Rainfall Data

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	0	0	0	25	193	108	142	123	242	104	2	0
2004	0	0	0	73	176	126	106	29	184	7	3	0
2005	0	0	39	37	63	14	25	110	198	59	72	47
2006	0	0	NM	78	199	177	87	278	450	226	47	0
2007	0	4	0	18	216	321	53	57	254	205	39	0
2008	16	NM	0	13	235	34	156	27	79	143	23	0
2009	0	0	1	42	269	41	14	102	115	96	0	0
2010	0	NM	2	2	80	102	81	174	93	428	0	56
2011	0	0	35	73	213	89	66	418	83	250	5	13
2012	NM	0	7	63	15	39	12	56	374	74	9	0

Note: NM means the amount of rain fall could not be measured for some reason

Source: Department of meteorology and hydrology

Table 5.49 Average Number of Raining Days

Month	Mean temperature (celsius)		Mean Total Rainfall (mm)	Mean Number of Rain Days	Season
	Daily min.	Daily max.			
Jan	13.3	28.6	4	0.4	Dry season
Feb	14.9	32.1	3	0.4	
Mar	19.7	35.8	1	0.4	
Apr	24.4	38.4	40	3.3	
May	25.8	36.8	138	8.3	Raining season
Jun	25.8	34.2	116	7.2	
Jul	25.8	34.3	83	5.9	
Aug	25.2	32.3	136	8.7	
Sep	24.9	33.1	150	8.1	
Oct	23.5	32.2	125	6.8	
Nov	19.4	30.2	38	2.8	
Dec	14.8	28.2	6	0.7	Dry season
TOTAL			840 mm/year	53 days/year (Rain:48, Dry:5)	

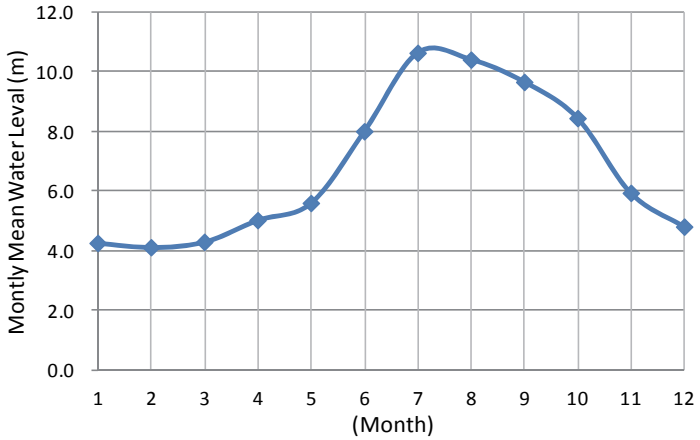
Note: Climatological information is based on monthly averages for the 30-year period1961-1990.

Source: World Meteorological Organization (http://www.worldweather.org/180/c00588.htm)

Although the number of rainy days is 53 days per year, not all of these days are unworkable. Considering the information obtained from interviews with local contractors, five (5) days in the dry season and sixteen (16) days (which is one third of the total (48/3=16)) in the rainy season are considered unworkable.

(3) Seasonal Water Level Difference

The water level of the Ayeyarwaddy River in the Mandalay region increases significantly when the rainy season starts in May. The difference between the dry season (Dec-Apr) and rainy season (May-Nov) is quite large. The water level difference in 2012 is shown below.



Source: Department of meteorology and hydrology

Figure 5.101 Water Level Difference of Ayeyarwaddy River in Mandalay

(4) Wind

The data of wind speed and direction was not available during this FS study. However it is assumed that the occurrence of wind strong enough to disturb the construction work can be negligible based on interviews with local contractors.

(5) River Current

The river current measurement was carried out along the Ayeyarwaddy River near Mandalay Port to upstream of the Sagaing Bridge in July 2013, which was during the raining season. The measurement was done at two depths, 1.5m and 4m from the water surface. The result showed that the average current velocity is between 1.169 – 1.347m/s (2.3 – 2.7 knot). It was reported that sometimes at some locations, the current speed will go up to 2.0 m/s (4 knot), which is quite fast. However, it is occasional and therefore in this study, the river current is assumed to have no significant impact on the construction work and the unworkable days.

(6) National Holidays

The biggest holiday is the New Year Holiday (Water Festival) which lasts for about two weeks. The total numbers of holidays is 26 days per year on average.

Table 5.50 National Holidays

Month	Number of days	National holidays
Jan	1	Independence Day, Union Day
Feb	1	Peasant's Day
Mar	3	Full Moon Day of Tabaung, Armed Forces Day
Apr	13	Myanmar New Year Holiday (Water Festival)
May	2	World Worker's Day, Full Moon Day of Kasone
Jun	0	-
Jul	2	Martyr's Day, Full Moon Day of Waso
Aug	0	-
Sep	0	-
Oct	1	Full Moon Day of Thadingyut
Nov	2	Full Moon Day of Tazaungdaing, National Day
Dec	1	Christmas Day
Total	26 days	

Source: Study Team

(7) Workable Days

Considering site conditions explained, the total of unworkable days are calculated as 100 days in one year.

Table 5.51 Unworkable Days

Type of unworkable days	Number of days
Sundays	53
Holidays	26
Raining days in dry season	5
Raining days in wet season	16
Total unworkable days	100

Source: Study Team

With reference to reclamation work by sand pump barges, they usually work on Sundays and only stop working during the Water Festival period. As such, the work ratio for general construction work and sand reclamation work are estimated as follows:

- ✓ Work ratio for general construction works: 1-(100/365*100) = 0.73.
- ✓ Work ratio for sand pumping works: 1 - (13+16) x 1.2 / 365 = 0.90

(8) Material Availability

Major construction materials, such as ready-mixed concrete, reinforced bar, structural steel, gravel, aggregate, rubble and armour stone, as well as sand both from river and quarry, are available locally. The supply capacity is also sufficient.

1) Concrete

One of the biggest concrete supply companies in Myanmar has currently one batching plant with the supply capacity of 60m3/hr. The concrete strength they can supply ranges 15-60 N/mm2. There are several other concrete suppliers and therefore no problem of supply capacity is anticipated.

2) Reclamation Sand

Sand for filling or earth works are dredged from the river by sand pump barge. There are 30 companies forming the sand pumping group, and they have a total of 30 pumping barges. One barge can carry 28 to 42 m3, and usually the distance between the dredging location and pumping location is within 1 mile. They are able to make 5 trips per day and 7-8 trips per day in rainy season and dry season respectively. The maximum depth they can dredge is around 18m which is deep enough to do the dredging throughout the year. The average annual production of sand is calculated as 1.5 million m3/year (=35m3 (average) x 6 tips/day x 30 barges x 300 days x 0.8)


Source: Study Team

Figure 5.102 Sand Pumping at Ayeyarwaddy River

3) Rubble and Armour Stone from Quarry

A major quarry for stones/rocks is located around 16 miles to the east of Mandalay. In the distance of 16 miles, one dump truck can make three to four trips per day to transport stones/rocks between the proposed project site and the quarries. For stone work in the Mandalay region, stones which weigh less than 100kg/pcs are commonly used because of the fact that most of these works are carried out by manual labour, not by machinery. However, the quarry can supply armour stone of 500kg class as well. Both 10 ton and 20 ton dump trucks are used to carry the stones, and according to a local contractor, the quarry is able to supply around 1,000m3/day.

4) Heavy Machinery and Piling Equipments

A large capacity crawler crane is difficult to procure in Mandalay, so it will need to be brought from Yangon. Also piling related equipment, such as a piling barge, a pile driving machine, a diesel/hydraulic hammer, and a vibro hammer will also need to be procured from Yangon. This is due to the fact that most of the piling in Myanmar is bore-piles and square RC piles.


Source: Study Team

Figure 5.103 Local Piling Machine

5.10.2 Scope of Works

The scope of the construction work required for the Mandalay port development project is summarized in Table 5.52. The main facilities to be constructed are the jetty, access trestle, cargo yard and access road.

Table 5.52 Scope of Construction Works

No		Facility	Works	Unit	Quantity
1		Jetty construction			
	Op.1	Floating pontoon type	Fabrication (90m x 25m)	No	2
			Installation	No	2
	Op.2	Fixed Pier Type	Jetty construction	m	164
2		Access trestle			
	2-1		Piling (Steel Pipe Pile)	No	215 ～ 250 (subject to jetty structure)
	2-2		Structure works (RC)	LS	1
3		Cargo yard		m2	29,540
	3-1		Stone revetment	m3	70,000
	3-2		Land reclamation	m3	137,000
	3-3		Concrete pavement	m2	29,540
	3-4		Buildings Office/ Work Shop Warehouse	 m2 m2	 500 1,128 (2,256)
	3-5		Utilities	LS	1
4		Access road		m	304
	4-1		Stone revetment	m3	6,483
	4-2		Sand fill	m3	14,453
	4-3		Pavement	m2	3,040
5		Equipment			
	5-1		Truck Crane (100ton) Truck Crane (50ton) Forklift (3ton) Trailer (20ft) Truck (10ton) Generator (100KVA) Pallet	No No No No No No No	0 (1) 2 (2) 3 (5) 1 (1) 3 (5) 1 (2) 5,500 (5,500)

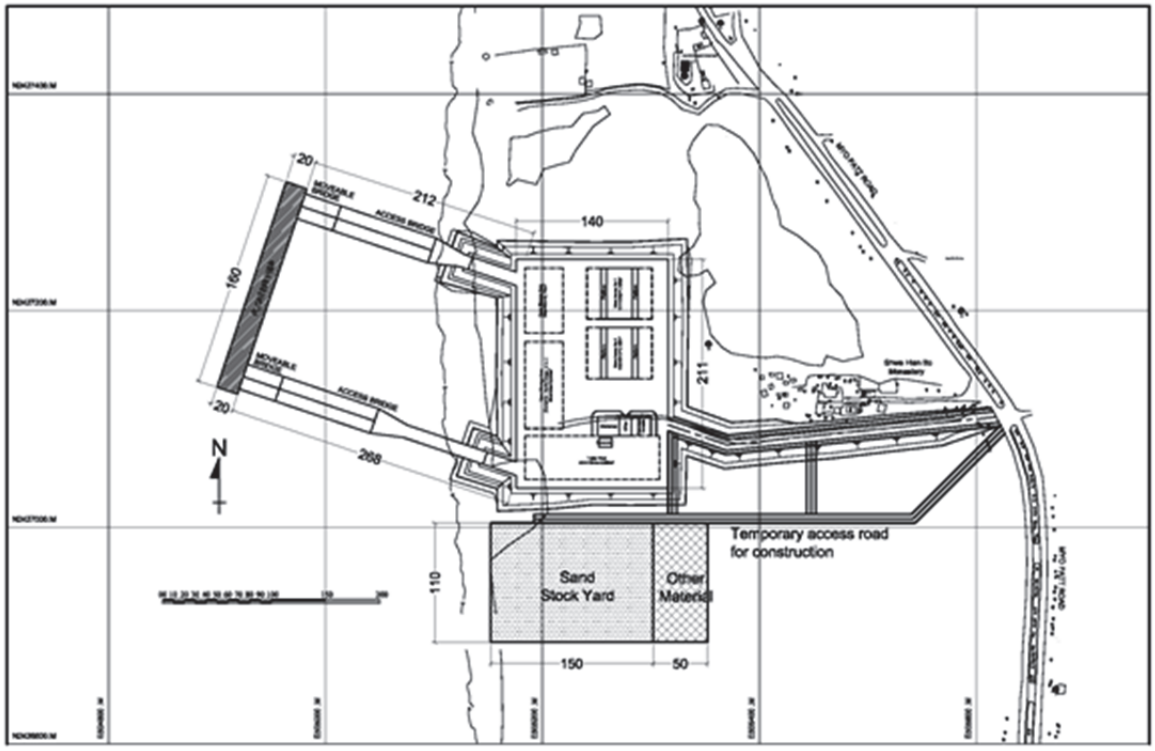
Remarks: Above figures mean for cost estimates, ( ) figures mean for design

Source: Study Team

5.10.3 Construction Plan

(1) Plan layout of Mandalay Port

The plan layout of Mandalay Port is shown below. As described in the scope of the work, the port comprises of four main facilities and the construction method/sequence of each facility is explained in this chapter.



Source: Study Team

Figure 5.104 Plan Layout of the Mandalay Port

(2) Temporary Works

Prior to the commencement of the main construction work, there will be preparation work, such as a site office setup, leveling of the project yard and preparing a temporary yard.

The temporary yard will be used for temporary stock of material such as sand, stone etc with an access road for trucks to transport the materials. The planned location and layout of the temporary yard is shown in Figure 5.104.

(3) Reclamation Works

The reclamation of the access road and cargo yard will be carried out by the sand pumped from the Ayeyarwaddy River. The sand will be temporarily stocked at the yard next to the cargo yard, and transported to the fill site whenever required by dump trucks. The bull dozer will do the leveling, and a road roller will compact the sand by layers of around 30cm to secure sufficient stability.

The total amount of sand required is around 137,000 m3 for the cargo yard and 14,500 m3 for the access road. Ten sand pump barges in total are planned to supply the sand for the project. Considering the work ratio of 0.90 as mentioned previously, daily supply volume is estimated at 1,890 m3/day.

$210m^3$/day/barge x 10 barges x 0.9 = $1,890m^3$/day

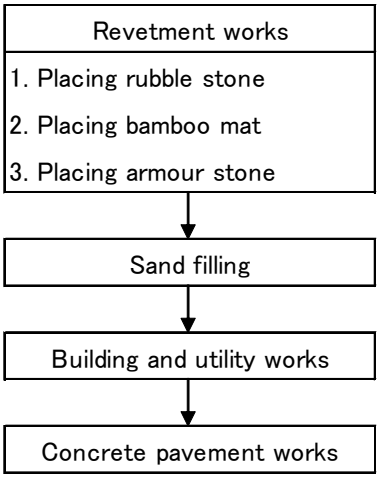
(4) Construction of Cargo Yard

The existing ground elevation of the cargo yard location is between 4.0 – 6.5 m CDL. As the design top elevation of the cargo yard is 11.0m CDL, an average of 6.0m in height needs to be reclaimed. Sand from the river is the most economical and suitable material for the reclamation. The work shall commence towards the end of the rainy season so that the area is above water which enables easier and faster construction. Due to the seismic condition of the project area, necessary measures to prevent the affect of ground liquidation should be further studied in the next stage.

Prior to the sand fill of the cargo yard, stone revetment will be constructed. Rubble stone from the quarry will be transported to the site by 20ton dump trucks, and placed at the designated location. Bulldozers will grade the stone and the excavator will trim the slope in accordance with the designed slope ratio. Then bamboo mats will be placed at the toe, followed by the placing of armour stone.

Once the stone revetment is constructed for some sections, the sand filling can commence. The sand will be leveled and compacted layer by layer (around 30cm thickness for each layer) in order to ensure sufficient stability.

When the sand is filled up to the designed elevation, concrete pavement works will commence. Sub-grade material will be placed and compacted, and the surface concrete will be casted on site. The construction sequence of cargo yard is shown below:



Source: Study Team

Figure 5.105 Construction Sequence of Cargo Yard

(5) Access Trestle

An access trestle is a pile pier structure with steel pipe piles. The steel pipe piles will be procured from a foreign country, such as Japan or Viet Nam, and transported from Yangon to Mandalay through inland waterways.

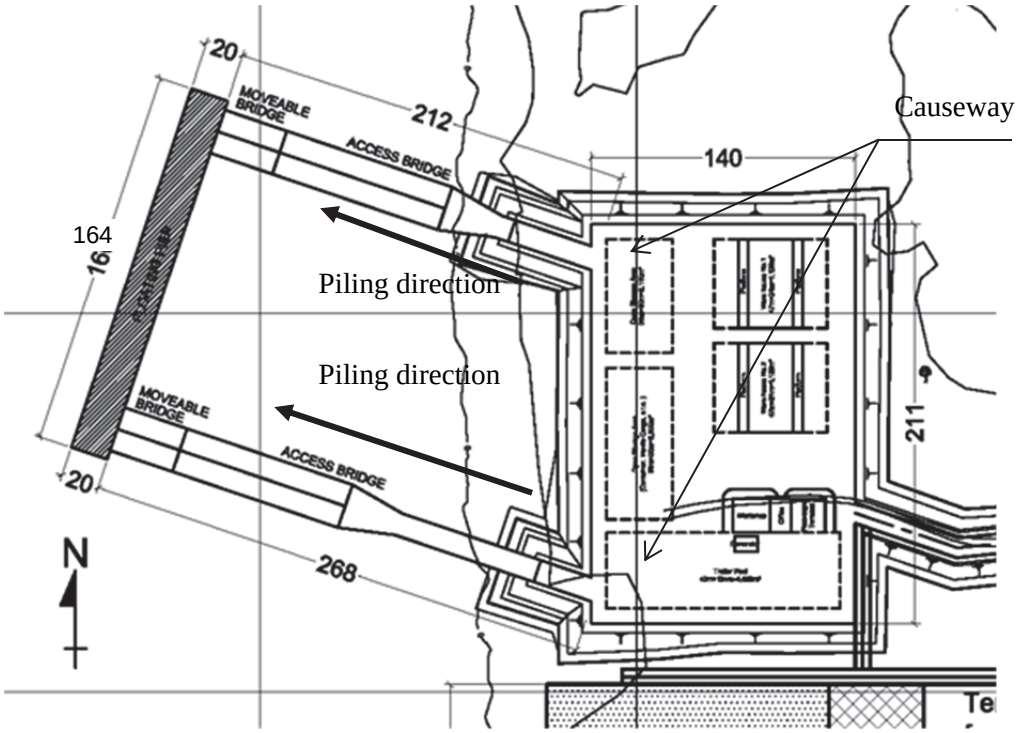
The existing riverbed elevation where the piles will be driven varies from -2.0m to +2.5m CDL. Considering the draft limitation of maximum 1.5m during dry season between Yangon and Mandalay, and also the difficulty and cost of land transportation, the piles shall be transported by barge on the Ayeyarwaddy River during the rainy season.

There are several methods to drive the piles such as driving by a piling barge, a crane barge with flying hammer, or from the land. In the case of driving from the land, the area needs to be temporarily reclaimed for the piling machine to work, and the sand needs to be removed after the piling is completed and will require additional work. Therefore, piling from the water is recommended in this study. As no contractor in Myanmar owns a piling barge, it has to be brought from a foreign country together with the contractor and all other necessary equipment. However, there are eight bridges on the navigation route between Yangon and Mandalay which limit the clearance height of vessels going underneath. Detailed information could not be obtained during this study, but the maximum clearance height is said to be around 40 feet (assume this is during the high water season). It is uncertain that the piling barge can go under the bridge or not, and therefore the flying hammer method is recommended.

The crane barge equipped with a small leader will lift and set the pile to the design position. After confirming the pile position and the angle in case of raker pile, the flying hammer (with ram weight of around 16 tons) will drive the pile until the required bearing capacity is obtained which will be confirmed by measuring the rebound. The pile length varies from 36.5m to 41.5m in one length and the

weight of pile is more than 11 tons, which will be possible only by using a crane barge with sufficient boom length.

The construction plan is made on the assumption of 3 piles made daily. The rainy season lasts only for 6 months, from middle of May until middle of November, and it needs to be completed within that period and demobilize. Otherwise the barge might not be able to tow back until the next rainy season. The piling shall start from the landside (shallower side) towards the center of the river (deeper side) as shown below.

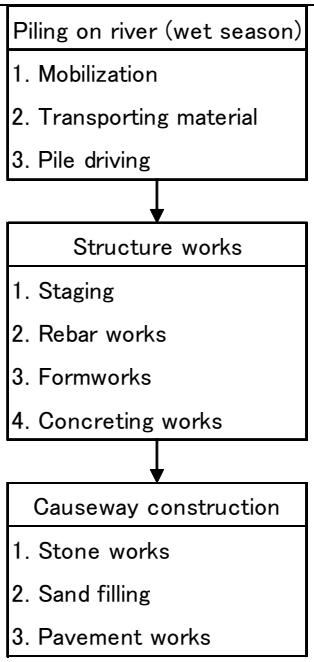


Source: Study Team

Figure 5.106 Piling Work Plan

The structure work will follow after the piling work. First the staging will be installed by bracket and H-beams, and the base formwork will be fixed. After the reinforcement bar is tied and installed together with a pile cap, the side formwork will be fixed and the concreting will be carried out by a crane barge equipped with a concreting hopper bucket. A concrete truck will be transported on a flat barge from the already reclaimed yard area.

Part of the access trestle with a shallow river bed depth will be the causeway instead of a pile pier structure. The same steel pipe pile will be driven by the flying hammer method. After the pile is driven, the causeway will be constructed by filling in sand and stone. The surface will be covered by concrete pavement, connecting the cargo yard and RC structure of pile pier type access trestle. The construction sequence of the access trestle is shown below:

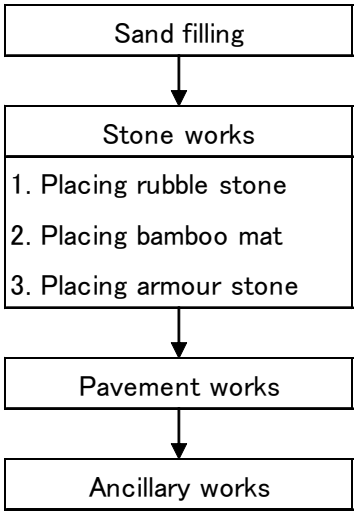


Source: Study Team

Figure 5.107 Construction Sequence of Access Trestle

(6) Access Road

The construction of an access road is to start in the dry season. The sand transported from the temporary stock yard will be compacted layer by layer using a road roller. Then the rubble stone from the quarry will be placed. After the bamboo mat is placed, armour stone will be laid and leveled by the excavator and masonry. The construction sequence of access road is shown below:



Source: Study Team

Figure 5.108 Construction Sequence of Access Road

(7) Jetty Construction

The jetty structure of the Mandalay Port will either be a floating pontoon type or fixed pile pier type. The construction procedure of a fixed pile pier type jetty is same as that of an access trestle. It starts from piling works on the river by crane barge with a flying hammer followed by the staging and structure work. Consequently the construction sequence can be referred to Figure 5.107 as well.

Floating Pontoon Type Jetty

The possibility of fabricating the floating pontoon in Myanmar is studied in this section. Three types of pontoon can be considered; 1) steel structure (SS) pontoon, 2) Reinforced Concrete hybrid (RCH) pontoon, and 3) Pre-stressed concrete hybrid (PCH) pontoon. Their dimensions are 90m (L) x 25m (B) x 4.0~4.4m (H), and two pontoons will be connected by the connecting bridge so that the total berth length will be 180m.

1) Fabrication Yard

There is a IWT shipyard in Mandalay but it is not equipped with adequate facilities such as cranes, steel place cutting machines, semi-auto welding machines, etc. In Yangon, there is the Dalla shipyard which is owned and operated by IWT, but its condition of facility and equipment is not adequate either. Private shipyards may have high standard equipment, but their capability is uncertain as they have no experience in fabricating such pontoons. Therefore, the fabrication of the pontoons should be carried out in another place or facility.

One option is to bring the necessary equipment and fabricate the pontoon at the temporary yard constructed on the river bank of the Ayeyarwaddy River beside the proposed jetty location. The proposed area can be compacted and leveled during the dry season, and then covered by lean concrete.

Source: Study Team

Figure 5.109 River Bank of Ayeyarwaddy River in Dry Season

2) Material Availability

Considering the availability and also the quality of local material, major materials including steel plates, structural steel, pre-stressed cable etc need to be procured in/from foreign countries like Japan, Thailand and Singapore. According to the interview with MPA (Myanmar Port Authority), it is common practice to call an international tender for procurement of steel materials when a certain quality is required.

3) Equipment

It is observed that most of the work at the shipyard is carried out by manual labour. One of the reasons for this is the lack of equipment, especially lifting equipment, in the shipyard. Therefore, even if the steel structure barge is being manufactured at the IWT dockyards the steel plate of thickness of 6-8mm is usually used which is quite thin and those cut plates are carried by group of workers by hand. In the construction of a floating pontoon for Mandalay Port, a lifting crane is mandatory.

In Japan, steel plate cutting is done by the numerically controlled (NC) cutting machine. Manual work by gas cutting torch is not realistic in fabricating such large pontoons. A semi-auto welding machine is not available in the IWT shipyard, but some private shipyards own such a welder and it is possible to rent.

Source: Study Team

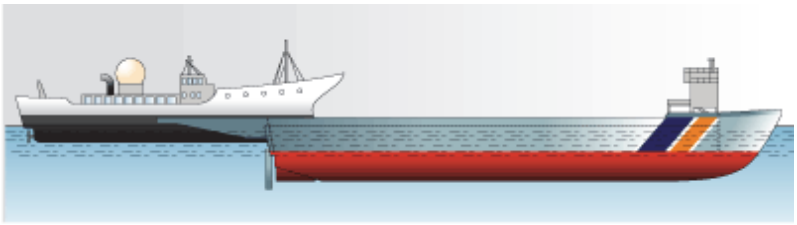
Figure 5.110 Manual Work with Old Equipment at IWT Shipyard

4) Subcontractor

As mentioned previously, IWT shipyard has no adequate equipment and it is difficult to fabricate the floating pontoon at their yard. Private shipyards in Yangon have better equipment and facilities, but many of them will not likely be able to provide the quotation even if we ask for it as they have no similar experience of fabricating pontoons with such a large size and structure.

5) Conclusion

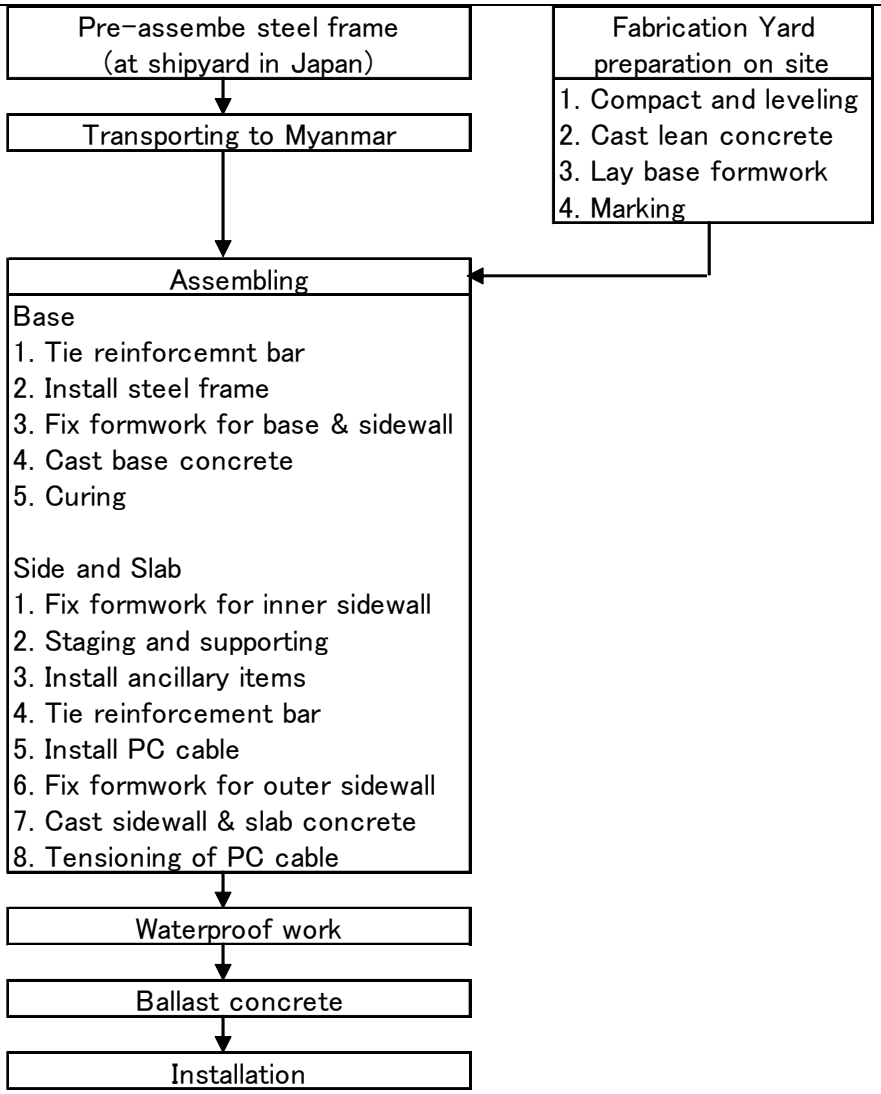
For SS and RCH pontoons, it is difficult to fabricate them in Myanmar at present. Even if the steel frame with plates can be assembled into smaller parts and delivered to Myanmar, there seems to be no suitable equipment for assembling. When assembling smaller parts of steel frames by welding, blasting will be necessary prior to the anti-corrosive painting in order for the pontoon to be protected from corrosion. However, such blasting machines are not common in Myanmar. So, these two types need to be fabricated in another country, like Japan, and be transported to Myanmar. RCH is not suitable for towing through the ocean because the adherence of the outer concrete and the steel structure is not strong enough, so a sinking barge or semi-submergible transport vessel will be used. The transportation of a SS pontoon can be done either by towing or by sinking barge.



Source: Website of Binan development Co., Ltd (http://www.j-bdc.com/business/tenyu.html)

Figure 5.111 Example of Sinking Barge

There is the possibility that a PCH pontoon could be assembled at the site in Mandalay. The steel frame would be assembled into smaller parts in Japan, and then transported to the temporary fabrication yard at the Mandalay port site through inland waterways. Those parts will be joined by bolts and nuts, and assembled by a crane with 50-80 ton lifting capacity. The outer concrete will be casted by the pump truck after the reinforcement bar is tied, the formwork is fixed and the PC cable is installed. After the concrete is casted, the PC cable will be tensioned. The procedure of PCH pontoon is shown below:

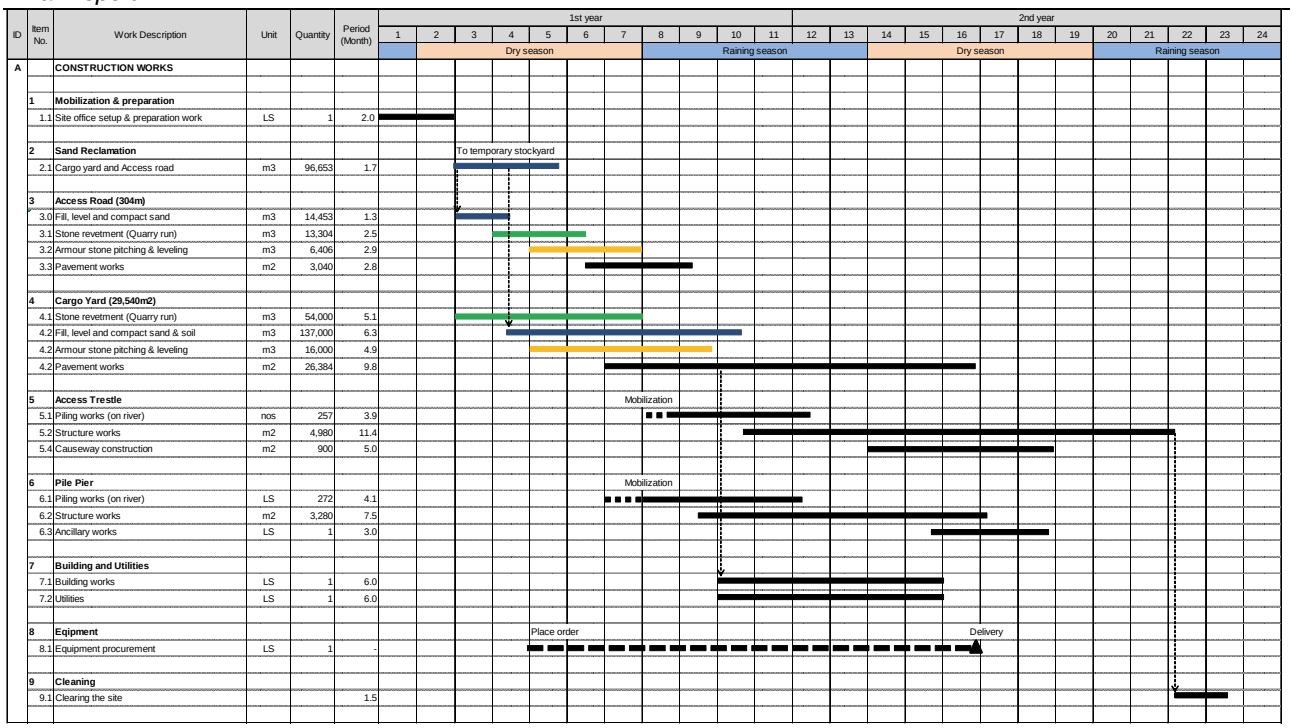


Source: Study Team

Figure 5.112 Construction Sequence of Floating Pontoon Fabrication

(8) Construction Schedule

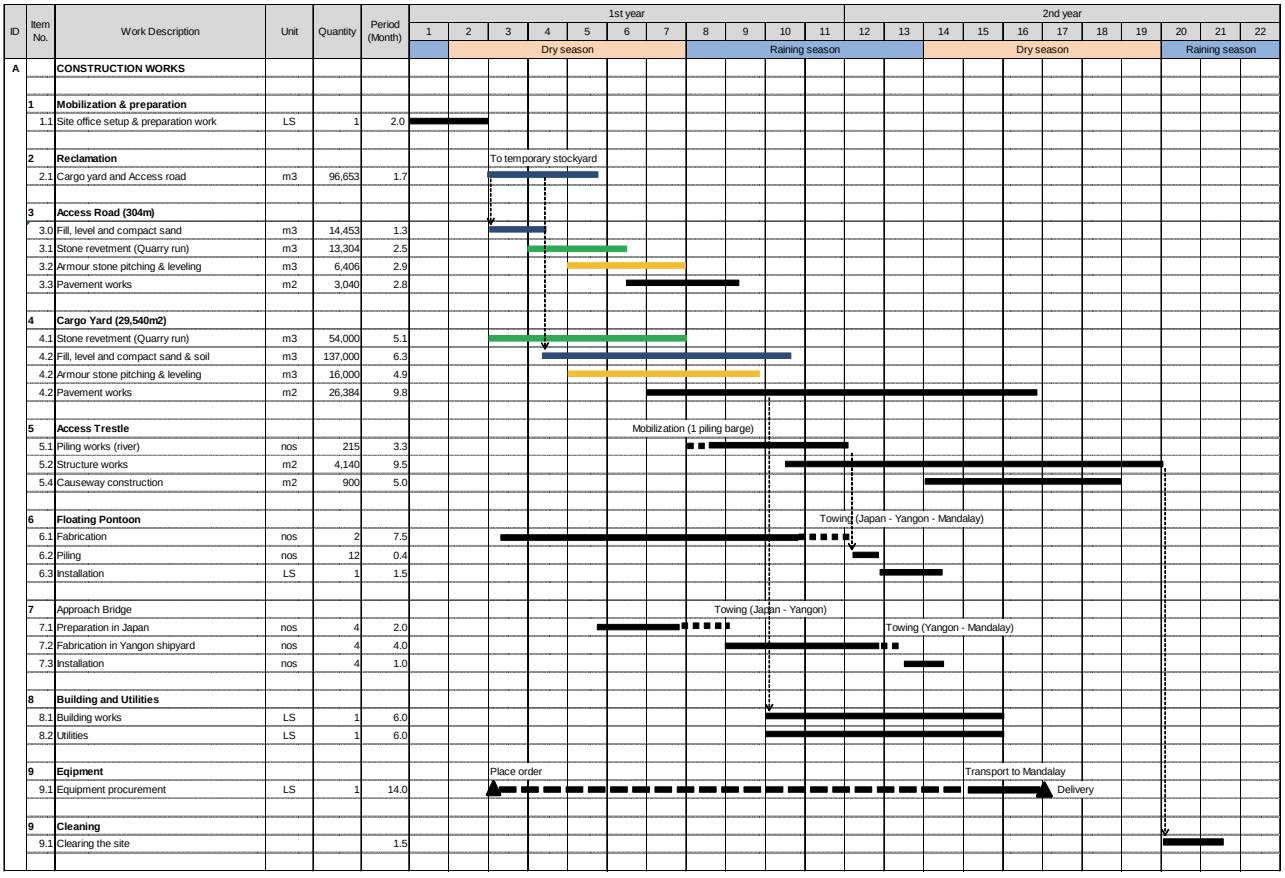
The overall construction period for a fixed pile pier type jetty is estimated at around 23 months including preparation and a site clearing period. In the case of a floating jetty type, the total period is around 21 months. The work shall commence at the end of the rainy season so that the reclamation work for an access road and cargo yard can easily be started, and also the contractor will have sufficient time to plan and prepare for the piling works. The estimate construction schedule for both structure types is shown below.



ID	Item No.	Work Description	Unit	Quantity	Period (Month)
A		**CONSTRUCTION WORKS**			
	1	**Mobilization & preparation**			
	1.1	Site office setup & preparation work	LS	1	2.0
	2	**Sand Reclamation**			
	2.1	Cargo yard and Access road	m3	96,653	1.7
	3	**Access Road (304m)**			
	3.0	Fill, level and compact sand	m3	14,453	1.3
	3.1	Stone revetment (Quarry run)	m3	13,304	2.5
	3.2	Armour stone pitching & leveling	m3	6,406	2.9
	3.3	Pavement works	m2	3,040	2.8
	4	**Cargo Yard (29,540m2)**			
	4.1	Stone revetment (Quarry run)	m3	54,000	5.1
	4.2	Fill, level and compact sand & soil	m3	137,000	6.3
	4.2	Armour stone pitching & leveling	m3	16,000	4.9
	4.2	Pavement works	m2	26,384	9.8
	5	**Access Trestle**			
	5.1	Piling works (on river)	nos	257	3.9
	5.2	Structure works	m2	4,980	11.4
	5.4	Causeway construction	m2	900	5.0
	6	**Pile Pier**			
	6.1	Piling works (on river)	LS	272	4.1
	6.2	Structure works	m2	3,280	7.5
	6.3	Ancillary works	LS	1	3.0
	7	**Building and Utilities**			
	7.1	Building works	LS	1	6.0
	7.2	Utilities	LS	1	6.0
	8	**Eqipment**			
	8.1	Equipment procurement	LS	1	-
	9	**Cleaning**			
	9.1	Clearing the site			1.5

Source: Study Team

Figure 5.113 Estimated Construction Schedule (Fixed Pile Pier Type)



ID	Item No.	Work Description	Unit	Quantity	Period (Month)
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	1.1	Site office setup & preparation work	LS	1	2.0
	2	**Reclamation**			
	2.1	Cargo yard and Access road	m3	96,653	1.7
	3	**Access Road (304m)**			
	3.0	Fill, level and compact sand	m3	14,453	1.3
	3.1	Stone revetment (Quarry run)	m3	13,304	2.5
	3.2	Armour stone pitching & leveling	m3	6,406	2.9
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	4.2	Armour stone pitching & leveling	m3	16,000	4.9
	4.2	Pavement works	m2	26,384	9.8
	5	**Access Trestle**			
	5.1	Piling works (river)	nos	215	3.3
	5.2	Structure works	m2	4,140	9.5
	5.4	Causeway construction	m2	900	5.0
	6	**Floating Pontoon**			
	6.1	Fabrication	nos	2	7.5
	6.2	Piling	nos	12	0.4
	6.3	Installation	LS	1	1.5
	7	Approach Bridge			
	7.1	Preparation in Japan	nos	4	2.0
	7.2	Fabrication in Yangon shipyard	nos	4	4.0
	7.3	Installation	nos	4	1.0
	8	**Building and Utilities**			
	8.1	Building works	LS	1	6.0
	8.2	Utilities	LS	1	6.0
	9	**Eqipment**			
	9.1	Equipment procurement	LS	1	14.0
	9	**Cleaning**			
	9.1	Clearing the site			1.5

Source: Study Team

Figure 5.114 Estimated Construction Schedule (Floating Jetty Type)

5.10.4 Cost Estimate

(1) Basic costs of Materials, Equipment and Workers

The cost survey was carried out in Yangon and Mandalay in August and September, 2013. The information and data were obtained from the standard price book of the Mandalay District for 2013-2014 published by the Ministry of Construction, and also from contractors having considerable experience in the execution of construction projects in Myanmar.

1) Materials Costs

The construction material cost is summarized below. All the rates are based on the cost of delivery to site except for the steel pipe piles, steel sheet piles and PHC piles. These items will need to be imported from a third country, and the below rates are CIF Yangon price.

Table 5.53 Major Material Costs

	Item	Spec.	Unit	Purchase price (obtained price)		Remarks
				Kyat	USD	
1	Reinforced bar	D11-20mm	ton	810,000	-	
2	Reinforced bar	D21-30mm	ton	800,000	-	
3	Cement	Portland	50kg	6,500	-	
4	Concrete	18-21 N/mm2	m3	63,500	-	
5	Concrete	24-30 N/mm2	m3	70,500	-	
6	Corse aggregate	Gravel (river shingle)	m3	7,500	-	
7	Fine aggregate	For concrete (quarry)	m3	12,500	-	
8	Fine aggregate	For construction (quarry)	m3	8,000	-	
9	Filling soil	By pump barge	m3	2,000	-	
10	Rock	Armor, rubble	m3	39,600	-	
11	Bitumen	-	ton	600,000	-	
12	Diesel	-	Litre	950	-	
13	Steel pipe pile	D=700mm, t=12mm	ton	-	1,200	Import (CIF Yangon)
14	Steel pipe pile	D=1,000-1,300mm	ton	-	1,400	Import (CIF Yangon)
15	Steel sheet pile	Type-II~IV	ton	-	950	
16	PHC pile	D=1,000	m	330,000	-	From Vietnam
17	ILB	t=80mm	m2	6,560	-	For pavement

Source: Study Team

2) Equipment Costs

The table below shows equipment rental costs including operator, engine oil and miscellaneous expenses except for fuel, based on a eight hour working day.

Table 5.54 Equipment Cost

	Item	Spec.	unit	Rental price		Remarks
				Kyat	USD	
1	Bulldozer	15 ton	day	300,0000	-	-
2	Dump truck	10 ton	day	120,000	-	-
3	Dump truck	20 ton	day	150,000	-	-
4	Excavator	1.3m3 class	day	300,000	-	-
5	Motor grader	-	day	300,000	-	-
6	Road roller	5-15ton	day	100,000	-	-
7	Mobile/Truck crane	Lifting capacity 20ton	day	450,000	-	-
8	Crane barge	Lifting capacity 20ton	day	800,000	-	-
9	Flat barge	1,000 ton	day	200,000	-	IWT charter rate
10	Flat barge	400 ton	day	150,000	-	IWT charter rate
11	Tug boat	HP350	day	105,000	-	IWT charter rate

Source: Study Team

3) Labor Costs

Labor costs are shown in the table below. These are all national engineers and workers, and those from third countries are not considered in this FS.

Table 5.55 Labor Costs

	Item	unit	Labor wage		Remarks
			Kyat	USD	
1	Civil engineer	mth	500,000	-	-
2	M&E engineer	mth	400,000	-	-
3	Foreman	day	10,000	-	-
4	Operator	day	40,000	-	-
5	Skilled worker	day	7,000	-	-
6	Mason	day	6,000	-	-
7	Carpenter	day	6,000	-	-
8	Common labor	day	5,000	-	-

Source: Study Team

4) Costs for Execution Works

The average cost of executing the work is obtained from the local contractors. They are subject to the volume and specification of the works, so the below rates are only for reference.

Table 5.56 Basic Rates for the Execution of Works

	Item	Spec.	unit	Work Rate		Remarks
				Kyat	USD	
1	Excavation	-	m3	2,687	-	
2	Filling work	-	m3	2,571	-	By sand pump barge
3	Masonry work	Rubble stone placing	m3	1,934	-	Exclude material
		Armour stone placing	m2	12,380	-	Exclude material
4	Placing concrete	By concrete pump truck	m3	79,500	-	On land
			m3	111,150	-	On water
5	Reinforced bar works	-	ton	96,280	-	On water
6	Formwork	Timber formwork	m2	35,141	-	On water incl. material
7	Piling on water	Steel pipe pile	no	-	4,527	Exclude material cost
8	Transporting of steel pile piles	By 1,000 ton class flat barge including tug boat	no	585,683	-	Assume 24nos per trip

Source: Study Team

(2) Outline of Cost Estimation

The construction costs consist of direct cost and indirect cost. Direct cost includes the basic costs of materials, equipment, workers and execution work. Project cost is composed of “direct cost”, “the cost of common temporary works”, ”the cost of site management expenses” and “general management cost”. Mobilization, demobilization and direct temporary work cost are included in the direct cost.

The cost of common temporary work varies depending on the facility component included in the project. It is assumed to be 5% of the direct cost in this study.

The cost of site management expenses and general management costs are composed of costs for a contractor to construct, manage and maintain the site office, to maintain & continue company operation such as the interest payment to banks, expense for stockholders, social insurances & taxes, reservation for various risks, company profits etc. The ratio quoted from the local contractors is 20% to 30%. In this study, it is set at 20%.

Project Cost: C = A+B
Direct cost: A
General expenses: B = 20% of A

(3) Condition of Cost Estimate

For the cost estimation in this FS, the following conditions are taken into account.

1) Exchange Rate

The common exchange rates provided by JICA for the projects in Myanmar in 2013 are as follows.

USD 1 = JPY 99.2
USD 1 = Kyat 970.9
JPY 1 = Kyat 0.102

2) Assumed Price Escalation Rate

The following price escalation rates for both the local and foreign currency portions are calculated based on the project implementation schedule. In this cost estimates, the construction commencement is set from 2016.

- ✓ Foreign currency portion: 1.3 % per annum
- ✓ Local currency portion: 4.9 % per annum

3) Physical Contingency

The rate of physical contingency is 5%. The amount of physical contingency is obtained by multiplying the rate by the total of construction cost and price escalation.

4) Commercial Tax

In Myanmar, there is no so-called value added tax (VAT), but commercial tax is imposed on services/imported materials. The rate varies depending on the item, but in average 5% of the provided service is taken in to consideration in this report.

5) Import Tax

Import tax is assumed to be exempted by the agreement between both governments, so it is not included in the project cost in this study.

6) Consulting Service

Consulting service is calculated by multiplying 8% to the total amount of construction cost, price escalation and physical contingency.

7) Land Acquisition

The land of the proposed project area is owned by DWIR, so no land acquisition is required. There are some illegal occupants, so compensation might be necessary after finalizing all the details during the detail design stage.

(4) Summary of Project Cost

1) Fixed Pier Type Jetty

The estimated total project cost is Kyat 17,576,866,801 for the local portion and USD 16,424,525 for the foreign portion. This amount is equivalent to JPY 3,422,147,000 in total.

The project cost, breakdown of construction cost and annual cost are summarized below.

Table 5.57 Summary of Project Cost (Fixed pile pier jetty)

ID.	Item No.	Work Description	Unit	Quantity	Local Portion (Kyat)		Forein Portion (USD)		TOTAL in JPY	Remarks
					Unit Rate	Amount	Unit Rate	Amount		
A		*Construction Expenses*								
	1	Preparation, Vessels	LS	1	243,616,275	243,616,275	0	0	24,848,000	
	2	Reclamation	m3	96,653	6,921	668,907,577	0	0	68,228,000	
	3	Access Road	m	304	4,767,968	1,449,462,235	0	0	147,845,000	
	4	Cargo Yard (140m x 211m)	LS	1	5,966,686,830	5,966,686,830	0	0	608,602,000	
	5	Access Trestle	LS	1	2,425,959,279	2,425,959,279	4,664,562	4,664,562	710,172,000	
	6	Pile Pier	m	164	8,875,222	1,455,536,329	42,452	6,962,067	839,101,000	
	7	Buildings and Utilities	LS	1	820,144,043	820,144,043	0	0	83,654,000	
	8	Equipment	LS	1	135,375,000	135,375,000	1,675,255	1,675,255	179,993,000	
		Total construction expenses (A)				13,165,687,568		13,301,884	2,662,443,000	
B		**Price escalation**	%	-		2,200,588,157		595,321	283,515,000	Local: 4.9%, Foreign: 1.3%
C		**Physical contingency (5%)**	%	5		768,313,786		694,860	147,298,000	
		Sub total (A+B+C)				16,134,589,512		14,592,065	3,093,256,000	
D		**Consulting Service**	%	8		1,290,767,161		1,167,365	247,460,000	
E		**Administration Cost**	%	0.5		151,510,128			15,454,000	
F		**Commercial Tax**	%	5				665,094	65,977,000	
		GRAND TOTAL				17,576,866,801		16,424,525	3,422,147,000	

Note: TOTAL amount in Japane Yen is the amount of rounddown below 1,000 JPY

Source: Study Team

Table 5.58 The Breakdown of the Project Cost (Fixed pile pier jetty)

No.	Description	Unit	Q'ty	Local Portion (Kyat)		Forein Portion (USD)		Remarks
				Unit Rate	Amount	Unit Rate	Amount	
1	**Preparation works**	LS	1					
1.1	Preparatin works	LS	1	36,888,075	36,888,075	0	0	
1.2	Working vessels	LS	1	206,728,200	206,728,200	0	0	
	Summ				243,616,275		0	
2	**Reclamation**	m3	96,653					
2.1	Cargo yard	m3	82,200	6,921	568,882,526	0	0	
2.2	Access road	m3	14,453	6,921	100,025,051	0	0	
	Summ				668,907,577			
3	**Access Road (L=304m)**	m	304					
3.1	Stone Works							
a	Quarry run	m3	13,304	57,510	765,113,339	0	0	material and work
b	Bamboo mat placing	m2	2,552	7,610	19,421,741	0	0	material and work
c	Armour stone placing & leveling	m3	6,406	65,495	419,559,689	0	0	material and work
3.2	Concrete Pavement	m2	3,040	80,713	245,367,466	0	0	incl. subgrade, curb, drain
	Summ				1,449,462,235		0	
4	**Cargo Yard (Area=29,540m2)**							
4.1	Stone Revetment							
a	Quarry run	m3	54,000	57,510	3,105,541,215	0	0	
b	Bamboo mat	m2	5,911	7,610	44,985,074	0	0	
c	Armour stone	m3	16,000	62,651	1,002,415,100	0	0	
d	Concrete Pavement	m2	26,384	42,767.13	1,128,368,088	0	0	
4.3	Soil filling	m3	54,800	12,507	685,377,353	0	0	1m thickness x 2 layers
	Summ				5,966,686,830		0	
5	**Access Trestle**							
5.1	Piling works							
a	Transporting piles	no	257	585,683	150,520,617	0	0	
b	Mobilization/Demobilization	LS	1	0	0	324,000	324,000	
c	Pile driving	no	257	0	0	13,144	3,378,034	
5.2	Structure works							
a	Staging	m2	4,980	42,667	212,483,652	0	0	
b	Formwork	m2	8,948	35,141	314,449,446	0	0	
c	Rebar works	ton	383	734,880	281,797,085	0	0	
d	Concreting	m3	3,835	111,150	426,215,790	0	0	
5.3	Causeway							
a	Quarry run	m3	5,000	45,643	228,214,375	0	0	material and work
b	Sand fill	m3	4,000	5,493	21,970,514	0	0	material and work
c	Armour stone placing and leveling	m2	5,000	51,980	259,900,000	0	0	material and work
d	Concrete pavement	m2	900	33,126	29,813,028	0	0	including subgrade
e	Other direct expenses	%	5		96,268,225		185,102	
f	General expenses	%	20		404,326,546		777,427	
	Summ				2,425,959,279		4,664,562	
6	**Pile Pier (Berth Length =180m)**							
6.1	Piling							
a	Mobilization/demobilization	LS	1	0	0	648,000	648,000	
b	Transportation of piles	no	272	585,683	159,305,867	0	0	
c	Pile (Material)	no	272	0	0	11,027	2,999,434	
d	Pile driving	no	272	0	0	4,527	1,231,371	
6.3	Structure works							
a	Staging	m2	3,280	42,667	139,949,072	0	0	
b	Formwork	m2	5,614	35,141	197,274,374	0	0	
c	Rebar works	ton	255	734,880	187,188,634	0	0	
d	Concreting	m3	2,547	111,150	283,121,280	0	0	
6.4	Ancillary works							
a	Fender	no	12	0	0	50,403	604,839	
b	Bollard	no	24	0	0	1,742	41,806	
c	Installation	%	30		188,348,336			
d	Other Direct Expense		5		57,759,378		276,272	
e	General Expense	%	20		242,589,388		1,160,344	
	Summ				1,455,536,329		6,962,067	
8	**Buildings**							
8.1	Office buildings	m2	200	367,000	73,400,040	0	0	
8.2	Warehouses	m2	1,128	367,000	413,976,226	0	0	
8.3	Workshop	m2	360	275,250	99,090,054	0	0	
8.4	Gate	no	1	7,645,838	7,645,838	0	0	
8.5	Utilities							
a	water pipe	LS	1	47,697,983	47,697,983	0	0	
b	electricity	LS	1	39,258,323	39,258,323	0	0	
c	lighting	LS	1	81,547,200	81,547,200	0	0	
d	Drainage	LS	1	57,528,380	57,528,380	0	0	
	Summ				820,144,043		0	
9	**Equipment**							
9.1	Equipment							
a	Truck crane (100ton)	no	0	0	0	1,004,000	0	CIF Yangon
b	Truck crane (50ton)	no	2	0	0	519,788	1,039,577	CIF Yangon
c	Forklift (3ton)	no	3	0	0	38,989	116,966	CIF Yangon
d	Prime mover with 20 feet chassis	no	1	0	0	179,325	179,325	CIF Mandalay
e	10 ton truck	no	3	0	0	98,396	295,188	CIF Mandalay
f	Generator (100KVA)	no	1	0	0	44,200	44,200	CIF Mandalay
g	Pallet	no	5,500	21,450	117,975,000	0	0	
9.2	Transportation							
a	Transportation of equipments	LS	1	17,400,000	17,400,000	0	0	Yangon to Mandalay
	Summ				135,375,000		1,675,255	
	GRAND TOTAL				13,165,687,568		13,301,884	

* Unit rate is inclusive of general expenses

Source: Study Team

Table 5.59 Yearly Project Cost (Fixed pile pier jetty)

ID.	Item No.	Work Description	Unit	Quantity	Base year in 2013				2014		2015		2016		2017		TOTAL in JPY
					Unit Rate (Kyat)	Amount (Kyat)	Unit Rate (USD)	Amount (USD)	Local	Foreign			Local	Foreign	Local	Foreign	
A		*Construction Expenses*															
	1	Mobilization and preparation	LS	1	243,616,275	243,616,275	0	0					243,616,275	0	0	0	24,848,000
	2	Reclamation	m3	96,653	6,921	668,907,577	0	0					668,907,577	0	0	0	68,228,000
	3	Access Road	m	304	4,767,968	1,449,462,235	0	0					1,449,462,235	0	0	0	147,845,000
	4	Cargo Yard (140m x 211m)	LS	1	5,966,686,830	5,966,686,830	0	0					4,773,349,464	0	1,193,337,366	0	608,602,000
	5	Access Trestle	LS	1	2,425,959,279	2,425,959,279	4,664,562	4,664,562					1,698,171,495	3,265,194	727,787,784	1,399,369	710,172,000
	6	Pile Pier	m	164	8,875,222	1,455,536,329	42,452	6,962,067					1,018,875,430	4,873,447	436,660,899	2,088,620	839,101,000
	7	Buildings and Utilities	LS	1	820,144,043	820,144,043	0	0					328,057,617	0	492,086,426	0	83,654,000
	8	Equipment	LS	1	135,375,000	135,375,000	1,675,255	1,675,255					0	0	135,375,000	1,675,255	179,993,000
		Yearly construction expenses (A)				13,165,687,568		13,301,884					10,180,440,094	8,138,641	2,985,247,474	5,163,243	2,662,443,000
B		**Price escalation**	%	-									1,571,052,122	321,551	629,536,035	273,770	283,515,000
C		**Physical contingency (5%)**	%	5									587,574,611	423,010	180,739,175	271,851	147,298,000
D		**Consulting Service**	%	8							645,383,580	583,683	387,230,148	350,210	258,153,432	233,473	247,460,000
E		**Administration Cost**	%	0.5									104,818,835		46,691,293		15,454,000
F		**Commercial Tax**	%	5									0	406,932	0	258,162	65,977,000
		GRAND TOTAL											12,831,115,810	9,640,343	4,100,367,410	6,200,499	3,422,147,000

Source: Study Team

2) Floating Type Jetty

The estimated total project cost is Kyat 16,823,085,543 for the local portion, and USD 27,426,683 for the foreign portion and the total amount is equivalent to JPY 4,436,677,000.

The project cost, breakdown of construction cost and annual cost are summarized below.

Table 5.60 Summary of Project Cost (Floating jetty)

ID.	Item No.	Work Description	Unit	Quantity	Local Portion (Kyat)		Forein Portion (USD)		TOTAL in JPY	Remarks
					Unit Rate	Amount	Unit Rate	Amount		
A		*Construction Expenses*								
	1	Preparation, Temporary Yard, Vessels	LS	1	243,616,275	243,616,275	0	0	24,848,000	
	2	Reclamation	m3	96,653	6,921	668,907,577	0	0	68,228,000	
	3	Access Road	m	304	4,767,968	1,449,462,235	0	0	147,845,000	
	4	Cargo Yard (140m x 211m)	LS	1	5,966,686,830	5,966,686,830	0	0	608,602,000	
	5	Access Trestle	LS	1	2,132,478,718	2,132,478,718	3,968,966	3,968,966	611,234,000	
	6	Floating pontoon	no	2	306,235,834	612,471,668	7,770,522	15,541,045	1,604,143,000	
	7	Approach Bridge	no	4	128,265,028	513,060,111 0	255,502	1,022,006	153,715,000	
	8	Buildings and Utilities	LS	1	820,144,043	820,144,043	0	0	83,654,000	
	9	Equipment	LS	1	135,375,000	135,375,000	1,675,255	1,675,255	179,993,000	
		Total construction expenses (A)				12,542,202,457		22,207,272	3,482,262,000	
B		**Price escalation**	%	-		2,129,976,909		999,359	316,394,000	Local: 4.9%, Foreign: 1.3%
C		**Physical contingency (5%)**	%	5		733,608,968		1,160,332	189,933,000	
		Sub total (A+B+C)				15,405,788,334		24,366,963	3,988,589,000	3,988,589,000
D		**Consulting Service**	%	8		1,232,463,067		1,949,357	319,087,000	
E		**Administration Cost**	%	0.5		184,834,142			18,853,000	
F		**Commercial Tax**	%	5				1,110,364	110,148,000	
		GRAND TOTAL				16,823,085,543		27,426,683	4,436,677,000	

Source: Study Team

Table 5.61 The Breakdown of the Project Cost (Floating pontoon jetty)

No.	Description	Unit	Q'ty	Local Portion (Kyat)		Forein Portion (USD)		Remarks
				Unit Rate	Amount	Unit Rate	Amount	
1	**Preparation works**	LS	1					
1.1	Preparatin works	LS	1	36,888,075	36,888,075	0	0	
1.2	Working vessels	LS	1	206,728,200	206,728,200	0	0	
	Summ				243,616,275		0	
2	**Reclamation**	m3	96,653					
2.1	Cargo yard	m3	82,200	6,921	568,882,526	0	0	
2.2	Access road	m3	14,453	6,921	100,025,051	0	0	
	Summ				668,907,577		0	
3	**Access Road (L=304m)**	m	304					
3.1	Stone Works							
a	Quarry run	m3	13,304	57,510	765,113,339	0	0	material and work
b	Bamboo mat placing	m2	2,552	7,610	19,421,741	0	0	material and work
c	Armour stone placing & leveling	m3	6,406	65,495	419,559,689	0	0	material and work
3.2	Concrete Pavement	m2	3,040	80,713	245,367,466	0	0	incl. subgrade, curb, drain
	Summ				1,449,462,235		0	
4	**Cargo Yard (Area=29,540m2)**							
4.1	Stone Revetment							
a	Quarry run	m3	54,000	57,510	3,105,541,215	0	0	
b	Bamboo mat	m2	5,911	7,610	44,985,074	0	0	
c	Armour stone	m3	16,000	62,651	1,002,415,100	0	0	
d	Concrete Pavement	m2	26,384	42,767.13	1,128,368,088	0	0	
4.3	Soil filling	m3	54,800	12,507	685,377,353	0	0	1m thickness x 2 layers
	Summ				5,966,686,830		0	
5	**Access Trestle**							
5.1	Piling works							
a	Transporting piles	no	215	737,961	158,661,615	0	0	
b	Mobilization/Demobilization	LS	1	0	0	408,240	408,240	
c	Pile driving	no	215	0	0	16,562	3,560,726	include material
5.2	Structure works							
a	Staging	m2	4,140	53,761	222,570,225	0	0	
b	Formwork	m2	7,438	44,278	329,353,341	0	0	
c	Rebar works	ton	319	925,949	295,173,958	0	0	
d	Concreting	m3	3,188	140,049	446,448,202	0	0	
5.3	Causeway							
a	Quarry run	m3	5,000	57,510	287,550,113	0	0	material and work
b	Sand fill	m3	4,000	6,921	27,682,848	0	0	material and work
c	Armour stone placing and leveling	m2	5,000	65,495	327,474,000	0	0	material and work
d	Concrete pavement	m2	900	41,738	37,564,415	0	0	including subgrade
	Summ				2,132,478,718		3,968,966	
6	**Floating pontoon**							
6.1	Fabrication							
a	Fabrication	no	2	30,558,403	61,116,807	5,999,344	11,998,688	local portion is connecting bridge
b	Transportation (Japan-Yangon)	no	2	0	0	1,417,894	2,835,787	
6.2	Piling							
a	Transporting piles	no	12	737,961	8,855,532	0	0	Steel pipe piles
b	Supporting Pile driving	no	12	0	0	58,881	706,570	
c	Frame work	LS	2	157,904,601	184,089,527	0	0	
d	Protection pile	no	34	9,288,506	315,809,202	0	0	RC square piles
6.3	Installation							
a	Transportation (Yangon-Mandalay)	no	2	16,918,524	33,837,048	0	0	
b	Installation	LS	2	4,381,776	8,763,552	0	0	
	Summ				612,471,668		15,541,045	
7	**Approach bridge**							
7.1	Fabrication							
a	Fabrication	no	4	122,524,909	490,099,635	241,094	964,374	
b	Transportation (Japan-Yangon)	no	4	0	0	14,408	57,632	
7.2	Installation							
a	Transportation (Yangon-Mandalay)	no	4	4,229,631	16,918,524	0	0	
b	Installation	no	4	1,510,488	6,041,952	0	0	
	Summ				513,060,111		1,022,006	
8	**Buildings**							
8.1	Office buildings	m2	200	367,000	73,400,040	0	0	
8.2	Warehouses	m2	1,128	367,000	413,976,226	0	0	
8.3	Workshop	m2	360	275,250	99,090,054	0	0	
8.4	Gate	no	1	7,645,838	7,645,838	0	0	
8.5	Utilities							
a	water pipe	LS	1	47,697,983	47,697,983	0	0	
b	electricity	LS	1	39,258,323	39,258,323	0	0	
c	lighting	LS	1	81,547,200	81,547,200	0	0	
d	Drainage	LS	1	57,528,380	57,528,380	0	0	
	Summ				820,144,043		0	
9	**Equipment**							
9.1	Equipment							
a	Truck crane (100ton)	no	0	0	0	1,004,000	0	CIF Yangon
b	Truck crane (50ton)	no	2	0	0	519,788	1,039,577	CIF Yangon
c	Forklift (3ton)	no	3	0	0	38,989	116,966	CIF Yangon
d	Prime mover with 20 feet chassis	no	1	0	0	179,325	179,325	CIF Mandalay
e	10 ton truck	no	3	0	0	98,396	295,188	CIF Mandalay
f	Generator (100KVA)	no	1	0	0	44,200	44,200	CIF Mandalay
g	Pallet	no	5,500	21,450	117,975,000	0	0	
9.2	Transportation							
a	Transportation of equipments	LS	1	17,400,000	17,400,000	0	0	Yangon to Mandalay
	Summ				135,375,000		1,675,255	
	GRAND TOTAL				12,542,202,457		22,207,272	

* Unit rate is inclusive of general expenses

Source: Study Team

Table 5.62 Yearly Project Cost (Floating pontoon jetty)

ID.	Item No.	Work Description	Unit	Quantity	Base year in 2013				2014		2015		2016		2017		TOTAL in JPY
					Unit Rate (Kyat)	Amount (Kyat)	Unit Rate (USD)	Amount (USD)	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	
A		*Construction Expenses*															
	1	Mobilization and preparation	LS	1	243,616,275	243,616,275	0	0					243,616,275	0	0	0	24,848,000
	2	Reclamation	m3	96,653	6,921	668,907,577	0	0					668,907,577	0	0	0	68,228,000
	3	Access Road	m	304	4,767,968	1,449,462,235	0	0					1,449,462,235	0	0	0	147,845,000
	4	Cargo Yard (140m x 211m)	LS	1	5,966,686,830	5,966,686,830	0	0					4,773,349,464	0	1,193,337,366	0	608,602,000
	5	Access Trestle	LS	1	2,132,478,718	2,132,478,718	3,968,966	3,968,966					852,991,487	1,587,586	1,279,487,231	2,381,380	611,234,000
	6	Floating pontoon	no	2	306,235,834	612,471,668	7,770,522	15,541,045					428,730,168	10,878,731	183,741,500	4,662,313	1,604,143,000
	7	Approach Bridge	no	4	128,265,028	513,060,111	255,502	1,022,006					359,142,078	715,404	153,918,033	306,602	153,715,000
	8	Buildings and Utilities	LS	1	820,144,043	820,144,043	0	0					328,057,617	0	492,086,426	0	83,654,000
	9	Equipment	LS	1	135,375,000	135,375,000	1,675,255	1,675,255					0	0	135,375,000	1,675,255	179,993,000
		Yearly construction expenses (A)				12,542,202,457		22,207,272					9,104,256,901	13,181,722	3,437,945,556	9,025,550	3,482,262,000
B		**Price escalation**	%	-									1,404,974,834	520,799	725,002,075	478,560	316,394,000
C		**Physical contingency (5%)**	%	5									525,461,587	685,126	208,147,382	475,205	189,933,000
D		**Consulting Service**		8							616,231,533	974,679	369,738,920	584,807	246,492,613	389,871	319,087,000
E		**Administration Cost**	%	0.5									125,018,301		61,004,258		18,974,000
F		**Commercial Tax**	%	5										659,086		451,277	110,148,000
		GRAND TOTAL											11,529,450,542	15,631,541	4,678,591,885	10,820,464	4,436,798,000

Source: Study Team

5.11 Economic and Financial Analysis

5.11.1 Introduction

Feasibility of the "New Mandalay Port Development Project" is analysed from financial viability and contribution to the national economy. Internal Rate of Return of Finance (FIRR) and Internal Rate of Return of Economy (EIRR) calculated from annual cash flow are employed as evaluation indicators in this section.

(1) Pre-Conditions

The following pre-conditions are utilised for financial and economic analysis:

1) "With-project" Case and "without-project" Case

Developing the new Mandalay Port is defined as the "with-project" case and not developing the new Mandalay Port is defined as "without-project," respectively. In the "with-project" case, the Phase 1 part of handling cargo at the new port of which the volume is illustrated in Figure 5.115 out of the whole potential cargo demand will be shifted from the riverbank to the new port. On the other hand, the same volume of cargo is going to be handled on the riverbank in the "without-project" case. As a result, road transportation will be more attractive for shippers, in terms of cost and time, and the potential demand on the new port will be shifted to road transport.

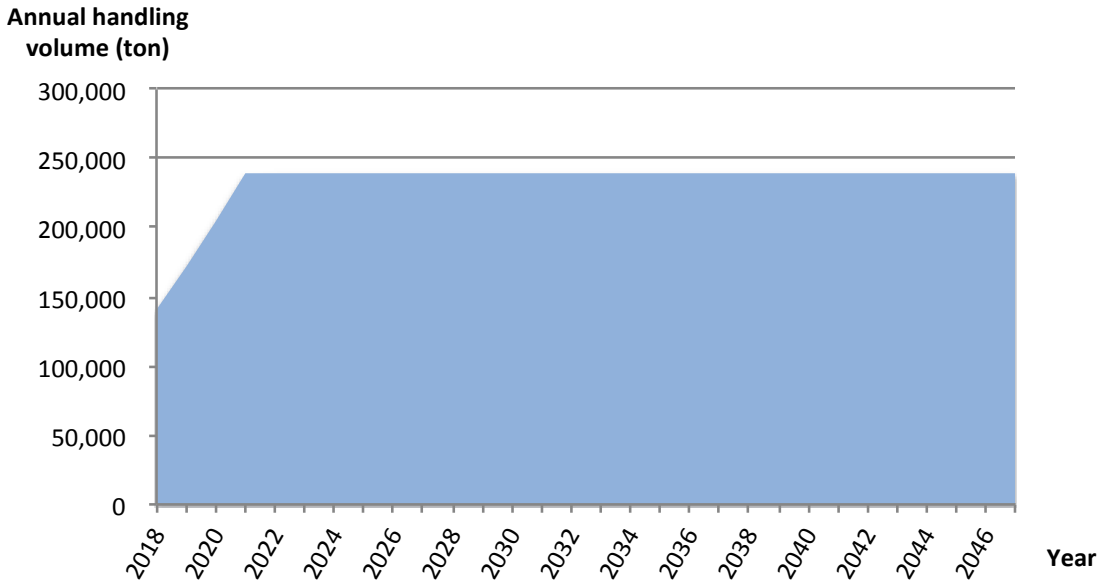


Figure 5.115 Annual Handling Volume at New Mandalay Port

2) Calculation of Revenue and Maintenance Cost

Revenue and maintenance costs which are generated from handling the cargo volume in Figure 5.115 is calculated annually.

3) Project Implementation Schedule

Engineering service will be commenced in January 2014. A selected consultant team will conduct the basic design and detailed design of the new port and prepare bidding documents in the first 12 months, and the selection of a contractor will be processed in the following 12 months.

Construction work will start in January 2016, and the construction of the port facilities and procurement

of loading and unloading machines will be completed within 24 months. Operation of the new port will be started in January 2018.

4) Project Life

Economic and financial analysis will be conducted from 2014, the timing of starting the engineering service, to 2047, the 30th year of the port operation.

As described in the next section, the lifetime of civil works is set at 50 years. Therefore, residual value of the civil works which will account for 40% of the civil works cost is listed in the cash flow table in 2047, the final year of the project.

5) Replacement Investment

Major components of the port facilities are set as below:

- Civil works (access road, yard, bridge, etc.): 50 years,
- Buildings (warehouse, office building and passenger terminal): 30 years,
- Loading and unloading machines (cranes, forklifts, trucks, a trailer and generators): 10 years

Loading and unloading machines will be replaced in the 10th and 20th years when their lifetimes end.

6) Price and Exchange Rate

The price level as of September 2013 is employed in this economic and financial analysis, and the exchange rate is set as 1 US Dollar = 99.2 Japanese Yen = 970.9 Myanmar Kyat.

5.11.2 Financial analysis

(1) Investment Cost

The costs for the construction of port facilities and procurement of loading and unloading machines are indicated in the section 4.10. However, price escalation is not considered in the economic and financial analysis. As a result, annual costs for the construction and procurement are tabulated as Table 5.63. On the other hand, administration costs which are set as 0.5% of the construction and procurement cost is included in the investment cost.

Table 5.63 Investment Cost of the Mandalay New Port (Phase 1)

Unit: million Kyat

	2014	2015	2016	2017	Total	Remarks
Administration	33	33	33	33	130	0.5% of construction and procurement
Consultant service	1,577	218	315	315	2,426	8% construction and procurement
Construction and procurement	–	–	19,381	8,649	28,030	Including contingency and taxes
Total of investment	1,610	251	19,729	8,997	30,587	

Source: JICA Study Team

(2) Operation and Maintenance Cost

Items of operation and maintenance cost and these conditions are identified as below:

1) Maintenance Cost

Annual small-scale repairs of the port facilities, such as repair and re-pavement of access roads and painting work, are major items of maintenance costs. The maintenance cost is set as 2% of the pavement costs of access roads until the 10th year of the operation, and 10% of that after 11th year of the operation, respectively.

2) Operation Cost of Loading and Loading Machines

The operation cost of loading and unloading machines (a 100-ton crawler crane, 50-ton crawler cranes, forklifts, trucks, a trailer and generators) is set as Table 5.64.

Table 5.64 Operation Cost of Loading and Unloading Machines

Machines	Fuel consumption per hour (litre)	Cost per hour (Kyat)	Number of machines
100-ton crawler crane	17.0	16,150	1
50-ton crawler crane	11.0	10,450	2
Forklift	1.4	1,330	5
Truck (11-ton)	7.6	7,220	5
Trailer (20-feet)	14.1	13,195	1
Generator (backup for power -down)	16.0	15,200	2

Note: One litre of diesel oil costs 950Kyat; one generator is a back-up for the other one.

Source: JICA Study Team

3) Personnel Cost for Port Administration and Stevedores

As described in the section 4.12, the port administration organization consists of six departments. Each department consists of five staff members and one manager, and a Chief Executive Officer (CEO) manages the whole organization. Therefore, the total administration members account for 37 officials.

The stevedores consist of one foreman and 25 workers for one gang (manual labour), one operator, one foreman and 10 workers for one gang (machine handling). Four manual gangs (two gangs and two shifts) and four machine gangs (two gangs and two shifts) are necessary to form a minimum rotation, and one gang is reserved for holidays.

Table 5.65 Personnel Costs for Port Administration and Stevedores

	Position	Number	Salary per month (Kyat)
Port administration	Chief Executive Officer	1	210,000
	Managers	6	180,000
	Staff	30	90,000
Stevedores	Crane operators and foremen	15	90,000
	Workers	175	60,000

Source: JICA Study Team

4) Operation and Maintenance Cost

Annual disbursement of the total operation and maintenance cost is indicated in Table 5.66.

Table 5.66 Operation and Maintenance Cost

Unit: million Kyat

Period	Maintenance	Operation of loading and unloading machines	Port administration	Stevedores	Total
2018	1.3	488.8	47.9	142.2	680.2
2019	1.3	488.8	47.9	142.2	680.2
2020	1.3	578.7	47.9	142.2	770.1
2021	1.3	578.7	47.9	142.2	770.1
From 2022 to 2027	1.3	489.9	47.9	142.2	681.3
After 2028	6.5	489.9	47.9	142.2	686.5

Source: JICA Study Team

(3) Project Revenue

1) Existing Tariff Structure

The Myanmar Port Authority (MPA), which manages Yangon Port, sets Port Dues, Berthing Charges, Wharfage Charges and Conservancy Charges as Table 5.67. If these tariff systems are applied to a passenger cum cargo vessel, of which the total length is 50 meters long, 600 GRT and cargo capacity of 200 tons, each charge is calculated as in Table 5.68.

Table 5.67 MPA's Charges

Tariff items	Domestic vessels	Ocean liners
Port Dues	2 Kyat/cargo volume tons/half year	25 US dollars/100 GRT/ month
Berthing Charge (per 24 hours)	500 Kyat/ship length 25 feet (7.6 metres)	125 US dollars (400 GRT -800 GRT)
Wharfage Charge (per anchoring)	20 Kyat/ton	
Conservancy Charge (per anchoring)	25 Kyat/ton	

Source: MPA

Table 5.68 Examples of MPA's Charges Payment

Tariff items	Domestic vessels	Ocean liners
Port dues	800 Kyat	1,748,000 Kyat
Berthing charge (per 24 hours)	3,300 Kyat	121,000 Kyat
Wharfage charge (per anchoring)	19,500 Kyat	
Conservancy charge (per anchoring)	24,300 Kyat	

Note: Case of 50 metres length, 600 GRT 200 ton of cargo capacity with exchange rate of 1 US dollar = 970.9 Myanmar Kyat

Source: MPA

The price level of MPA's Port Dues and Berthing Charges are very different between domestic vessels and ocean liners. According to MPA officials, all of the profit at Yangon Port is generated from charges for ocean liners, and a part of that profit is used for subsidizing port operation for domestic vessels.

Table 5.69 Charges of Loading/unloading and Warehouse at Yangon Port

Tariff items	Domestic vessels	Ocean liners
Stevedoring charge (transporting rice, beans, cement per ton)	–	19,500 Kyat
Stevedoring charge (general cargo other than above per ton)	–	24,000 Kyat
Crane rental charge (more than 10 ton per hour)	48,500 Kyat	
Forklift rental charge (4 ton per hour)	4,900 Kyat	
Warehouse rental charge (per m^2 per day)	168 Kyat	

Source: MPA

Cargo handling charges are set only for ocean liners at Yangon Port because stevedores for domestic vessels are day labourers dispatched from the Ministry of Labour. Shippers negotiate with the labourers directly to handle cargoes, and pay money immediately. The cost is 100 Kyat per 50kg rice bag when the JICA Study Team member had an interview survey at the Lanthit Jetty of Yangon Port. As indicated in Table 5.70, the price level is almost the same as on the Mandalay riverbank. Stevedoring charges are also very different between domestic vessels and ocean liners.

Table 5.70 Payment for Cargo Handling at Mandalay Riverbank

Tariff items	Price	Remarks
Stevedoring Charge (general cargos per ton)	4,000 Kyat	Rice, salt, cement, etc.
Berthing Charge (per anchoring)	7,000 Kyat	50–60 feet ships (15–18 metres)
	9,000 Kyat	80–90 feet ships (24–27 metres)
	12,000 Kyat	120-150 feet ships (37–46 metres)

Source: JICA Study member's interview at Mandalay

2) Setting Tariff Levels for Operation of the New Mandalay Port

It is necessary to introduce a new tariff system which will enable operation of the new port without trouble and to recover the initial investment as much as possible. One of the referable tariff systems is MPA's tariff for domestic vessels, however, it is difficult to introduce the system as it is because its price level is too low. As mentioned in the previous section, almost all of the profit of Yangon Port comes from tariffs for ocean liners, and MPA keeps the tariff system for domestic vessels lower. In addition to that, it would be difficult for a port operator to promote private vessels' shift from manual cargo handling at the riverbank to machine handling at the new Mandalay Port if it sets a higher price level than the current level.

Reflecting these conditions, the JICA Study Team set the new tariff system at the new Mandalay Port as indicated in Table 5.71. Tarrifs on domestic vessels are half that of the ocean liners regarding port dues and berthing charges, referring to examples in Indonesia and the Philippines. Manual labour charges (payment for stevedores) are the same as the on-going manual labour charges at the Mandalay riverbank. Machine handling charges in Mandalay are also the same as the current price level at Yangon Port.

Table 5.71 Tariff System at New Mandalay Port

Tariff items	Price	Remarks
Port dues	12,100 Kyat/ 100GRT/ month	50% of ocean liners
Berthing charge (per 24 hours)	60,700 Kyat (400–800 GRT)	50% of ocean liners
Wharfage charge (per anchoring)	20 Kyat/ton	Same as MPA
Conservancy charge (per anchoring)	25 Kyat/ton	Same as MPA
Stevedoring charge	4,000 Kyat/ton	Same as manual handling
Crane rental charge (100 ton and 50 ton per hour)	48,500 Kyat	Same as MPA
Forklift rental charge (4 ton per hour)	4,900 Kyat	Same as MPA
Warehouse rental charge (per m^2 per day)	168 Kyat	Same as MPA

Source: JICA Study Team

Table 5.72 indicates the project revenue of the new port when the tariff system of Table 5.71 is introduced. In accordance with an increase of cargo handling volume from 140,770 tons in 2018 to 240,000 tons in 2022, each tariff will also increase. Project revenue will account for 826 million Kyat in 2018 and 1,035 million Kyat in 2022, respectively. After 2022, the cargo-handling volume will stay at 240,000 tons annually, and the total project revenue will also continue to be 1,035 million Kyat.

If 240,000 tons of cargo is handled by manual labour, the total cost will be 960 million Kyat. The sum of port dues, berthing charges, cargo handling charges and warehouse rental charges, which are borne by shippers and ship owners, will be 1,035 million Kyat, which is almost same level. On the other hand, the efficiency of cargo handling will be improved by 3.4 times in terms of time. It would be an attractive service for private vessels.

Table 5.72 Project Revenue of New Mandalay Port

Unit: million Kyat

Period	Cargo handling volume (ton)	No of vessels		Port Dues	Berthing Charge	Wharfage, Conservancy	Loading/ unloading	Warehouse	Total
		Passenger cum cargo	Cargo						
2018	140,770	389	454	54	37	6	671	58	826
2019	172,303	476	555	66	46	8	703	70	893
2020	205,040	567	661	78	54	9	736	84	961
2021	239,019	660	770	91	63	11	770	98	1,033
After 2022	240,000	663	773	92	64	11	771	98	1,035

Source: JICA Study Team

(4) Calculation of Financial Internal Rate of Return

Table 5.73 indicates the annual cash flow from 2018 to 2047. Figures from the 2nd column to the 5th column of the table are cost items and figures in the 7th column, which are calculated from project revenues minus the cost items, are the annual net cash flow.

Table 5.73 Cash flow of New Port Development Project (Financial Analysis)

Unit: million Kyat

Year	Administration cost	Consultant cost	Construction and procurement	Operation and maintenance	Project revenue	Net cash flow
2014	33	1,577				-1,610
2015	33	218				-251
2016	33	315	19,381			-19,729
2017	33	315	8,649			-8,997
2018				680	826	146
2019				680	893	212
2020				770	961	191
2021				770	1,033	263
2022				681	1,035	354
2023				681	1,035	354
2024				681	1,035	354
2025				681	1,035	354
2026				681	1,035	354
2027			1,850	681	1,035	-1,496
2028				686	1,035	348
2029				686	1,035	348
2030				686	1,035	348
2031				686	1,035	348
2032				686	1,035	348
2033				686	1,035	348
2034				686	1,035	348
2035				686	1,035	348
2036				686	1,035	348
2037			1,850	686	1,035	-1,501
2038				686	1,035	348
2039				686	1,035	348
2040				686	1,035	348
2041				686	1,035	348
2042				686	1,035	348
2043				686	1,035	348
2044				686	1,035	348
2045				686	1,035	348
2046				686	1,035	348
2047			-6,317	686	1,035	6,665
						-3.4%

Source: JICA Study Team

Financial Internal Rate of Return (FIRR) which is calculated from the annual net cash flow is minus 3.4%. The result means that the project can generate annual profit annually except for the years of the initial investment and renewal investment, but the annual profits cannot recover the sum of the initial investment and renewal investment. On the other hand, the annual profits can cover the sum of the renewal investment in 2027 and 2037.

Table 5.74 shows major interests rates in Myanmar to consider a discount rate. If a soft loan is used for the project, a 0.01% discount rate is appropriate, and if a domestic financial resource is used for the project, a 10% discount rate is appropriate, respectively.

Table 5.74 Major Interest Rates in Myanmar

Kind of interest	Level of interest rate	Timing and source
Central Bank Rate	10%	As of November 2013 Central Bank of Myanmar Web site
Maximum Bank Lending Rate	13%	As of November 2013 Central Bank of Myanmar Web site
Government Treasury Bonds (5 years)	9.5%	As of November 2013 Central Bank of Myanmar Web site
JICA ODA Loan	0.01%	Effective from October 2013 JICA Web site
Inflation rate	2.8%	Average of 2012/13 (estimation) IMF Article IV Consultation Report

(5) Sensitivity Analysis

Table 5.75 indicates the results of sensitivity analysis. Figures in the 2nd column are FIRR under different changes of conditions. Increase in construction and procurement costs do not change FIRR so much but increases of operation and maintenance costs and the reduction of project revenue makes a significant impact on FIRR.

Table 5.75 Result of Sensitivity Analysis

Unit: %

Cases	FIRR
Base case	-3.4
10% increase of construction and procurement cost	-3.6
10% increase of operation and maintenance cost	-3.9
10% reduction of project revenue	-4.1

Source: JICA Study Team

Table 5.76 tabulates the necessary increase of the project revenue under which the project is financially feasible under the current levels of investment costs and operation and maintenance costs. If the project revenue is increased by 1.60 times, the project would be financially feasible under the employment of a soft loan (JICA ODA loan), and if the project revenue is increased by 4.30 times, the project would be financially feasible under the employment of a domestic financial resource, respectively.

Table 5.76 Increase of Project Revenue

Unit: %

Cases	Increase of project revenue
Soft loan (0.01%)	160%
Domestic financial resource (10%)	430%

Source: JICA Study Team

As for the reduction of the investment costs under constant operation and maintenance costs and project revenue, the project with an employment of a soft loan is financially feasible if the burden of the investment cost is limited to 19% of the total cost.

(6) Introduction of a Floating Pontoon

The JICA Study Team intends to install a pile pier for the new Mandalay Port in the financial analysis so far. In this section, the financial feasibility of the port if a floating pontoon is installed instead of the pile pier is calculated. If the floating pontoon is installed, it is possible to conduct manual labour safely and more smoothly at the Mandalay Port which has 8 meters of water level difference during the rainy season and dry season.

On the other hand, installing the floating pontoon would increase the investment cost because the floating pontoon could not be produced in Myanmar at this time. Table 5.77 shows the investment cost of the new Mandalay Port if the floating pontoon should be installed. The investment cost amounts to 40 billion Kyat, more expensive than the case of a pile pier by 9.6 billion Kyat.

Table 5.77 Investment Cost of the Mandalay New Port
(Case of Introducing Floating Pontoon, Phase 1)

Unit: million Kyat

	2014	2015	2016	2017	Total	Remarks
Administration	43	43	43	43	171	2% of construction and procurement
Consultant service	2,033	282	407	407	3,128	8% construction and procurement
Construction and procurement	–	–	23,637	13,249	36,886	Including contingency and taxes
Total of investment	2,076	324	24,087	13,698	40,185	

Source: JICA Study Team

FIRR will drop to minus 4.5% if the pile pier is replaced by a floating pontoon, and the port operator receives the same amount of revenue and disburses the same amount of operation and maintenance costs.

5.11.3 Economic Analysis

(1) Calculation of Economic Benefit

As defined in the section 5.11.1(1), potential demand for the new Mandalay Port (indicated by Figure 5.115) would shift to road transportation in the case of “without-project”. The difference of the transportation cost of the volume between trucks and river ships is treated as an economic benefit in this economic analysis.

Destinations and origins of cargo and those cargo volumes are analysed from the demand forecast model employed in the master plan study of this survey program. Table 5.78 indicates the proportion of import and export to and from the Mandalay Region and the distance from the city of Mandalay. The table shows that 53% of the cargo is transported from the Mandalay Region to the Yangon Region or transported from the Yangon Region to the Mandalay Region.

Table 5.78 Proportion of Import/export and Distance from Mandalay

Regions and States	Proportion of import/ export	Distance from Mandalay (km)
Mon	0	662
Ayeyarwady	1	778
Bago	3	485
Kachin	8	417
Kayah	0	682
Kayin	0	432
Magway	4	281
Mandalay	4	146
Nay Pyi Taw	1	239
Rakhine	0	646
Sagain	12	435
Shan	15	514
Thaninthary	0	1,293
Yangon	53	605

Source: JICA Study Team

The average cost of truck transport (17-ton truck) between Yangon and Mandalay is 36,000 Kyat per ton, and the cost for unloading one ton of cargo amounts to 4,000 Kyat. On the other hand, the average cost of a river ship connecting at the same place is 15,000 Kyat considering the differences between the upstream and downstream of the Ayeyarwady River, and between the dry season and rainy season. Table 5.79 indicates the differences of cost between truck transport and river ship transport when handling cargo at the new Mandalay Port is exported to destinations and imported from origins by tucks or river ship. The difference accounts for 3.4 billion Kyat in 2018 and 5.7 billion Kyat in 2022, respectively. The level will be kept during 2023 and 2047.

Table 5.79 Difference of Cost between Truck Transport and River Transport

Unit: million Kyat

Year	Cost of truck transport	Cost of river transport	Difference of cost
2018	1,581	4,942	3,361
2019	1,936	6,049	4,114
2020	2,303	7,199	4,895
2021	2,685	8,392	5,707
After 2022	2,696	8,426	5,730

Source: JICA Study Team

(2) Calculation of Economic Cost

Costs of construction, procurement and consultant service which is presented in section 4.10 are employed as the same as the analysis in the section 5.11.2, however, price escalation and contingency are not included in the investment cost in the Economic Analysis. In addition, the economic price which is calculated from construction and procurement costs divided by standard conversion factor (SCF) is calculated in order to correct the distortion between the domestic price (price for non-tradable goods) and the international price (price for tradable goods). 0.88 of SCF which is employed in "*Feasibility Study on the Yangon – Mandalay Rail Improvement Project*" is used in this analysis[1]. Table 5.80 indicates the annual disbursement of the investment cost (economic price basis). Administration costs which is 0.5% of construction and procurement cost are listed in the table as well as the analysis from section 5.11.2.

[1] Owing to lack of data to calculate SCF in Myanmar, the figure is introduced from the surrounding countries in recent years. Examples of SCF in the surrounding countries are 0.88 in India, 0.86 in Cambodia and 0.87 in Vietnam.

Table 5.80 Investment Cost of New Mandalay Port Project (Economic Price)

Unit: million Kyat

	2014	2015	2016	2017	合計	Remarks
Administration	31	31	31	31	123	0.5% of construction and procurement
Consultant service	1,475	204	295	295	2,269	8% of construction and procurement
Construction and procurement	–	–	16,861	7,640	24,501	Not including price escalation, taxes and contingency
Total of investment	1,506	235	17,186	7,966	26,892	

Source: JICA Study team

Regarding the operation and maintenance costs of the port facilities, the cost introduced in the financial analysis is employed as it is.

(3) Calculation of Economic Internal Rate of Return

Table 5.81 tabulates the annual cash flow of the new Mandalay Port Development Project with economic price basis. Figures from the 2nd column to the 5th column of the table are cost items and figures in the 7th column which are calculated from economic benefit minus the cost items are the annual net cash flow.

Table 5.81 Cash flow of New Port Development Project (Economic Analysis)

Unit: million Kyat

Year	Administration cost	Consultant cost	Construction and procurement	Operation and maintenance	Project revenue	Net cash flow
2014	31	1,475				-1,506
2015	31	204				-235
2016	31	295	16,861			-17,186
2017	31	295	7,640			-7,966
2018				500	3,361	2,861
2019				500	4,114	3,614
2020				551	4,895	4,345
2021				551	5,707	5,156
2022				606	5,730	5,124
2023				606	5,730	5,124
2024				606	5,730	5,124
2025				606	5,730	5,124
2026				606	5,730	5,124
2027			1,746	606	5,730	3,379
2028				610	5,730	5,120
2029				611	5,730	5,119
2030				611	5,730	5,119
2031				611	5,730	5,119
2032				611	5,730	5,119
2033				611	5,730	5,119
2034				611	5,730	5,119
2035				611	5,730	5,119
2036				611	5,730	5,119
2037			1,746	611	5,730	3,373
2038				611	5,730	5,119
2039				611	5,730	5,119
2040				611	5,730	5,119
2041				611	5,730	5,119
2042				611	5,730	5,119
2043				611	5,730	5,119
2044				611	5,730	5,119
2045				611	5,730	5,119

Year	Administration cost	Consultant cost	Construction and procurement	Operation and maintenance	Project revenue	Net cash flow
2046				611	5,730	5,119
2047			-5,511	611	5,730	10,630
						14.7%

Source: JICA Study Team

Economic Internal Rate of Return which is calculated from net cash flow is 14.7%. The level exceeds 12%, which is recognized as the social discount rate, an indicator of economic analysis. The level is normally utilized in infrastructure development projects in developing countries. Therefore, the project is feasible from the point of the national economy.

(4) Sensitivity Analysis

Table 5.82 compiles the result of the sensitivity analysis. Figures in the 2nd column are EIRR under different changes of conditions. Increases in the construction and procurement costs and the drop of economic benefit drop EIRR by more than 1% point, however, EIRR is still more than 12%. Impact of the changes in operation and maintenance costs on EIRR is limited.

Table 5.82 Result of Sensitivity Analysis

Unit: %

Cases	EIRR
Base case	14.7
10% increase of construction and procurement cost	13.5
10% increase of operation and maintenance cost	14.5
10% reduction of project revenue	13.2

Source: JICA Study Team

(5) Introduction of Floating Pontoon

The economic analysis of the new Mandalay Port with a floating pontoon is calculated as well as the Financial Analysis. Table 5.83 indicates the investment cost of the new Mandalay Port with a floating pontoon in economic price. The amount is 36 billion Kyat, which is more expensive than the case of a pile pier by 9.4 billion Kyat.

Table 5.83 Investment Cost of the Mandalay New Port (Case of Introducing Floating Pontoon, Economic Price)

Unit: million Kyat

	2014	2015	2016	2017	合計	Remarks
Administration	41	41	41	41	163	0.5% of construction and procurement
Consultant service	2,302	319	460	460	3,542	8%
Construction and procurement	–	–	20,810	11,788	32,598	Not including price escalation, taxes and contingency
Total of investment	2,343	359	21,311	12,289	36,303	

Source: JICA Study Team

EIRR will drop to 11.1% if the pile pier is replaced by a floating pontoon, and the project will generate the same amount of economic benefits and disburse the same amount of operation and maintenance costs. The result is little lower than social discount rate (12%).

5.11.4 Conclusion

The new Mandalay Port Development Project is feasible from the point of contribution to the national economy but is not feasible from the point of a financial aspect. EIRR of the project is 14.7%, above 12% which is a benchmark to conclude that the project has value in terms of promoting national economic development. On the other hand, FIRR of the project is minus 3.4%. The project generates an annual profit after starting operation, and the sum of the profit can cover only the renewal of the investment in 2027 and 2037. However, the annual profit cannot cover the initial investment.

When project revenue increases by 1.60 times, FIRR exceeds 0.01% which is discount rate of a soft loan if the investment cost and operation and maintenance cost keep the current level. And if the burden of the investment costs by the project implementation body drops to 35%, FIRR will exceed 0.01% with the current level of operation and maintenance costs and project revenue. If such conditions are fulfilled, the project is financially feasible.

Financial and Economic Analysis in this Chapter are conducted under an assumption that a pile pier is installed at the Mandalay New Port. However, if a floating pontoon is installed, it will be possible to conduct manual labour safely and more smoothly at the Mandalay Port which has 8 meters of water level difference between the rainy season and dry season. The disadvantage of installing a floating pontoon is a hike of the investment cost. The investment costs would increase by 9.6 billion Kyat in both the financial and economic costs because a floating pontoon would be produced outside of Myanmar. As a result, FIRR will drop to minus 4.5%, and EIRR will decrease to 11.1%, respectively.

5.12 Port Management and Operation

In Myanmar, coastal ports are managed and operated by a government organization, Myanmar Port Authority (MPA). These coastal ports serve both domestic and international trade.

For river ports, including Mandalay Port, one of the duties of the DWIR (Directorate of Water Resources and Improvement of River Systems) is to "stabilize the inland river ports". But, there are no substantial port and harbor facilities, such as wharves or cargo handling equipment, in river ports. Cargo handling operation is carried out by private companies and IWT (Inland Water Transport), along the natural river shore, either directly or using old and time-worn vessels as pontoons. There seems to be no port management operations for river ports in Myanmar.

To implement a river port development project and to manage the facilities of the port, it is necessary to designate some organization (existing or to be newly set-up), which will carry out the management of the river port. That organization will be responsible for the management and operation of the port, i.e., maintaining port facilities in a good condition, management and maintenance of cargo-handling apparatus in the port, deciding port tariffs, collecting port charges, and data acquisition about throughput of the port. Actual cargo handling operation will be done by the above mentioned organization or by private operators.

At present, there are two government organizations under the Ministry of Transport which are related to inland water transport and river port management, i.e. DWIR and IWT.

Objectives of DWIR are as follows:

- To improve navigation channels and to stabilize the inland river ports.
- To protect the river bank from erosion.
- To cooperate with other organizations in demarcation of dangerous water levels.
- To utilize the river water for domestic use and agriculture all year round.
- To prevent bank erosion of border rivers.
- To observe the long term existence of cross river bridges by river engineering points of views.
- To manage the prevention of river water pollution.
- To achieve adequate depth for maximum loading capacity of vessels
- To carry out the transportation of passengers and freight along the navigable waterways in Myanmar.
- To operate ferry services for the convenience of passengers and vehicles.

On the other hand, the main function of the IWT is to provide river transport services in Myanmar, utilizing its facilities to optimize transport performance while meeting public requirements, as the state owned enterprise for transportation.

In considering river port management, there is not only one answer as to which organization should be responsible for its management and operation, and how to consider burden sharing among individual sectors, i.e. central government, local government, public sector, and private sector. (Ref-1, River port management in Western countries) The study team pointed out that it is up to the Myanmar government to decide which organization, existing or to be newly set-up, will be responsible for port management and operation, and how the burden should be shared among sectors, such as the central government, local governments, public sector and private sector.

(In considering the river port management system in Myanmar, the study team pointed out that it is necessary for Myanmar MOT (Ministry of Transport) to make discussions among those who are concerned, and to make a decision about which organization (existing or to be newly set-up) will be responsible for port management, and about sharing the burden among sectors, i.e. among central government and local government, among public sector and private sector.)

The Myanmar side, after discussions, decided that DWIR will be responsible for the implementation of

the construction work of the river port, and that IWT will be entrusted port facilities and will be responsible for management of the port.

There are many kinds of work to be done for management and operation of the port, i.e. maintenance of facilities, deciding port tariffs, collecting port charges, data acquisition of cargo and passenger throughput, actual cargo handling operations, etc. For actual cargo handling operations, some port management bodies, such as MPA, are doing cargo handling operations by their own staff. But, it is not recommended for IWT which has no staff at present for cargo handling operations to hire staff and start cargo handling operations. This is to avoid to make an organization too big and to avoid inefficiency of public sectors.

To let the private sector be responsible for cargo handling operations, there will be two alternatives to choose, i.e.

1 to decide a private company or a joint venture which will manage and operate a whole terminal with a contract period of some decades, through a bidding process

2 IWT will manage port facilities, and entrust cargo handling operation to some private company, on one ship by one ship basis.

Considering the facts that the expected cargo throughput of Mandalay port is only 240,000 tons, and that the expected shape of the cargo is not container, but bags or general cargo, the first alternative is considered not realistic. It will be more realistic to consider alternative two, at present.

In the future, it will be necessary for IWT to make amendments to the organization's rules to set up a division which will act as a port management body.

In Japanese Ports and Harbours Law, roles of a port management body are defined as shown in Ref-2. In setting up organization within the IWT, necessary projects for the management of river ports in Myanmar should be selected from the list.

5.12 Reference-1 River Port Management in Western countries
To consider the organization for the management of a river port system, it is useful to study examples of river port management systems in other countries. PIANC (the World Association for Waterborne Transport Infrastructure) made a comparative study on governance organization features of river ports in 2010.
The results of the study, which collected data from 12 ports, show that there is a great diversity in river port management in European and American ports.
The first aspect of the diversity is degree of intervention by port managing body.
○ General organizational function
○ + Management of land and infrastructures
○ + Management of superstructures
○ + Logistics operations
The second aspect is which organization controls the management body.
○ Central government
○ Regional state
○ Jointly controlled by Region/City or co-managed by local authorities
○ City

The third aspect is land and buildings (except on the water area) management.

○ Private property of port companies

○ Public property given over to a private manager

○ Public property given over to a public manager

○ Public property directly managed

The fourth aspect is which organization handles quays and landing piers.

○ Quays and landing piers are handled by a private industrial operator.

○ Quays and landing piers are handled by the management body.

The fifth aspect is which organization handles waterways

○ Waterways are handled by the management body.

○ Waterways are handled by a public operator like states, etc.

The sixth aspect is port superstructures and logistics.

○ Port superstructure and logistics are controlled by a managing body.

○ Port superstructure and logistics are controlled by logistics service operators.

○ Port superstructure and logistics are managed by industrial shippers at the port for their own use.

The study of PIANC shows that river port management systems are different from country to country. There is no one answer to the question, and should be decided by each individual country.

5-12 Reference-2 Roles of Port Management Body in Japanese Port and Harbour Law

In Japan, the roles of National Government, Port Management Bodies, and Private

Sectors are shared as the table below.

Table Role of National Government, Port Management Body, and Private Sector

		National Gov't	Port Man. Body	Private Sector
Long-term National Port and Harbour Policy		○		
Basic Policy on Port and Harbour Development and Use		○		
Port Planning		screening	○	
Construction of Port Facilities	Public	○	○	
	Private			○
Management			○	○
Operations				○

All of the ports and harbours (not only river ports) are managed by the public sector. Japan's port management bodies consist of proprietary-type organizations. In addition to constructing, maintaining, and managing port facilities (navigation channels, breakwaters, quay walls, cargo handling facilities and other functional facilities), port management bodies formulate policies for basic development plans in consideration of the development of the inland regions.

Port facilities (functional facilities) are leased to private sectors under the management of port management bodies. Actual operation (cargo handling, storage, land transport, etc.) is entrusted to private sectors, as stipulated by relevant laws and regulations.
Japanese ports and harbours law defines the business of a port managing body as listed below.
Article 12 (1) Functions of a port authority shall be as follows:
(i) port authority shall prepare the Port Plan.
(ii) to maintain the Port Area and Port Facilities under the management of the port authority in good operating condition (including the removal of floating materials, abandoned ships and other materials which may hinder the navigation of ships in the Port Area, cleaning water areas and preventing pollution within Port Area)
(iii) to execute the Port and Harbor works for the construction and improvement of Port Facilities (excluding waste disposal facilities) necessary for the development, utilization and preservation of the port and for preserving the area adjacent to the Port Area
(iii)-2 to create or improve land in the Port Area or Waterfront Area through reclamation of the water area, raising or leveling of ground or other works in addition to the works specified in the preceding item
(iv) to be entrust with the management of Port Facilities for public use (including the land necessary for the operation of the port) owned by the National Government or local governments
(iv)-2 to enforce the necessary regulations on the use of waterways and basins
(v) to operate, by itself, mooring facilities for public use which are needed to promote the convenience of the general public and to impose necessary regulations on ships (v)-2 to accept entrance notice and clearance notice from ships entering or clearing the port
(vi) to install facilities necessary for fire-fighting, rescue and security and to provide oil fences, chemicals and other materials necessary for the removal of oil spills in the Port Area
(vii) to conduct surveys and studies and compile statistics necessary for the development, utilization and preservation of the port, and publicize the port
(viii) to provide services to ships, including water supply, assistance in docking and undocking of ships and treatment of waste oils generated by ships and other services when these services are not provided properly and adequately by others
(ix) to lease out Port Facilities under its management which are not required for public use or are not appropriate for operation by itself
(x) to impose regulations regarding the use of Port Facilities on those who render services necessary for the port operation using transit sheds, cargo handling equipment and other Port Facilities managed by the Port Authority in order to ensure the smooth flow of cargo traffic and effective use of the said Port Facilities
(xi) to arrange services necessary for the operation of the port
(xi)-2 to facilitate loading and unloading storage, sorting and transportation of cargo in the Port Area and Waterfront Area in addition to the services specified on the preceding item
(xi)-3 to manage and operate dikes for waste disposal areas, marine waste treatment facilities (meaning facilities for the treatment of waste material), waste disposal facilities, and emission treatment facilities.
(xii) to establish or manage such facilities as resting areas or temporary living quarters for ships' crew and harbor workers for the promotion of their welfare
(xiii) to prepare and publicize the latest tariff showing the rates and charges for the services and facilities necessary for the utilization of the port
(xiv) Other activities necessary for providing the services set forth in preceding items

5.13 Environmental and Social Considerations

5.13.1 Legal Basis for Environmental Impact Assessment

Concrete steps for undertaking EIA are stipulated in the EIA Procedures. While it is yet to be finalized, a draft of the document and results of the interview to ECD (Environmental Conservation Department) in MOECAF (Ministry of Environmental Conservation and Forestry) officers reveal the EIA process in Myanmar to be generally as follows:

1) All development projects in Myanmar are subject to an environmental screening process through which, projects will be judged if they require any environmental review and if so, at which level (i.e. IEE or EIA).

2) EIA includes an environmental management plan and a social impact assessment report.

3) Public participation is required, when deemed necessary, for Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) and preparation of an Environmental Management Plan (EMP).

4) The project's executing agency forms an EIA Review Committee, which gives recommendations to the Minister of MOECAF from an environmental point of view whether to approve the EIA reports or not. The Minister makes the final decision based on this recommendation. The review period is 50 days for IEE and 90 days for EIA.

5) Members of the EIA Review Committee will be selected by the Minister of MOECAF and includes persons from the industry, academia, and civil society as well as government officials.

6) Involuntary resettlement is carried out under the responsibility of respective regional governments and hence will not be included in the EIA Procedures.

7) Costs involved in conducting EIA are to be covered by the project proponent.

8) EIA can be carried out in Myanmar only by firms that are registered under ECD/MOECAF.

5.13.2 Results of Environmental and Social Considerations

(1) Current Condition and Potential Impact

Current environmental and social condition and potential impacts likely caused by the Project are summarized as below:

Table 5.84 Current Condition and Potential Impact

Items	Current Condition and Potential Impact
Air Quality	Because the Project site is located in the river bed, far from residential and commercial area; air pollution affecting to people is minor. Current air quality condition has shown below acceptable level except dust. The level of impact can be considered to be not severe.
Noise Disturbance	Location of on / off shore works is far from residential and commercial area; while one religious facility (monk house) exists near the site. Since level of impact is not significant; noise disturbance shall be considered to minimize to affect to it.
Water Quality	Concentration of turbid water is high due to soil contamination; but source of soil is mostly natural origin. Human related pollution such as COD, oil and grease is low, it could be said human pollution including port activity is minor. During construction phase, turbid water may be discharged by on and off shore works. Also domestic wastewater will be generated by workers' activities. Maintenance dredging work will generate turbid water; while dredged sand can be re-used for construction materials, e.g.

Items	Current Condition and Potential Impact
Hydrology	Proposed port area is possible to be accumulated by soil; therefore maintenance dredging is required. Port design has considered mitigating sedimentation.
Protected Areas, Ecosystem	Upper stream form the Project site is known for habitats of Irrawady Dolphin which is registered as endangered mammals. Opposite side of Ayeyarwaddy River contains a protected area. However the Project is not expected to degrade ecological value in those areas. Aquatic biota in / around the Project area has shown common condition no specific ecosystem has been reported. ; fishing activity has mostly aimed of local use.
Land Use, Social Infrastructure	The Project site is located in the Ayeyarwaddy river bed, where is flooded during rainy season. Although the Project site and surrounding area have been cultivated; the area is officially controlled by DWIR. Two monk houses are located near the Project site.
Land Acquisition	Since the Project site is located in the seasonal flood area; no residents have been observed. However it shall be considered to compensate for agricultural production.
Local Economy, Job Opportunity	During construction, some people will be employed to help construction. Also supplemental services such as trading, repair shops, food shops will be needed in times. This is expected to benefit the local economy.

Source: JICA Study Team

(2) Environmental Impact Assessment

Table 5.85 describes environmental impact matrix.

Table 5.85 Environmental Impact Matrix

Environmental Parameters		Pre-construction	Construction							Operation & Maintenance				Overall
		Land Clearance	Mobilization of materials & equipment	Construction of cargo terminal, land reclamation	Construction of jetty	Construction of access road	Construction of access bridges	Operation base camp, if necessary	Facility building	Passenger loading / unloading	Cargo loading / unloading	Dredging	Ship maintenance	
Pollution	Air Pollution	C	-B	C	C	C	C	C	C	C	C	C	C	C
	Water Pollution	C	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B
	Waste	-B	C	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B
	Soil/Sediment Contamination	C	C	C	C	C	C	C	C	C	C	C	C	C
	Noise and Vibration	C	-B	-B	C	C	C	-B	-B	C	C	C	C	C
	Odor	C	C	C	C	C	C	C	C	C	C	C	C	C
Natural Environment	Ecosystem	C	C	-B	-B	-B	-B	C	C	C	C	C	C	-B
	Topography and Geology	C	C	C	C	C	C	C	C	C	C	C	C	C
	Subsidence / Erosion	C	C	C	C	C	C	C	C	C	C	C	C	C
	Global Warming	C	C	C	C	C	C	C	C	+B	+B	C	C	+B
	Landscape	C	C	C	C	C	C	C	C	C	C	C	C	C
Social Environment	Land Acquisition, Resettlement	-B	C	C	C	C	C	C	C	C	C	C	C	-B
	Living and Livelihood	-B	-B	C	C	C	C	-B	C	+B	+B	C	C	+B
	Local Economy	-C	+C	+C	+C	+C	+C	+C	+C	+B	+B	+B	+B	+B
	Historical / Cultural Heritage	C	C	C	C	C	C	C	C	C	C	C	C	C

Environmental Parameters	Pre-construction	Construction							Operation & Maintenance				Overall
	Land Clearance	Mobilization of materials & equipment	Construction of cargo terminal, land reclamation	Construction of jetty	Construction of access road	Construction of access bridges	Operation base camp, if necessary	Facility building	Passenger loading / unloading	Cargo loading / unloading	Dredging	Ship maintenance	
Land Use	C	C	C	C	C	C	C	C	C	C	C	C	C
Vulnerable Groups	C	C	C	C	C	C	C	C	C	C	C	C	C
Local Conflict	-B	C	C	C	C	C	C	C	C	C	C	C	C
Water Use / Right	C	C	C	C	C	C	C	C	C	C	C	C	C
Social Infrastructure / Services	C	C	C	C	C	C	C	C	C	C	C	C	C
Gender, Right of Children, Disabilities	C	C	C	C	C	C	C	C	C	C	C	C	C
Infectious Diseases	C	C	C	C	C	C	-B	C	C	C	C	C	C

Remark: positive: +, negative: -
A: Significant impact is expected, B: Moderate impact is expected, D: No / negligible impact is expected

Source: JICA Study Team

(3) Mitigation Measures and Monitoring Methods

Mitigation measures and monitoring methods are summarized as below:

Table 5.86 Mitigation Measures and Monitoring Methods

Impacts	Mitigation Measures	Methods of Monitoring
Pre-construction Stage		
Land Clearance	• Public consultation with affected persons (ex. farmers) • Installation of notification board concerning the project at the project site in order to prevent additional settlement. • Clear compensation process based on the public consultation • For farmland, acquisition of land and property (e.g. crops) after harvesting	• Site reconnaissance • Public hearing with stakeholders. • Interview survey with residents, communities
Construction Stage		
Noise Disturbance	• Routine maintenance of vehicles and construction equipment • Selection of low-noise emission machines and/or installation of silencers • Scheduling to avoid construction works taking place during rest hours and/or worship hours of the local people • Installation of barrier fence during construction to reduce noise disturbance if necessary • Development of working rules so as to, for example, avoid unnecessary use of air-horns, keep speed limit, turn off engines when not in operation and training drivers and operators to follow the rules • Scheduling to avoid much equipment operating at the same time near sensitive receptors	• Noise Level and Traffic Condition • Interview survey with residents, communities
Water Pollution	• Proper collection and storage of used oil and lubrication in a drum • Development of rules for waste management and training to workers to follow them • Development of closed drainage canal to avoid wastewater from spreading to river and farmland • Development of water treatment facilities (e.g. sedimentary sand tank to remove soil from wastewater) • Installation of proper temporary toilets	• Measurement (e.g. water quality, turbidity, pH, oil content) • Direct observation • Hearing to local residents on their perception and complaints
Employment/ Job Opportunity	• Priority to local residents/communities, especially those that were significantly affected by the project, for employment • Provision of clear and objective information on the project as well as the number, types and skills of labor needed through local networks, advertisements media or any other source that is	• Site reconnaissance • Public hearing with stakeholders. • Interview survey with residents, communities

Impacts	Mitigation Measures	Methods of Monitoring
	available, appropriate and effective. • Priority to local materials, food • Reasonable wages or salary level that is conformable with the types of skills and labor required in the area.	
Traffic Disturbance	• To install traffic signs at the entrance and exit gates connecting Myo Patt Road • To provide adequate parking lots in the construction site, and to forbid to park the vehicles on the roadside • To appoint a staff in charge of traffic control • To train the drivers and operators of heavy equipment to work in conformity with the applied SOPs • To arrange schedule of mobilization of equipment to avoid accelerating traffic congestion, and to avoid busy hours. • To coordinate with local government and traffic police regarding permanent or temporary road improvement to minimize traffic disturbance. • To cover transport vehicles with canvas to avoid material dropping.	• Direct observation • Survey records of traffic accident • Hearing to local residents on their perception and complaints
Waste	• Preparation of a temporary waste dumping site during storage • Development of closed drainage canal for wastewater and prohibition of discharging from the base camp without adequate treatment • Installation of a signboard to prohibit waste dumping at inappropriate areas • Collection of residue of oils including lubricating oil • Prohibition of placing materials (e.g. soil, gravel and sand) on road side or any other areas outside the project site • Installation of a fence to clarify the boundary between the Project site and beyond • Develop a rule for waste management, and nominate responsible person to implement said waste management • Reuse of sand materials for road improvement and others	• Observation survey • Interview survey with residents and local government.
Operation & Maintenance Stage		
Accident	• Establish or improve ship traffic rules • Educate fishermen about safety management • Establish working rules in the port area, and educate port workers	• Direct observation • Survey records of traffic accident • Hearing to local residents on their perception and complaints
Water Pollution	• Provide adequate sanitation system with proper maintenance of treatment facilities, toilet, canteen etc. • Protect oil leakage from ships • Block turbid water to spread out by	• Measurement (e.g. water quality, turbidity, pH, oil content) • Direct observation • Hearing to local residents on their perception and complaint

Impacts	Mitigation Measures	Methods of Monitoring
	fence if necessary • Prior inform schedule of dredging to the fishermen • Proper collection and storage of used oil and lubrication in a drum. Storage shall be set up at adequate locations to be protected from rain and water inundation • Development of adequate drainage canals and water treatment facilities to avoid polluted water from being discharged directly • Development of a contained storage area for oil, chemicals and others by ditch • Training of workers so that they follow waste management rules	

Source: JICA Study Team

5.13.3 Benefit from the Project

(1) Local Economy

The Project can encourage increasing job opportunity and local business chance. It is expected to recruit labors for construction works as well as for cargo loading / unloading in operation phase. In addition, service business for passengers such as food shop, souvenirs, land transportation services (taxi, bicycle-taxi, etc.) are enhanced. Those impact can encourage improving local economy.

(2) Global Warming (Reduction of GHG)

Modal shift of cargo transportation from truck to inland ship transportation can contribute to reduction of CO_2.

Condition on estimation of CO_2 reduction is as below

Demand of cargo handling volume from / to Mandalay is forecasted 240 thousand tons per year.

With case: this cargo will be conveyed by ship, cargo-handling machinery will be installed.

Without case: the cargo will be conveyed by truck. Cargo-handling is carried out with human-power.

CO_2 reduction by the Project is summarized in table below.

Table 5.87 CO_2 Reduction by the Project

	Year 2030
Cargo Handling Volume (thousand ton/year)	**240.0**
(million ton-km/year)	133.9
CO_2 Reduction Rate	
Ship (g-CO_2/ton-km) [1)]	46.6
Cargo-handling machinery (g-CO_2/ton) [2)]	580
Truck (gCO_2/ton-km) [3)]	158
Annual CO_2 Emission (ton-CO_2/year)	
Ship	
Ship transportation	6.238
Cargo-handling work	139
Total	6,377
Truck	21,151
Cargo vessel / truck (%)	30.1

Note:
1) Calculation based on DWIR (fuel consumption) and IPCC (CO2 emission ratio)
2) Evaluation and Reduction of Carbon Dioxide in Container Terminals, 2006
3) Environment and Transportation, Foundation for Promoting Personal Mobility and Ecological Transportation, 2011

Source: JICA Study Team

Annual CO_2 emission by inland transportation in 2030 is estimated 6,377 ton-CO_2, which counts for approximately 30 % of total CO_2 emission by truck transportation in the same year. It can lead to result that inland transportation is expected to reduce CO_2 emission and to contribute to global warming.

5.14 Contribution of Japan's ODA

5.14.1 Importance of Mandalay Port Development

The policy of the Japanese Government (2013) on official assistance to Myanmar is explained as follows:

"In order to assist the movement of Myanmar toward democratization and peacefulness of the nation, the Government of Japan will contribute to the infrastructure development for the local agricultural development, the peace with minority races, improvement of people's life, improvement of social weakness, and personal capacity building. Japan will also support infrastructure development as well as the establishment of laws and rules for Japanese private firms' business in Myanmar, such as the Thilawa SEZ development project. For the purpose to achieve these successful developments, the Government of Japan will forward the official development assistance to the target amount scaled 20 billion J¥ from the budget of 2013 FY, consisting of grant aid and yen loans. (MOF Japan)"

With respect to the above policy of Japan, the importance of the Mandalay Port development is summarized as follows:

(1) The Project to Contribute to Improve the People's Life of Myanmar

Inland water transport has the characteristics of low transportation cost by mass transport except that the travel time is longer than on-land transport. Therefore, promoting the industry of inland water transport, for example transport of suitable cargo such as rice & beans, fuel or heavy cargo, will contribute to stabilize price inflation of consumer goods, which will lead to a direct effect on the improvement of people's life.

(2) Important Role to Secure Transport Routes to Local Regions (improvement of social weakness)

Active water transport businesses are observed in the region where road networks are insufficiently developed looking at the present development status in Myanmar. Particularly in the area of the Ayeyarwady River upstream from Mandalay and the area along the Chindwin River, inland water transport will continue to play an important role on transport until a sufficient road network is developed in those regions. Mandalay is located at a strategic point between these regions therefore the river port development at Mandalay is quite important.

(3) Cost Effectiveness of Investment Comparing to Road/Rail Development

The scale of the initial investment of a river port is in the range 2 ~ 3 billion yen as it is estimated in this study. In comparison, road network development or railway development could cost 10 times or sometimes 100 times higher than the river port investment, mainly because the length of development is generally long with some hundreds of kilometers between major cities as the country is very wide. The development of a river port is cost effective in the viewpoint that sufficient function will be achieved with a smaller investment.

(4) Know-how of Port Operation and Management (personal capacity building)

In the river ports of Myanmar, there are no cargo handling facilities with machinery, only manual labour at the natural riverbank, therefore there is no port management body. Technical assistance in the field of port management will be needed at the same time the new modern port facilities are built. The use of Japan's port management know-how and technology is important.

(5) Connectivity to Thilawa SEZ Development Project (infrastructure development for Japanese private firms' business in Myanmar)

Currently Japanese ODA is put into the infrastructure development for Thilawa SEZ and national gate

port project. When the inland water transport system is established, container transport will become possible on the routes between river ports and the gate port. The development of river ports will contribute the national economic growth by establishing waterway routes by which import container cargo can be carried directly from the gate port to the river ports, or in reverse, industrial goods or agricultural products produced in inland areas can be carried from the river port to the gate port for export.

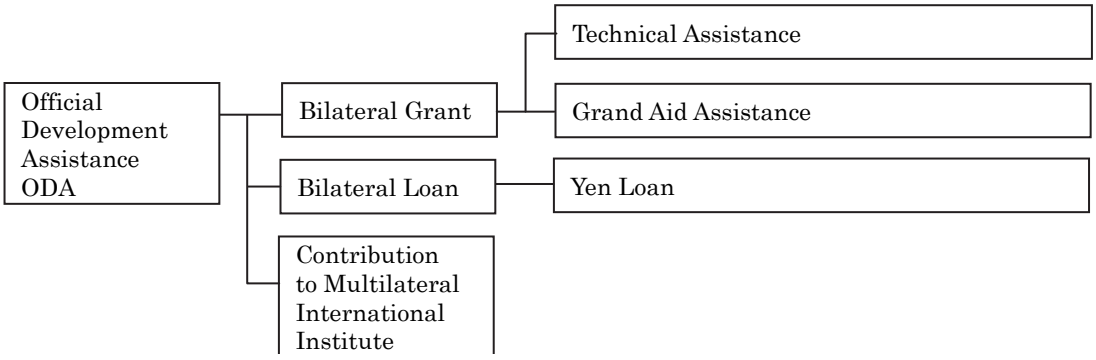
In addition, Myanmar is anticipating becoming a fruitful consumers market as the country holds approximately 60 million people. When Japanese private firms invest and go into business by using Thilawa SEZ, the inland waterways will play a very important role as the transportation route for products manufactured in the industrial park in Thilawa.

(6) Promotion of Inland Waterway Will Contribute Global Environment by Reducing Emission of Greenhouse Gas

It is generally well known that the use of waterway transport reduces the environmental burden created by transportation traffic compared to road transport. Although the heavy cargoes are not carried by waterway at present because only manual labour is available in the river ports, the port will be able to handle such cargoes when the system of equipment handling is established. For instance, cars whose selling demand is rapidly growing in Myanmar are currently transported from Yangon to Mandalay by being driven individually. If waterways can carry the cars by barge, emissions of exhaust gas by this means will be much reduced.

5.14.2 The Forms and Aims of Japan's ODA

In this part, what sort of form of Japan's ODA is suitable for Mandalay Port development project is discussed. The considerations are made on three forms of ODA, i.e., Grand Aid Assistance, Yen Loan, and Technical Assistance. Figure 5.116 shows the categories of the forms of Japan's ODA.



Source: JICA

Figure 5.116 Forms of Japan's ODA

These forms are explained briefly as follows (Source: MOF Japan):

(1) Grant Aid Assistance

Grant Aid Assistance is a form of ODA in which the fund is granted to the developing country. The fund is used for the procurement of goods/equipment, facilities or services for the purpose of the economic/social development of the developing country.

The major applicable fields of the assistance are 1) basic human needs (BHN) such as health and sanitation, water supply, education, and agricultural development, 2) development of social infrastructure, 3) protection of the environment, and 4) human capacity building. In recent years, the applicable fields were extended to 5) protection and restoration for disasters, 6) assistance for peace keeping, 7) removal of land mines, 8) measures against terrorism and maritime safety, etc.

(2) Yen Loan Assistance

Yen Loan Assistance is a form of ODA in which the fund is lent to the developing country. The low interest and long return period of the loan is applied with the aim to assist developing countries.

In order for the developing countries to achieve economic growth by own effort in view of a longer time period, it is important to build the economic/social infrastructure for the constant and sustainable growth of the developing country. It is however not easy for the developing countries to raise sufficient funds from the free money market. The Yen Loan plays an important role by offering very gentle conditions to the developing countries.

By placing the obligation for the developing country to return the loan, the country that receives the loan is encouraged to have a self-effort to keep proper financing conditions, which puts good effect on the development of the country.

The applicable fields of the assistance are determined taking into account the structure of economy of the country that receives the loan, national development master plan and government policy on the allocation of budget, etc. The amount of the applied Yen Loan for "economic infrastructure" such as for the projects of road, rail, bridge, port, and power generation, shared 66.7 % (E/N based) of total amount in 2009 FY.

(3) Technical Assistance

Technical assistance is a form of ODA in which Japanese advanced technology and knowledge is transferred to the developing country in order to develop human resources which then should be capable to undertake social/economic development projects. The aim of the Technical Assistance extends to assist local engineers to develop technology complying to local conditions, and the field of regulations and organizations.

The applicable fields of the assistance are very wide expanding from the field of BHN, such as health and sanitation, to the field of industrial engineering.

5.14.3 Suitable Form of Japan's ODA for Mandalay Port Development Project

(1) "Grant Aid Assistance" or "Yen Loan Assistance"

The results of economic analysis and financial analysis for the Mandalay Port Project are summarized as follows:

Economic Analysis:	EIRR =	13.2% (Sensitivity Analysis 11.7% ~ 13.0%)
Financial Analysis:	FIRR =	-4.7% (Sensitivity Analysis -4.9% ~ -5.4%)

The result of the economic analysis shows that the project has enough effect on the national economy.

The important issue is the question that whether Grant Aid is suitable for the project, or Yen Loan is suitable for the project. The result of the financial analysis shows xx%, in which the figure is recognized as the acceptable level of feasibility.

However, the project contains an unknown factor on the question whether enough port users will be obtained, and whether the expected revenue will be achieved, because a new operation system and port fees will be applied to the place where there has never been any system or fees. In addition, it is assumed that many trial and errors should be needed during the initial period in order to ensure the system runs properly. Moreover, there might be the question whether or not the manual cargo handling operation at the natural riverbank, which has been the method for hundreds of years, will really change to equipment operation with collecting user's fees.

Considering these uncertain factors on the operation, it is recommended that the project should first have a pilot project made by the public sector which has the initiative to start changing the conventional way of operation. In this context, the project is suitable to apply the form of Grant Aid

Assistant of Japan's ODA. The aims of the pilot project in view of responsibility of the public sector are stipulated as follows:

- Introduce the cargo handling equipment in order to change the conventional manual handling to equipment handling.
- Applying the function of port operational management, improve the inland water transport system and make an effort to reduce transportation costs.
- Introduce the use of pallets or containers for handling cargo, i.e. use of unit cargo, and promote their wide spread use to the private transport industry.
- Formulate port tariffs for a national river port, make it an initial standard, and spread it to the new development of river ports.

It is assumed that the pilot project should point the direction toward the privatization of public cargo transportation and river port operation. It is important for the government sector to implement the project on an initial trial and work out the achievement of a suitable management system.

(2) "Technical Assistance"

In addition to the above implementation of the pilot project, the task of Japan's "Technical Assistance" will be important. The following items of Technical Assistance should be applied together with the execution of the Grant Aid project:

- Technology transfer regarding river port construction
- Technical transfer regarding maintenance and repairing of the port facilities
- Knowledge/know-how transfer regarding port operation and management
- Technical transfer regarding future port planning and design

5.15 Recommendations

5.15.1 Establishment of Statistics Database

Port statistics is quite important on the point that the future port development plan shall be based on the data of the past port handling volume and its recent movement.

At present, cargo volume handled by public transportation is recorded by IWT, the regional offices of IWT keep records and it is forwarded to the HQ. The following issues should be improved:

1) IWT's data covers only a part of the total cargo volume (for Mandalay Port IWT handles merely 17% of the whole volume), in which private operators' volume is not included.
2) A superficial format of statistical data is prepared, but some differences in the items of data are found depending on each regional office.
3) The data are generally recorded by hand, electric data are not available. Even common spread sheet software (such as EXCEL) is not used for the recording. The records are submitted by regional offices to HQ by paper based documents.
4) The recorded data is not intended for planning the future ports or transport business, instead the data are recorded only for IWT's fee collection and revenue calculation.
5) The data recorded by IWT are only for the volume carried by passenger-cum-cargo ships which are directly operated by IWT. Most of the cargo barges owned by IWT are leased to private businesses, therefore barge transport data are not recorded by IWT.

Cargo statistics were not carried by private operators until 2011. DMA has commenced to collect such private data since 2012, but it is still needs improvement. The following issues need to be improved:

1) Because the statistics are newly being recorded, the recording format is still being modified.
2) The data are generally recorded by hand, electric data are not available. Even common spread sheet software is not used for recording.
3) Data have not been well prepared where liquid cargo or sand/stone, etc. is included in general cargo data. The statistics have to be improved so that it can be used for future port planning.

The following improvements will be needed:

1) An organization which records and organizes both public and private statistics is required. Taking into account that the private cargo volume is larger than the volume of IWT, it is practical that DMA should deal with both public/private statistics for the time being.
2) It is urgently needed to unify the data format and to use spread sheet software by computer.
3) The existing records which cover y/m/d of cargo arrival & departure, its volume and kind of cargo, and destinations, should be extended to more precise records including arrival/departure time, time for cargo operation and duration of mooring, etc.

5.15.2 Port Planning

At present there is no port facility for cargo operation, thus there is no organization to plan future port development. Starting with the Mandalay Port development as a turning point, it is recommended that the government should establish a port management body which holds and maintain the statistics and to undertake future port planning.

5.15.3 Execution Agency of Port Development

Throughout the latest discussions by the government, DWIR will be assigned to perform as the execution body for the Mandalay Port Development. However DWIR does not have much experience

on such development. Starting with the Mandalay Port development, DWIR should re-organize its own institute and should make an effort for build the capabilities of its staff to deal with the work from detailed design and through the management of the construction work.

5.15.4 Management Structure and Privatization

In implementing the project, both DWIR and IWT will be the implementation bodies. DWIR will construct the port, and it will be entrusted to IWT for management. Close coordination among DWIR and IWT is necessary.

The main offices of DWIR and IWT are in Yangon and are far from the Mandalay project site, and so the contact system among branch offices and main offices is important.

IWT, which will be responsible for port management, has no experience in the management and operation of port facilities, and has no organization or staff to do so. Enhancing management and the operational capacity of IWT is needed. Items for this will be as follows:

1) to amend laws or regulations to decide the roles and responsibilities of IWT
2) budget and auditing systems for port management
3) realization of proper maintenance and management of port facilities
4) realization of safe and efficient cargo handling operation
5) acquiring knowledge on safety and environmental aspects
6) acquisition and arrangement of cargo and passenger throughput
7) training of staff in charge of port management

For the above enhancement of the ability of IWT, Japanese assistance through JICA could be helpful.

Private participation of the cargo handling operation should be further discussed before the commencement of the new port.

5.15.5 Requirement of a Government Organization to Manage Whole Inland Water Transport System

In this study, it is recommended that the project is executed with cooperation between DWIR and IWT. However in the future, when the modernization of several river ports will be achieved, it is recommended to establish a government organization which manages the whole inland water transport system. The assumed organization should deal with the following work:

1) Establish and maintain statistics which covers the data of country wide cargo transport and port handling volume.
2) Planning of the modernization of the inland water transport system of whole country and its advancement.
3) Maintenance and repairing of existing port facilities.
4) Research and development for the appropriate development of an inland water transport system in view of coordinating the suitable use of other transportation modes, such as road or rail facility building.
5) Establishment and timely review of the suitable port tariff system for waterway transport and port operation.
6) Financial management which achieves suitable revenue to return the initial investment, to run the port operation, and maintenance & repairing (M&R).
7) Forwarding the privatization of river transportation businesses and port operation.

5.15.6 Establishment and Review of the Suitable Port Tariff System

These two aims to establish the port tariff system conflict with each other:

1) Port tariffs shall be prescribed for the government to receive sufficient revenue to repay the initial investment and to run the operation and maintenance costs.
2) When port tariff rates remain high, it pushes up the transportation costs, and consequently domestic private transport operators' business might decline.

With respect to the latter point, the high port tariff contains a risk that the modernization of cargo handling will slow the movement from manual labour (free of charge) to equipment handling (by tariff charge). Inland water transport is advantageous as a cheaper transportation alternative however its travel time is longer than rail or road. In order to achieve the benefits of waterway transport, the establishment of tariffs and its control should be undertaken by a public organization.

5.15.7 Maintenance and Repairing (M&R)

M&R of public facilities is very important in view of running and maintaining public properties properly. For the M&R of port facilities, it is required to carry out periodic inspections and to make up a suitable maintenance schedule, and to repair at the appropriate intervals. With running the building works of the port, the M&R plan should be made and the establishment of an inspection and repair manual will be needed.

5.15.8 Required Detailed Study for Application of Floating Jetty

In this study, the floating jetty is proposed to be installed which is advantageous to ease manual labour in addition to the planned handling by equipment. This is a suitable option for the initial stage of the modernization of port operation. However, the result of river flow analysis indicated the tendency of sediment to accumulate at the jetty location. In the future planned detailed design study, the following further studies are needed:

1) To survey the river bed feature at the time both before and after the flood season in order to find the seasonal change in depth of the river bed more accurately.
2) To apply the result of the above mentioned survey to the calibration of the model analysis for getting a more accurate analysis.
3) In this report, the river flow analysis was applied only for the time period of 50 days based on the past highest flood record in order to see the tendency of sedimentation. The analysis for a one year period is recommended including flood and dry seasons to demonstrate a more practical movement of riverbed elevation.
4) In case floating jetty is finally selected, a practical method to remove the sediment below the jetty should be surveyed and proposed.

This report does not finally conclude the type of jetty as a floating jetty. The jetty should be designed as a fixed piled jetty if it is judged that the risk is high of the bottom of the floating jetty touches the riverbed due to seasonal sedimentation.

5.15.9 Effect on Reducing Emission of Greenhouse Gas

The project of the Mandalay Port development has the effect of reducing 200,000tons CO^2 emission by activating the inland water transport sector. From the viewpoint on the effect of environment, it is anticipated to achieve the project execution.

Chapter 6 Procurement of Ships for Inland Water Transport

6.1 Present Status of Ships for Inland Water Transport

IWT has a fleet of 413 ships. The main ship is the Passenger-cum-Cargo, of which IWT owns 146. In terms of age of ship, there are 45 ships below the age of 20. There are 68 ships over 50 years of age, and the fleet is aging. Also, most of the ships don't have enough navigational device and safety equipment.

Most of the IWT ships are too large in comparison to natural condition of each service route. The depth of the Ayeyarwady River, the biggest river in Myanmar is only 1.5m in the dry season. Therefore the shipbuilding technology for practical demand for passengers against the shallow water level is limited. Private shipping companies that have a flexible operation, operate with several small ships which have shallow drafts.

6.2 Development Concept

Presently, many of the ships for inland water transport owned by IWT are getting older and therefore, the Government of Myanmar had requested Japan to renew the ships by using the Japanese Yen Loan scheme. For this opportunity, the JICA Study Team reviews the contents of this request carefully and aims to make a plan to procure necessary ships with an appropriate scale.

Passenger ship routes which have high needs and don't disturb private ship operation business, should be selected to fufill the requirements of the Japanese ODA with consultation with the Counterpart.

On cargo ships, the role of IWT should be sorted from the role of private operators and the routes with a high demand or potentially high demand should be selected. Finally, appropriate ships, which have higher transport efficiency and lower transport cost, are proposed.

Basically, type of ships to be used should have a shallow draft to be navigable at shallower water in during the dry season and the size should be decided to be as safe as possible to turn in sharp bends. For the management of these technically difficulties, Japanese technology will be incorporated into the renewal. At the same time, it should be considered that less impact to the environment, less Co2 & NOX emissions, and lower operation and maintenance costs are made by shifting from old engines to new.

With regard to speed of new ships, an appropriate speed will be calculated and proposed based on the present circumstances in Myanmar. The space for passengers on board will be set basically based by the Japanese standard and the type of seat will be selected by considering the condition of future use.

Presently in Myanmar, a type of boat generally called a "Speed Boat" is very common. The characteristics of the boat is that the length is quite long compared to the width and the aspect ratio seems to be very weak against a rolling force although river waves do not have so strong force in the transverse direction. Considering this point, it is important that safety structure of a ship is proposed based on Japanese experience.

As a premise, this study will be conducted with aiming to apply a Japanese Yen Loan scheme, however, it will be advanced with keeping an eye on the possibility of applying Grant Aid as well.

6.3 Demand Forecast of Passenger and Cargo Transport

6.3.1 Passenger Demand Forecast

(1) Current Passenger Flow

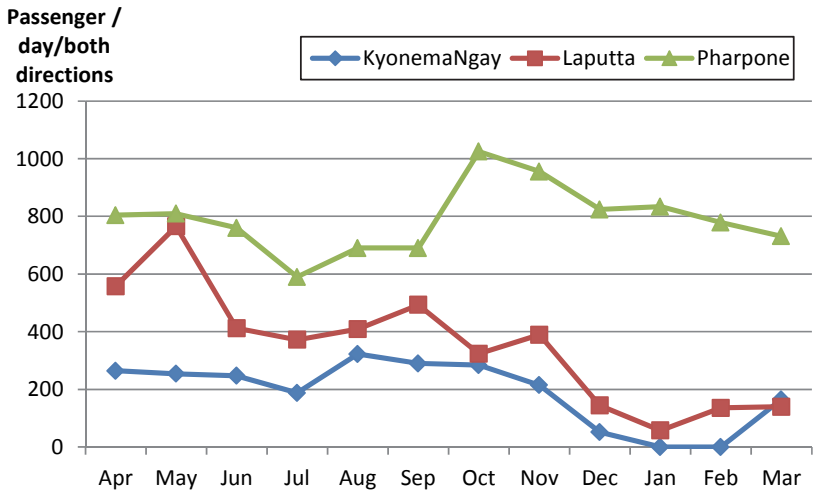
Table 6.1 shows the daily average passenger volume for IWT by route. Figure 6.1 shows seasonal fluctuation for IWT passengers by route. Daily passenger volume between Yangon and Pharpone is approximately 350 – 450. The seasonal fluctuation of passengers is large for Kyonema Ngay and Laputta. There is high demand in the rainy season for these sections.

Table 6.1 Current Passenger Flow by IWT

Unit: Passenger / day

TAZ No.[1]		50, 47,49, 71	66	67	69	Total
	PortName	Yangon	KyonemaNgay	Laputta	Pharpone	
50, 47,49, 71	Yangon	-	97	170	356	623
66	KyonemaNgay	93	-	-	-	93
67	Laputta	180	-	-	-	180
69	Pharpone	435	-	-	-	435
Total		708	97	170	356	1,331

Source: IWT



Source: IWT

Figure 6.1 Seasonal Fluctuation for IWT Passenger between Yangon and Other Cities

(2) Service Level Comparison

IWT and the Long Distance-Bus are operated between Yangon and other cities. The Fare for both transportation modes is similar but travel time is quite different.

[1] Traffic Analysis Zone: Refer to main report for master plan

Table 6.2 Service Level of IWT

Section			Distance	Time(hour)		Speed (km/h)	Fare(Ordinary) (Kyat)
			km	up	down	Average	
Yangon	-	Pharpone	103	9.3	8.3	11.7	1,500
Yangon	-	Laputta	270	27.8	26.9	9.9	3,500
Yangon	-	Kyonema Ngay	190	18.3	18.3	10.4	2,000

Source: IWT

Table 6.3 Service Level of Long Distance Bus

Section			Distance (km)	Time[2] (hour)	Frequency (Buses/day)	Fare(Ordinary) (Kyat)
Yangon	-	Pyarpone	100	2.5	16	1,700
Yangon	-	Laputta	240	6.0	3	3,200
Yangon	-	Kyonema Ngay[3]	170[4]	4.3	7	2,400

Source: Myanmar Travels & Tours Directory 2013

(3) Future Demand Forecast

Considering the differences of travel time by IWT, car and long-distance bus, it is assumed that bus passengers may not change over to IWT. On the other hand, sometimes roads in the study target area will be flooded in the rainy season. Therefore, passenger demand for IWT in the rainy season is assumed to remain in the future. It is also assumed that future passengers will increase only based on economic growth, and not increase based on the diversion from other transportation modes such as long distance-buses.

1) Socio-economic Framework

Table 6.4 shows the current and future GDP by TAZ. High economic growth is forecasted in the Yangon area. The estimated growth rate is 9 – 11 % per year. In the delta area, the future growth ratio is estimated as 3 – 5 % per year. In the whole of Myanmar, the annual average growth ratio is approximately 7%. Compared to other areas, the economic growth ratio in the delta area is assumed to be low.

Table 6.4 Future GDP Forecast

TAZ	TAZ Name	GDP (Billion Kyats)				Annual Average Growth Ratio (AAGR)		
		Y2013	Y2015	Y2020	Y2030	Y2013 -Y2015	Y2015 -Y2020	Y2020 -Y2030
47	Yangon (North)	2,624	3,222	5,209	13,678	11%	10%	10%
48	Yangon (East)	3,435	4,250	6,946	16,035	11%	10%	9%
50	Yangon (West)	3,320	3,839	5,426	8,018	8%	7%	4%
66	Myaungmya	687	752	894	1,323	5%	4%	4%
67	Laputta	572	627	738	1,008	5%	3%	3%
69	Pharpone	819	877	1,010	1,386	3%	3%	3%
71	Yangon (SouthWest)	907	1,119	1,924	4,400	11%	11%	9%
Other TAZ		37,537	41,881	57,931	114,652	6%	7%	7%
Total		49,901	56,567	80,078	160,500	6%	7%	7%

[2] Assumed the average speed at 40km/h
[3] Assumed to take the bus between Yangon - Wakema, the city located 20km north of Kyonema Ngay
[4] Including the access distance from Wakeda to Kyonema Ngay

2) Future Trip Generation

Future trip generation is estimated based on the future GDP and existing traffic volume. The GDP elasticity of trip generation from each zone from 2013 to 2015 and from 2015 to 2030 is defined as 1.0 and 1.2, respectively.

Table 6.5 Estimated Trip Generation for All Transportation Modes

TAZ	TAZ Name	Total Trip Generation (Trips/day)				Annual Average Growth Ratio (AAGR)		
		Y2013	Y2015	Y2020	Y2030	Y2013 -Y2015	Y2015 -Y2020	Y2020 -Y2030
47	Yangon (North)	24,438	30,007	53,122	167,398	11%	12%	12%
48	Yangon (East)	30,385	37,594	67,411	182,483	11%	12%	10%
50	Yangon (West)	27,302	31,570	47,685	76,051	8%	9%	5%
66	Myaungmya	2,846	3,115	3,831	6,121	5%	4%	5%
67	Labutta	1,959	2,147	2,609	3,788	5%	4%	4%
69	Pharpone	2,150	2,302	2,726	3,981	3%	3%	4%
71	Yangon (SouthWest)	629	776	1,477	3,954	11%	14%	10%
Other TAZ		210,739	239,607	376,450	953,909	7%	9%	10%
Total		300,448	347,118	555,311	1,397,685	7%	10%	10%

3) Future Trip Distribution

The person trip distribution for interzone travel is estimated by the Frater method. The passenger growth to the target area is low due to low economic growth.

Table 6.6 Trip Distribution in 2013

TAZ	YNG	66	67	69	Other TAZ	Total
YNG	8,226	2,524	1,505	1,860	68,639	82,754
66	2,524	0	0	0	322	2,846
67	1,505	0	0	0	454	1,959
69	1,860	0	0	0	290	2,150
Other TAZ	68,639	322	454	290	140,633	210,339
Total	82,754	2,846	1,959	2,150	210,339	300,048

Table 6.7 Trip Distribution in 2015

TAZ	YNG	66	67	69	Others	Total
YNG	11,206	2,800	1,694	2,024	82,182	99,906
66	2,800	0	0	0	317	3,117
67	1,694	0	0	0	454	2,148
69	2,024	0	0	0	279	2,303
Others	82,182	317	454	279	156,412	239,644
Total	99,906	3,117	2,148	2,303	239,644	347,118

Table 6.8 Trip Distribution in 2020

TAZ	YNG	66	67	69	Others	Total
YNG	23,334	3,471	2,137	2,457	138,299	169,698
66	3,471	0	0	0	360	3,831
67	2,137	0	0	0	471	2,608
69	2,457	0	0	0	269	2,726
Others	138,300	360	471	269	237,047	376,448
Total	169,699	3,831	2,608	2,726	376,447	555,311

Table 6.9 Trip Distribution in 2030

TAZ	YNG	66	67	69	Others	Total
YNG	63,840	5,537	3,018	3,606	353,881	429,882
66	5,537	0	0	0	584	6,121
67	3,018	0	0	0	769	3,787
69	3,607	0	0	0	376	3,983
Other TAZ	353,883	585	769	376	598,299	953,912
Total	429,885	6,122	3,787	3,982	953,909	1,397,685

4) Future Passenger Volume

In the rainy season, some roads in the study target area will be flooded. Passenger demand for IWT in the rainy season is assumed to remain the same in the future. Therefore, it is also assumed that future modal share for IWT passengers in this area will be same as it is now.

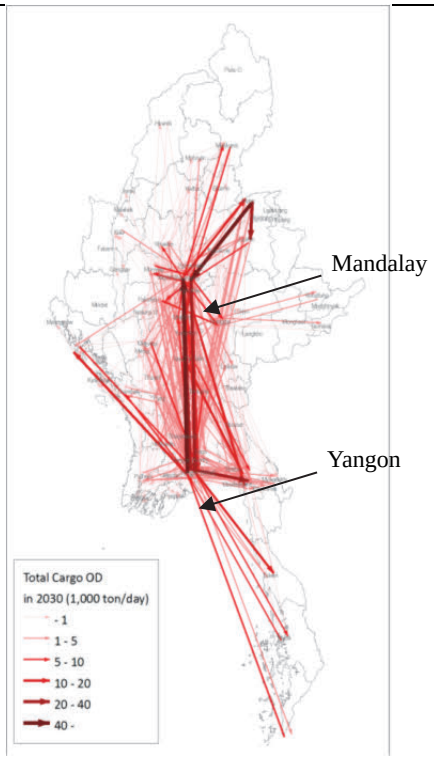
Table 6.10 Estimated Future Passenger Volume

Unit: Person / day

From	Yangon			KyonemaNgay	Laputta	Pharpone
To	KyonemaNgay	Laputta	Pharpone	Yangon		
2013	97	170	356	93	180	435
2015	108	191	387	103	203	473
2020	133	241	470	128	256	575
2030	213	341	690	204	361	844

6.3.2 Cargo Demand Forecast

The route of the cargo ships was assumed to be Yangon-Mandalay. As shown on Figure 6.2, the same route shows the largest cargo transportation demand among all regional transport routes.



Source: The Study Team

Figure 6.2 Demand of Cargo Transport in 2030 (incl. all trans. modes)

Table 6.11 shows the demand forecast for water transport of cargo between Mandalay and Yangon (provided that data excludes liquid cargo, sand & stones, and wooden logs). Demand was estimated by assuming a growth rate of regional GRDP, and based on the transport OD survey executed by the Study Team and statistical data provided by IWT and DMA. The calculation model was prepared capable to evaluate the effect of travel time and travel cost of each transport mode, and gross transport demand was distributed to each mode, i.e., waterway, road and railway. "With case" on the Table 6.11 means the case that an express road and railway between Yangon and Mandalay will be improved, in which travel time of road and rail will be shortened.

Table 6.11 Demand Forecast on Water Transport of Cargo between Mandalay and Yangon

unit: ton/day

Year	without case			with case		
	M→Y	Y→M	Total	M→Y	Y→M	Total
2015	160	873	1,033	114	519	633
2020	220	1,605	1,825	158	908	1,066
2030	229	2,901	3,130	165	1,512	1,677
2040	214	4,278	4,492	142	2,179	2,321

note1 : with case considers new express train & road will be developed
note2 : M: Mandalay, Y:Yangon

Source: The Study Team

The following Tables show the breakdown of Table 6.11 (provided that the data includes liquid cargo, sand & stones, and wooden logs).

Inland water freight volume between Yangon and Mandalay is one of the important routes. As shown in the following tables, inland water freight from Yangon to Mandalay is dominated by liquid bulk cargo such as diesel oil and petrol.

Table 6.12 Forecasted Cargo Volume between Yangon and Mandalay (without case)

unit: ton/day

	2015		2020		2030		2040	
	33 > 50	50 > 33	33 > 50	50 > 33	33 > 50	50 > 33	33 > 50	50 > 33
1.Live Animal & Animal Products	0	0	0	0	0	0	0	0
2.Fish and Aquatic Products	0	0	0	0	0	0	0	0
3.Vegetable and Fruits	0	0	0	1	1	1	0	1
4.Grain and Grain Products	10	12	14	15	15	9	11	3
5.Other Agricultural Products (ex. Plantation Product)	30	25	62	47	112	57	143	34
6.Foodstuff, Beverage and Animal Food	3	6	2	3	0	0	0	0
7.Petroleum, Oil and Gas	0	588	0	1,252	0	2,696	0	4,202
8.Coal, Ore, Stone and Sand	0	0	0	0	0	0	0	0
9.Cement, Construction Material (incl. steel-frame)	8	150	11	165	0	52	0	0
10.Fertilizer (incl. Urea)	1	0	0	0	0	0	0	0
11.Garment, Textiles and fabric	2	1	1	1	0	0	0	0
12.Wood and Wood Products	59	4	70	6	61	9	47	13
13.Paper and Printed Matter	0	0	0	0	0	0	0	0
14.Metal and Metal Products (excl. construction material)	0	0	0	0	0	0	0	0
15.Industrial Material, Chemicals	0	0	0	0	0	0	0	0
16.Household articles, miscellaneous	47	87	60	115	40	77	13	25
17.Machinery and Parts, Transportation	0	0	0	0	0	0	0	0
Total	160	872	221	1,605	229	2,902	214	4,278

Note: TAZ 33 is Mandalay, TAZ 50 is Yangon.

Source: The Study Team

Table 6.13 Forecasted Cargo Volume between Yangon and Mandalay (with Express train and truck)

unit: ton/day

	2015		2020		2030		2040	
	33 > 50	50 > 33	33 > 50	50 > 33	33 > 50	50 > 33	33 > 50	50 > 33
1.Live Animal & Animal Products	0	0	0	0	0	0	0	0
2.Fish and Aquatic Products	0	0	0	0	0	0	0	0
3.Vegetable and Fruits	0	0	0	1	1	1	0	0
4.Grain and Grain Products	7	8	10	11	10	6	0	0
5.Other Agricultural Products (ex. Plantation Product)	22	18	45	34	82	42	96	23
6.Foodstuff, Beverage and Animal Food	1	3	1	2	0	0	0	0
7.Petroleum, Oil and Gas	0	297	0	632	0	1,361	0	2,122
8.Coal, Ore, Stone and Sand	0	0	0	0	0	0	0	0
9.Cement, Construction Material (incl. steel-frame)	7	128	9	141	0	42	0	0
10.Fertilizer (incl. Urea)	1	0	0	0	0	0	0	0
11.Garment, Textiles and fabric	1	1	0	1	0	0	0	0
12.Wood and Wood Products	42	3	50	4	44	6	33	9
13.Paper and Printed Matter	0	0	0	0	0	0	0	0
14.Metal and Metal Products (excl. construction material)	0	0	0	0	0	0	0	0
15.Industrial Material, Chemicals	0	0	0	0	0	0	0	0
16.Household articles, miscellaneous	33	61	43	82	28	54	13	25
17.Machinery and Parts, Transportation	0	0	0	0	0	0	0	0
Total	114	519	160	908	165	1,513	142	2,179

Note: TAZ 33 is Mandalay, TAZ 50 is Yangon.

Source: The Study Team

6.4 Target Service Routes and Engineering Proposal

The preconditions for proposing new ships are in accordance with current knowledge, from Chapter 4 are as follows;

- As a basic requirement on ship procurement funded by Japanese ODA, the procurement should have a high need and it has to contribute to the aided country growth, and besides, it should have high publicness and should not disturb private ship operation business
- Most of IWT's ships are decrepit. Therefore the navigation equipment and emergency safety devices are poor.
- It is necessary to keep or lower operation and maintenance costs when new ships are planned because it tends to be on the increase due to price escalation.
- The present vessel type of IWT's passenger ships are called "passenger-cum-cargo" for the purpose of carrying passengers and cargoes at the same time. This combined ship type tends to have a larger body with a deeper draft compared to passenger only ships. Larger ships have worse fuel consumption and disturbs the advancement of speeding up. So IWT wishes to separate passenger and cargo transport.
- When design of new vessel is examined, the draft should be set at minimum based on present ship data owned by IWT
- The size, fuel consumption and speed of the proposed new ships are basically based on the specification of existing ships but better ideas in each part of the ships should be proposed consulting with IWT.

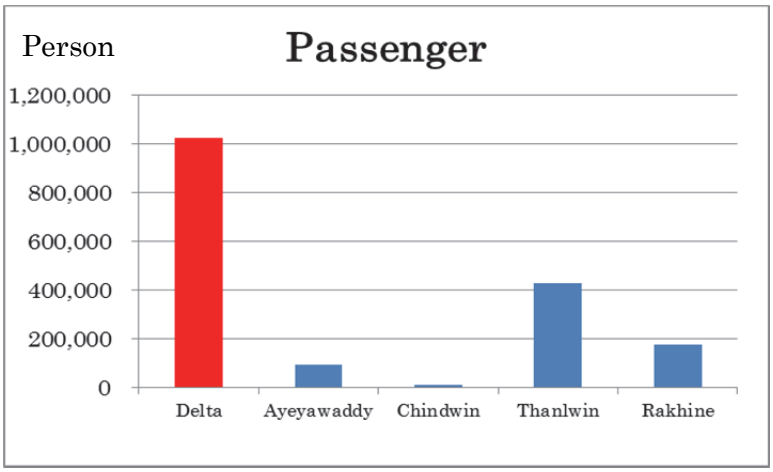
6.4.1 Examination for Service Route for New Ships

(1) Passenger Ship

There are two essential elements for applying Japanese ODA. The first is that the candidate project should have a high need and contribute to the growth of the aided country. The second is to have high publicness and not to disturb existing private business. From these points of view, it was necessary to find a route, which has a high demand and must depend on inland water transport due to an undeveloped road network or some other reason. Also, the candidate route should not have private vessel operation because an ODA project cannot disturb present private business. Under these circumstances, route information, especially on private business could not be collected at all, so the Study Team had to visit major key ports in each operational area of IWT and did hearing investigations.

1) Number of Passengers

The number of passengers in each division as described below (Delta Division: the 2011 financial year, others: the 2012 financial year), the Delta Division has an overwhelmingly high number of passengers. It is possible that the high numbers are because the Delta Division has Yangon which is economically developed and there are difficulties in the Delta area to improve roads because of the estuarine region.

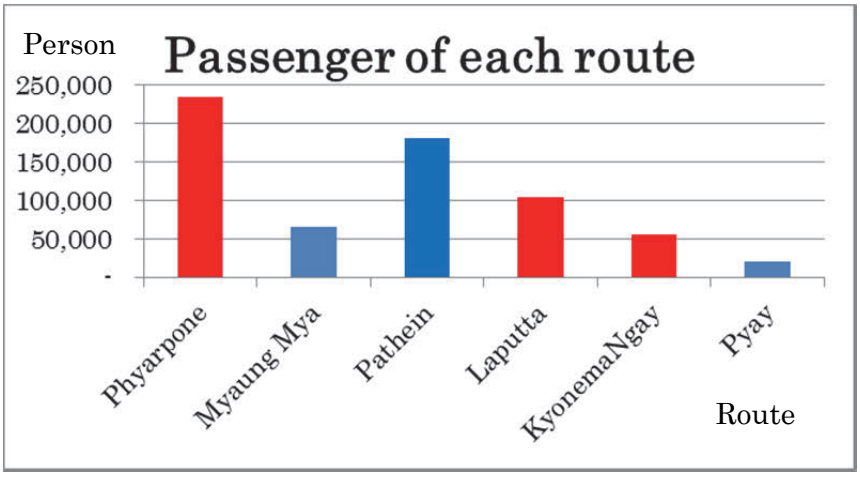


Source: The Study Team

Figure 6.3 Passenger for Each IWT Division

2) Selection for Appropriate Service Rout for ODA

In the Delta area, there are six river routes which have high needs and are without private operation. The 6 routes are from Yangon and the destinations are Pathein, Myaung Mya, Pyay, Phyarpone, Labutta and Kyonma Ngay. The following table shows the number of passengers for the six routes.



Source: The Study Team

Figure 6.4 Passenger for Each Service Route in Delta Division

Presently the infrastructure on river management in Myanmar is insufficient and many flood disasters happen in the rainy season. The trend is particularly prominent in Delta area because it has a widespread lower land swamp. The land condition severely limits access to roads to Yangon and so the local people have to depend on river water transport. However, recently roads connecting Yangon and Pathein, a key city of the Delta area, have been upgraded and the convenience of road transport is improving therefore users of inland water transport may tend to decrease. Myaung Mya is located on the way of the route by road so inland water transport users are decreasing as well. For similar reasons, inland water transport users to Pyay are also decreasing.

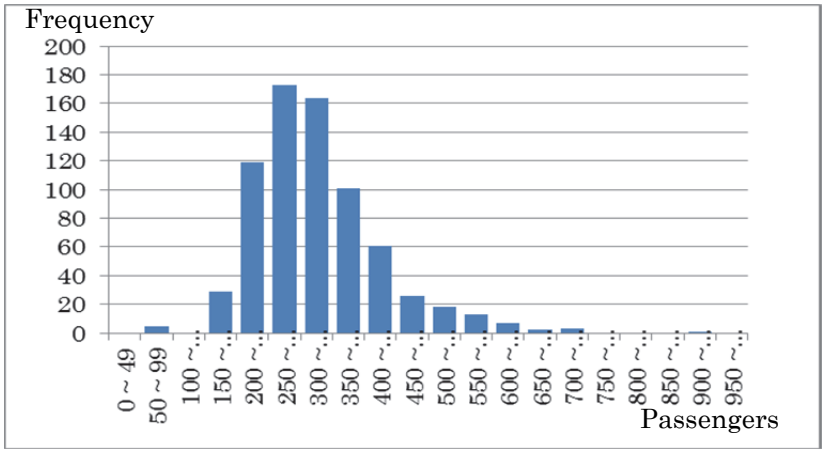
As for the remaining three routes, from Yangon to Phyarpone, Labutta and Kyonma Ngay, even now road transport is not yet active. The main reason is because of severed road access resulting from flood, but it is probable there is also another reason: that is the inconvenience of the bus stop location in Yangon. The bus stop is located about 15 miles from downtown and people need to pay additionally from downtown to the bus stop.

Considering these circumstances, it is assumed that users of inland water transport of the above three routes, from Yangon to Phyarpone, Labutta and Kyonma Ngay, will also decrease in the close future with the development of a road network, however, the local people living around three villages will have to depend on inland water transport only until the completion of the road network. Besides, these people are of a lower income level compared to the average of present Myanmar. Therefore, it is very important for them to secure a transport mode and it will contribute to fulfill a Basic Human Needs for the people. From this point of view, these three routes are selected as candidates to apply ODA.

The following are the present status of vessel operation in each route.

a) Yangon-Phyarpone route (Night liner)

The liner runs once a day. IWT operates about a dozen ship including “Min Hla”, “Min Ye”, and so on. The tour is 64 miles, it takes a one day (up line: 9.3hours, average speed: 5.9 knots, down line: 8.3hours, average speed: 6.6 knots). The average frequency of passengers is 324 passengers, and 90% frequency of passenger is 450 passengers.

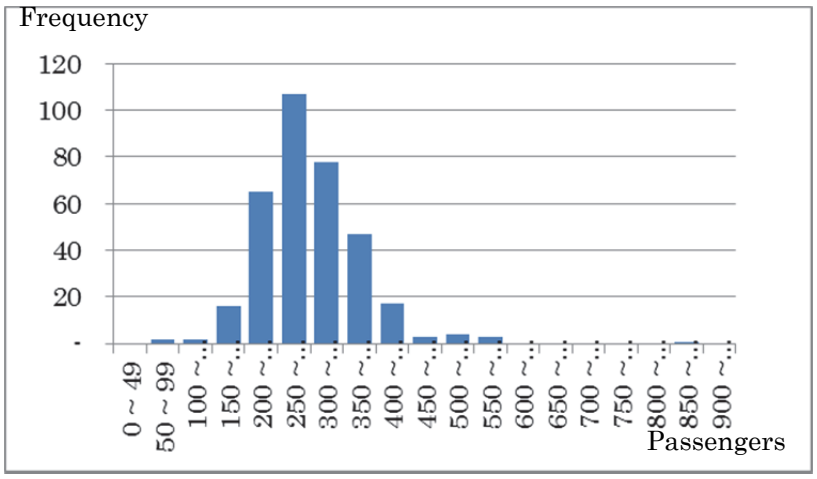


Source: The Study Team

Figure 6.5 Frequency for Passenger Yangon-Phyarpone Route

b) Yangon-Laputta Route (Domestic)

The liner runs three times a week. IWT operates about a dozen ships including “Babdoola”, “Waithanayar”, and so on. The tour is 168 miles, it takes two days (up line: 27.8 hours, average speed: 5.2 knot, down line: 26.9 hours, average speed: 5.9 knot). The average frequency of passengers is 300 passengers, and 90% frequency of passenger is 400 passengers.

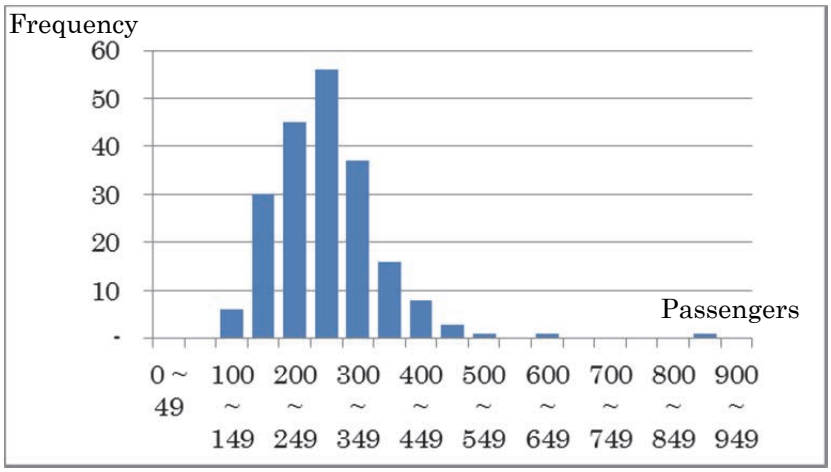


Source: The Study Team

Figure 6.6 Frequency for Passenger Yangon-Laputta Route

c) Yangon-KyonemaNgay route

The liner runs three times a week. IWT operates about a dozen ships including "A-7", "Bayin Naung", and so on. The tour is 118 miles, it takes a day (up line: 18.3 hours, average speed: 5.6 knots, down line: 18.3 hours, average speed: 5.6 knots). The average frequency of passengers is 227 passengers, and 90% frequency of passenger is 350 passengers.



Source: The Study Team

Figure 6.7 Frequency for Passenger Yangon-KyonemaNgay Route

3) The Concept of New Ships Plan

IWT has a strong desire to have more small ships. IWT would like to reduce operation costs with several small ships and operate with flexibility for off-peak periods the same as a private service company.

a) Type of Ship

Most of all private ship operators carry passenger and cargo seperately and IWT wishes to follow this trend. Considering the enhancement of transport efficiency, the trend is natural. A combined carrier of passenger and cargo has a larger ship body with a deeper draft compared to dedicated ships, and it seems that the character of a combined ship will disturb the advancement of speeding up and is worse for fuel consumption.

A concern of shifting to dedicated ships for passengers is how to handle the present cargo carried by existing passenger-cum-cargo vessels. According to hearing investigations, from Yangon to Phyarpone and Labutta cargo amounts to about 12,000 tons per year per one way respectively and from Yangon to Kyonma Ngay has about 6,000 tons per year per one way, and if so, the average volume of a ship is about 70 tons per voyage. Although a concrete manner to handle the cargo should be examined in another study, the handling volume is quite small so IWT will be able to handle it with their existing small cargo ships.

b) Passenger Capacity

Based on the date (the 2011 financial year) of IWT, the average frequency of passengers is in the range of 450 to 500 passengers, and 90% frequency of passenger is the range of 300 to 350 passengers. By IWT's conclusion, it is recommended that the capacity for each ship will be 150 passengers and they operate the same ships.

c) Fuel Efficiency

In general, the engine power output is proportional to the square of the speed. Thus, speeding up argues against increasing fuel economy. IWT requests that the fuel cost is less than or equal to 30 gallons per hour.

d) Speed

The passenger-cum-cargo ships of IWT can travel at a maximum speed of 10 knots. Actually, it travels at a speed of 5 to 8 knots in premium condition for fuel consumption. It is affected by the effect of the velocity of the water, too. On the other hand, the private sector has high-speed boats, which can travel at a maximum speed of 20 knots with 120 to 150 passengers. They are operated at a speed of 10 to 15 knots which do twice as much as IWT. IWT plans to introduce a ship which is as speedy as possible, but the fuel economy is at the top of their priorities. So, a suitable speed will be set.

e) Safe Operation

The rules and regulation of designing and operation are based on the Japanese Standard by arrangement with DMA. The structure of high speed boats in the private sector are designed to speed up effectively, in which the width is extremely narrow relative to its length. It is calculated for stability, but the high-speed boats are less stable than general ships. There is little rolling or waves on the river, but a dangerous external factor is the wake by side wind and rolling (especially, by high-speed boats).It is important that the internal factor is the loading condition. In this proposal, the high stability structure of ship is recommended. As for the navigational and safety equipment, the current IWT's fleet is underequipped and unsafe. The minimum equipment should be selected.

f) Environmental Consideration

With the result making a selection of the engine for new ship, the engine which emits common-sense CO2 and NOx in Japan will be selected. It is hoped that the high quality and accurate engines made in Japan will sustain an acceptable level of the rated specification for a long period with suitable maintenance. That will cut down maintenance and operation costs, although there are possibilities for contingencies like inflation.

g) Draft

The survey of the draft in service in the Delta division shows the following. The IWT have ships of 1.24m to 1.6m draft. The private sectors have ships of 1.2m to 1.25m. River surveys are not accurate enough but by studying the drafts of the new ships for IWT it has been concluded that the draft should be 1.2m, the same as private operators' ships.

(2) Cargo Ship

The trend of inland water transportation by individual routes should be increased. IWT leases all of its cargo barges to private operation companies and have no data for them. The percentage of private cargo transportation is 70 to 80 percent of all of cargo transportation, but data reduction is a work-in-progress so they can't be used.

1) High Demand Routes on Cargo Transport Sector

Putting the data in order, the amount of cargo handled by individual route was compared. As the diagram below indicates, it turns out that the amount of cargo in Mandalay-Bamaw route figures prominently. Bamaw is a door to border trade between Myanmar and China. The data as described previously doesn't include the private sector. But the tendencies of inland water transportation are by the said comparison.

The cargo volume is 143,000 tons in Yangon, the biggest in Myanmar. Next is 90,000 tons in Mandalay and 69,000 tons in Bamaw. These three ports have the biggest volume for cargo. This information comes from IWT and it can presumed that the trend for private operation companies is also as same as the one for IWT.

Bamaw is the entrance for international trade between China and Myanmar. The JETRO report and the related report described that the volume for inland water transportation is very big. And the JCC meeting mentioned that the Ministry of Transport in Myanmar wants to carry out port development priority there. But the Chinese government and DWIR is discussing a comprehensive agreement for port development in Bamaw. Unfortunately it is impossible go to Bamaw at this time, so it can't be investigated as a candidate for ODA.

In the background of democratic activity in Myanmar, demand for transportation between Yangon and Mandalay grows highly and inland road transportation also grows in accordance with development of roads. But inland water transport in this area is not developed yet. The reason is port facilities, including a behind stockyard, is undeveloped and an advantage for inland water transportation is not applied.

2) Selection of the Cargo Transport Route for Applying Japanese ODA

Myanmar is expected to experience high economic growth in the near future. It is absolutely certain that Myanmar grows up economically focusing around Yangon-Mandalay route. Thus, the same zone has a certain number of good road connections in Route 1, Route 2, and high-speed highway. But, the inland water transportation is not active in traffic.

Generally, the inland water transportation is less convenient than the ground transportation. In Myanmar, it is a problem that the current inland water transportation depends on cargo work only by man-power. That is, the bottleneck of the work is that there are no port facilities and the cargo handling isn't mechanized. From this aspect, it turns out that even Mandalay, expected to become a hub port, still depends on a human-powered harbor loading and unloading by using the natural river.

In this light, first the most important part is that port facilities have to be installed. Second, on the Yangon-Mandalay route there should be a time table for the freight ships. The mechanized cargo handling puts shipment in a position to unload quickly. Thereby it will be possible to operate cargo ships with solid cargo management and punctual operation. So a more efficient transport can be realized, rather than in small quantities.

As just described, when the inland water transportation becomes more efficient, there is a possibility that the heavyweight cargo, in particular rice, pulse and construction material, will come back to the inland water transportation. Installing new ships by ODA, this project must be the pilot project for modern inland water transport with a general purpose and mechanized cargo handling.

3) The Concept of New Ships

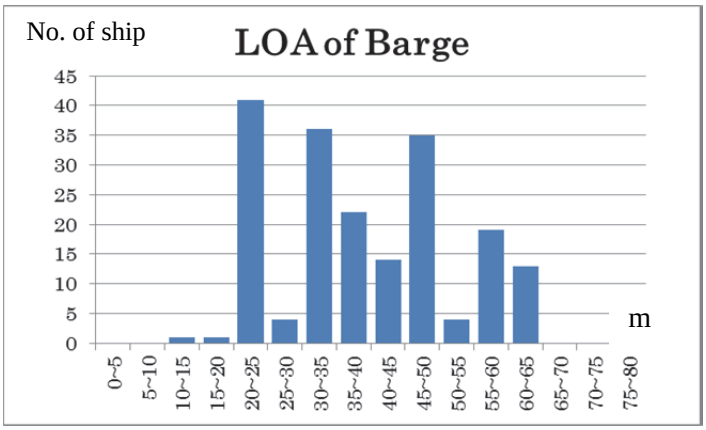
a) Type of Ship

IWT operates cargo ships which are passenger-cum-cargo. As mentioned earlier, the plan is that the shipping by a combination passenger and freight should make the shift to separate dedicated ships. The possibilities for a self-propelling ship were reviewed. But it was decided to use barge tugboats which are equal to containerized transportation from the prospect of port facility planning in Mandalay port.

Existing large cargo barges on the Ayeyarwady River are connected with tugboats by rope in a parallel position. However, it is very difficult for tugs to turn and control the barges in the shallow and narrow river. At this time there are no appropriate pusher boats. A pusher tug boat should also be procured because of the parallel connection between the barge and tug boat creates a big loss for power.

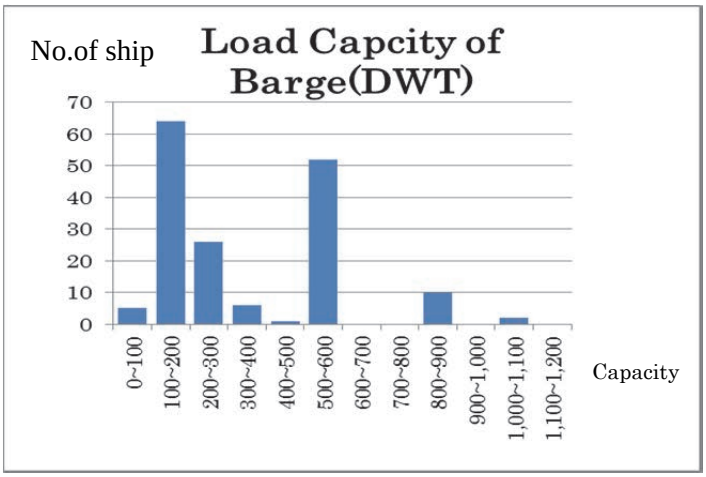
b) Size of Ship and Maximum Loading Capacity

IWT's barges are up to an overall length of 65m, with a maximum loading capacity of 1,000 tons. With consideration for the plan for port facilities at Mandalay harbor, a cargo ship which is broadly applicable to large cargo like food (rice, pulse) and construction materials (stone, cement, lumber) heavy machines and vehicles should be procured. In light of ship handling and operation without delay, the size of this type of ship is desirable to be equal to the largest class. So, the salvage barges which have the dimensions of 65m length, 15m breadth, and a maximum loading capacity of 1,000 tons would be the most appropriate, as well as the tugboat which suits that salvage barge.



Source: The Study Team

Figure 6.8 Comparison for Length of Existing IWT Cargo Barge



Source: The Study Team

Figure 6.9 Maximum Loading Capacity for Cargo Barge

c) Draft

A hearing survey shows that the water depth of the Ayeyarwady River on the Yangon-Mandalay route, is 1.7m (Hinthada-Pyey route, in the dry season for the December-April period), and 1.5m (Pyay-Mandalay route, in same period). The pusher boat "Shin-Hai" and the barge " Ba800" have a draft of 1.4 m. That draft has a lower tolerance for the water depth in the dry season. Furthermore, it is the limit for shallow draft for shipbuilding technology to keep 1.4 meter draft for tugboat pushing up to 1,000 tons cargo barges. Therefore a 1.4 m draft for new cargo barges should be used.

d) Speed

IWT's cargo ships (tugboat and barge) operate at a maximum speed of 5 knots, and it's about an hour each way. In consideration of increasing transport efficiency, and load capacity, and the demands for speeding up in the near future, the speed of ship should be 7 knots.

6.4.2 Point of Procurement Plan for New Ship

In today's Myanmar, they are able to build comparatively simple ships like a salvage barge. The work, like carrying building components, cutting by gas torch, and hand welding, are carried out by hand. On the other hand, in today's Japan, the shipbuilding has become automated in a part of a production line. A lot of the masters that are deft at manual work have already retired, there are not many left to hire. It's possible to dispatch experts, but it's impossible for masters to construct ships on site. There are not enough materials/ facilities for new ship building in Myanmar and can't be procured. For this reason, it is assumed that the new ships will be constructed in Japan. However, there is still a concern that if the procurement is from Japan, there will be a higher transportation cost. Sea travel distance from Japan to Myanmar is over 7,000km and it will create a higher cost just for transportation, and the initial investment cost, including other expenses, will also be higher. To avoid this cost increase, examination for this procurement needs further investigation, whether or not it can be procured from a third country which is closer to Myanmar, but this is out of the working range of this study. For further investigation, another study is necessary to confirm this possibility.

In terms of the passenger ship, the same type of ships should be procured in consideration of the following situation. First, there isn't so big a difference among the three routes on the subject of natural status and demand situation. Second, the same type of ships will have spare parts that are compatible with one another. Third, the same type of ships will bring the cost down. In terms of cargo ships, the same type of ship should be procured, because there is one route. The design of the proposed ship doesn't have the unique technique of Japan, but it is ingenious. Representative examples are as follows:

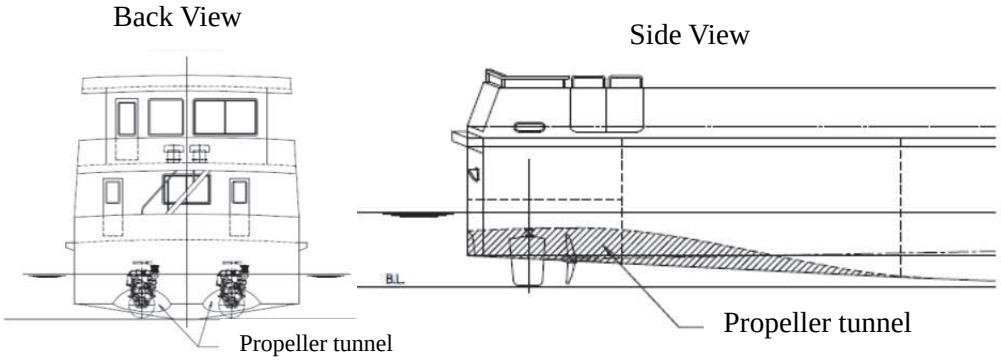
1) Passenger Ferry

a) Material of Hull

Steel or Fiber-Reinforced Plastic (FRP) are the materials being considered for the new ship hull. FRP is not common in present Myanmar so the steel hull is adopted in this study. An aluminum hull contributes to lighten weight, but the metallic processing is difficult and has a higher cost, so it was eliminated in preliminary stage.

b) Propulsion Device (Propeller tunnel)

The planed ship is tunneled at the stern for preventing propeller damage in shallow water. So, the propeller was put above the baseline with less damage by shallow water level in the dry season. The conceptual diagram is shown below.



Source: The Study Team

Figure 6.10 Concept Plan for Propeller Tunnel

c) Comfortable Equipment etc.

Reclining seats for all ships are proposed for long voyages. There are dirt tanks at the bottom of each ship which should not be disposed into the river. There are storage rooms under the front deck for hand baggage.

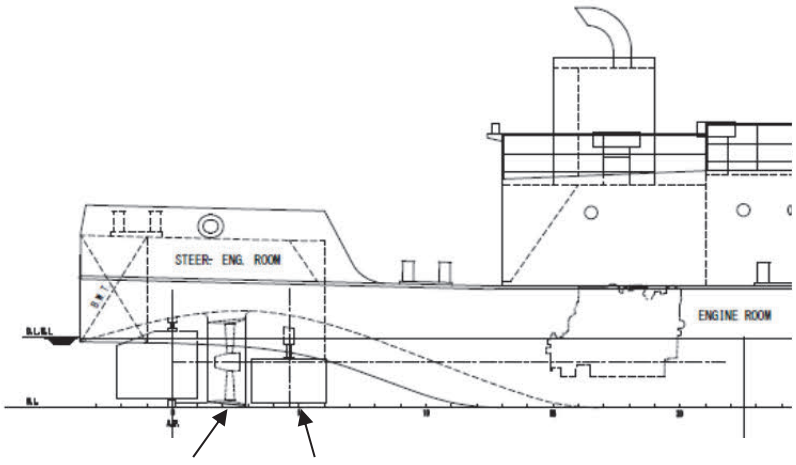
2) Cargo Ship

a) Material of Hull

Steel hull ships were designed, not a FRP hull, due to size for engine and hull balance for tugboats.

b) Propulsion Device

The pusher tugboat is needs to have a shallow draft reaching a limit of technology. Thereby the Tunnel stern which equips the Kaplan type of propeller with Kort nozzle easily will be used. Also the flanking rudder for self-navigation to improve the turning performance will be used.



Source: The Study Team

Figure 6.11 Combination for Propeller and Steering of Proposal for Building for Pusher Tugboat

c) Connected Piece between the Pusher Tugboat and Salvage Barge

The connecting piece between the pusher tugboat and salvage barge should be the spring type in order to release quickly, be reasonably priced and reduce the loss of power transmission.

d) Wheelhouse Height

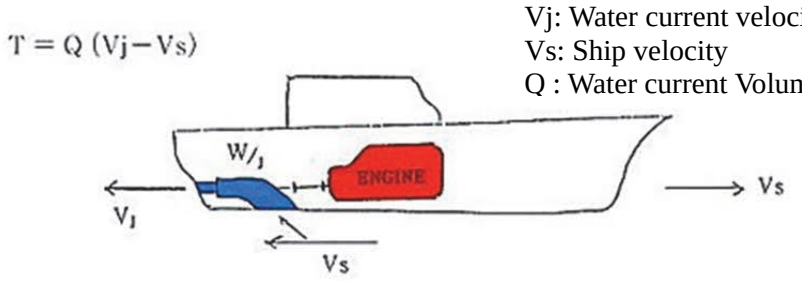
The wheelhouse height is designed higher, because the cargo is a wide variety of goods and corresponds to containerized transportation in the future.

6.4.3 Engineering Proposal

The key points for making design are set mainly two items, the first is to lower shipbuilding costs, and the second is approachability on maintenance in present Myanmar. If these conditions of these key points are eased, more effective ideas can be proposed. The concrete items are introduced in the following:

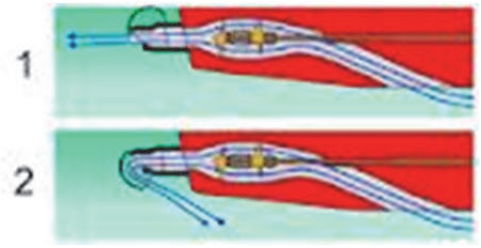
a) Water Jet Propulsion System

The water jet propulsion system is an efficient propulsive device for navigation on rivers and shallows. This device has no propeller and is powered by high discharge pressure. This is suitable for high-speed travel. The smaller device is used by a personal watercraft. Recently in Japan, it is used in high-speed boats, fast patrol craft and missile craft. It's possible for the passenger ferry to have a water jet propulsion system. But it is more expensive. Generally, it is said that the price of water jet propulsion system is one and a half times as much, or double. When this proposal adopt this system, it seems that the propelling device increases cost from about 65,000,000 Japanese Yen to about 97,000,000 Japanese Yen from 130,000,000 Japanese Yen. And its maintenance needs to have special skills. To introduce this to Myanmar, the technical assistance and training like a technology transfer program are required.



Source: The Study Team

Figure 6.12 Schematic Diagram for Water Jet Propulsion System



Source: The Study Team

Figure 6.13 Schematic Diagram for Water Jet Propulsion System

b) FRP Hull for Passenger Ferry

Steel hulls are popular in Myanmar, however, in case that the proposed ship size in this study, or smaller, is selected, a FRP hull also can be adopted. The merits and demerits of FRP hull are as follows:

Merits are:

① Lightweight and no erosion and rust

② Surface is smoother compared to steel full and sufficient durability, if ship size is appropriate.

③ Shorter maintenance time and lower maintenance cost, if special skill/ techniques are acquired.

④ More lightweight and shallower draft compared with steel hull (about 30% can be lighter)

⑤ Building cost for the first ship is almost same as steel hull. However, if same ship are built plurally, the cost of the second & the subsequent ships can be lowered by about 30 ~ 40% when same shell can be used.

On the other hand, demerits are:

⑥ It is necessary for acquiring special skill/ techniques for repair but generally it is recognized that the difficulty level is not so high.

⑦ It is difficult to condemn because FRP cannot be condemned with combustion.

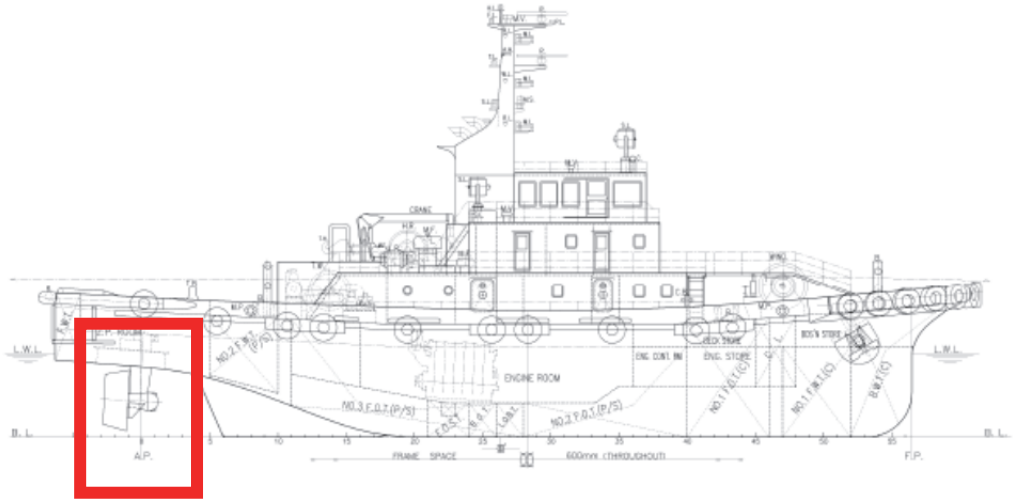
⑧ Although plural shipbuilding cost can be lower if same shell can be used, the building time will be longer because the shipbuilding cannot be in parallel.

Regarding item ④, if FRP hull is accepted as structure for new ships in this study, 1.0 m for draft can be designed and it's possible to increase the speed by 20% to 12.8 knots from 10.7 knots.

Regarding item ⑤, it is estimated that 220 million Japanese Yen per each steel hull ship in accordance with attached rough quotation. If FRP hull is acceptable, we can estimate around 150 million Japanese Yen for as from second build. But building period will be much longer than steel hull.

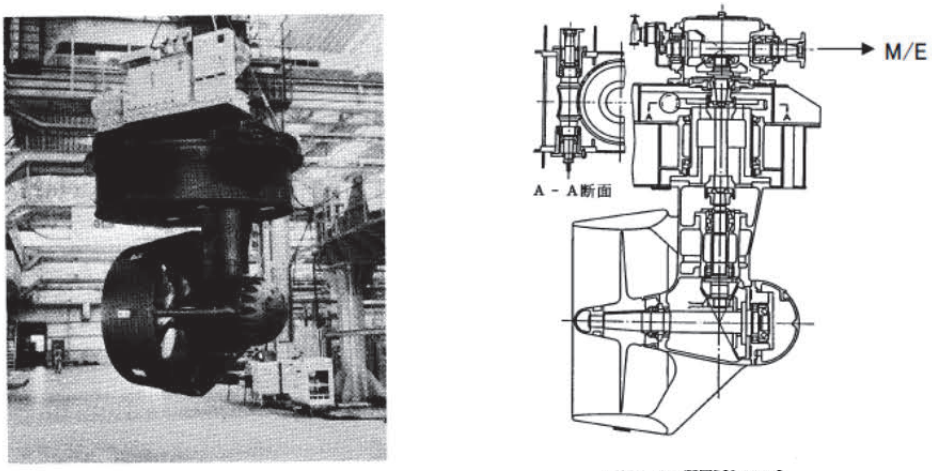
c) 360 Degree Circling Propeller for Pusher Tugboat

This is the popular propeller system for this class for all over the world including Japan. There is no need for a rudder, because the propeller itself swings 360 degrees.



Source: The Study Team

Figure 6.14 Tugboat with 360 Degree Propeller



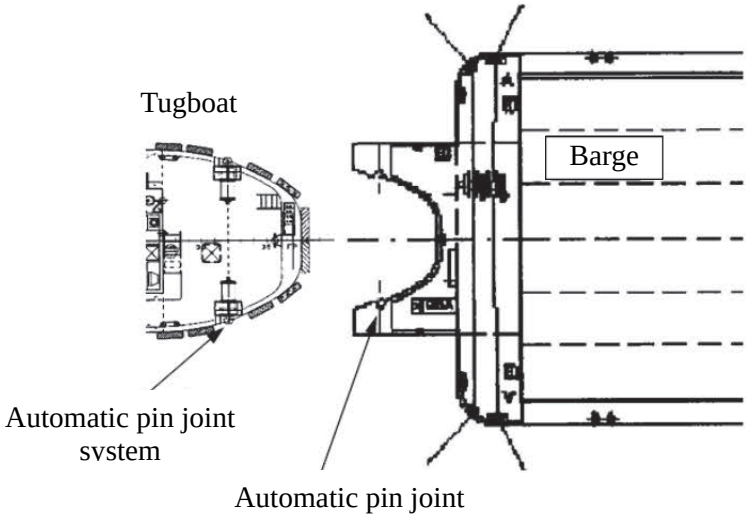
Source: The Study Team

Figure 6.15 Example for 360 Degree Propeller

The merit for this system is easy maneuvering control. But there are possibilities that the propeller will suffer big damages by hitting the river bank. The top of the system joint is ball joint (see above photo). Therefore it is very difficult for technical maintenance and needs high technical abilities and equipment for operation and maintenance.

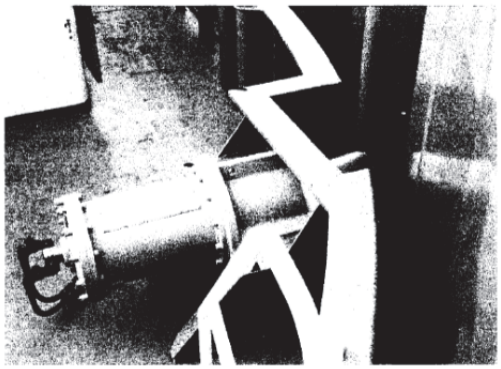
d) Joint System for Cargo Barge

Automatic pin joint system for pusher boat is major in Japan. This system is that a direct joint between pusher tugboat and cargo barge connect automatically like a train joint. It is safe with a short time for joint work. Thus the pusher type of tugboat is appropriate this time, but this joint system cannot be used because of high costs. However, it should be considered for future developments.



Source: The Study Team

Figure 6.16 Image for Automatic Pin Joint System for Pusher Boat



Source: The Study Team

Figure 6.17 Automatic Pin Joint System for Pusher Boat

6.4.4 Necessity for Technical Cooperation for Procurement for New Ships

In this opportunity, a key is to try to be compatible for present Myanmar but there are several items that should be newly introduced. As for these, this procurement should be in cooperation with dispatching Japanese expert(s), or sending trainee(s) to Japan, or a maintenance program with spare parts/ equipment. To make this procurement successful, comprehensive combined assistance is necessary.

a) Navigation Equipment

These ships are designed with the latest GPS, radar systems, audio systems and radio systems. Therefore experts must be dispatched for this equipment because only using manual books will be not enough for operation.

b) Maintenance for the Ships

Although the proposed ships in this study are considered to be compatible to Myanmar but the present level of ship maintenance in Myanmar is inadequate to maintain the ships in good condition for a long time and assistance by Japanese expert(s) is needed. Existing dock facilities in Myanmar, as a premise of further examination on ship maintenance, are very old and some of new processing machines are already not working. So it has to say that the workability is insufficient.

Basically when new ship procurement/ operations are examined, examination on existing dock facilities should be done in parallel. Especially on maintenance manners of ship engines and the related fields, Japanese technical transfer will be usable for Myanmar shipbuilding.

c) Port Management

In this survey it is supposed that there will be mechanical port operation and improving behind yard for introducing cargo barges. For their effective operation, a specialist for port management will be needed.

d) Safety Vessel Operation

With an increase of traffic volume of inland water transport with the further economic growth of Myanmar, safety facilities/ devices and training on navigation safety is necessary. Myanmar is still in the preliminary stage of economic growth and inland water transport does not generate enough although the potential is very high. So, those matters are still in their examination level even at the major river Ayeyarwady, according to IWT, DWIR and other related bodies.

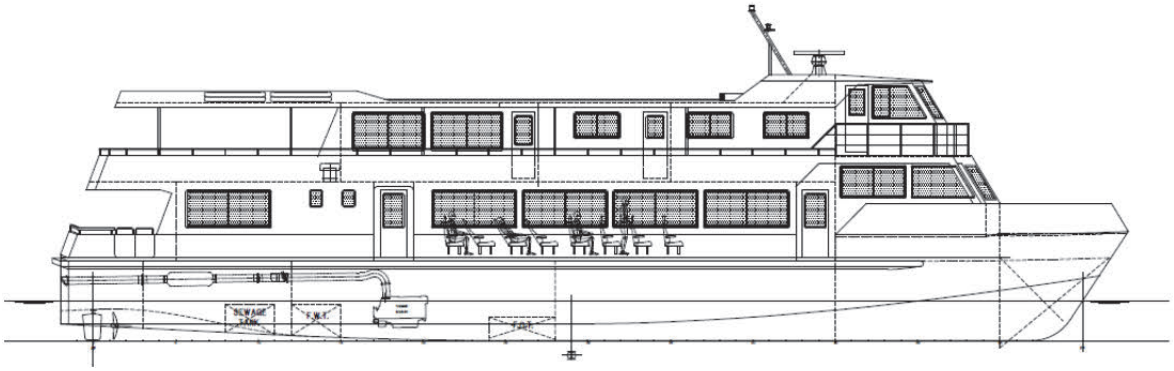
Assuming the future development of Myanmar inland water, improvement of the safety navigation system is essential but basic information/ data for the improvement e.g. statistics of traffic trend, volume, survey data of river, have not been prepared yet. Therefore, the first, expert for inland water transport should start to support collecting this basic information and based on this, a navigation expert should start to make a plan as the second step.

6.5 Preliminary Design of Ships

Basic design and specification for ships is as follows:

6.5.1 Passenger Ferry

(1) General Arrangement



Source: The Study Team

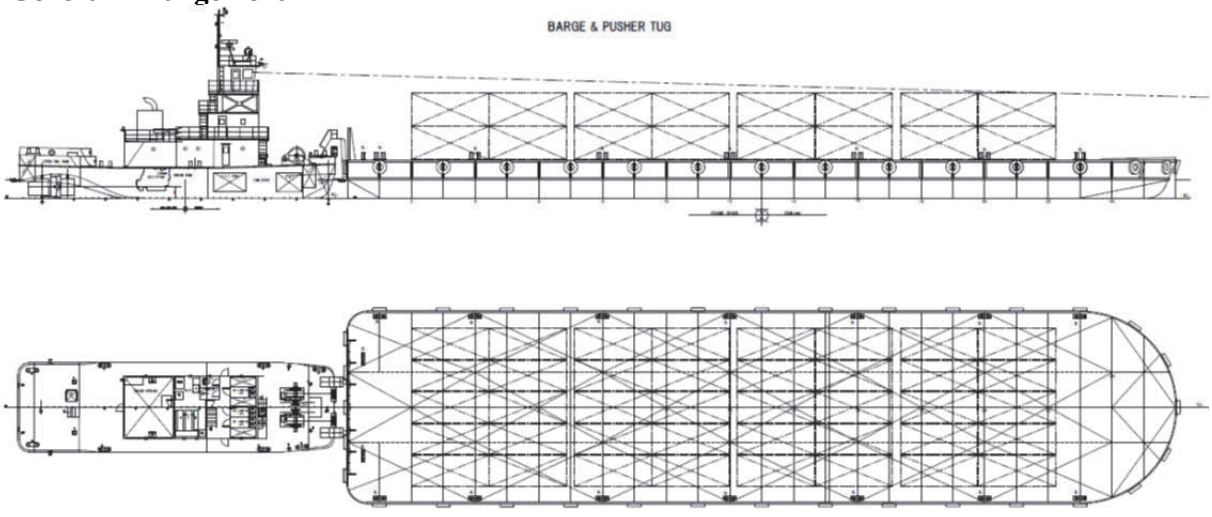
Figure 6.18 General arrangement for passenger ferry

(2) Specifications

L×B×D : 32.4×7.0×2.4m
Draft : 1.2m
Total tonnage : 280GT
Main engine : 500HP(368kW)×2 sets
Max. speed : 10.6knot (75%Load)
Passenger : 150 Persons

6.5.2 Cargo Ship

(1) General Arrangement



Source: The Study Team

Figure 6.19 General arrangement for Cargo Barge and Pusher Tugboat

(2) Specifications

Pusher tugboat		Cargo barge	
L×B×D	: 24.8×7×2.4m	L×B×D	: 65×15×3m
Draft	: 1.4m	Draft	: 1.4m
Total tonnage	: 140ton	Capacity	: 1,000ton
Main engine	: 850HP (625kW) × 2sets		
Designed speed	: 10.6knot (75% Load)		
Speed with cargo barge	: 7knot (75% Load)		

6.6 Ships Building Plan and Cost Estimate

6.6.1 Number of Ships for Building Plan

(1) Passenger Ferry

The minimum number for ships with capacity and speed for new ships which satisfy the current needs of passengers was estimated. The estimated results are as follows:

Table 6.14 Estimation for Number of New Ships, Compared with Existing Ships and New Ships

Existing Ship

Route	Trip	Distance	Time		Ave.Speed		frequency	Min. Nos
		(mile)	up (hour)	down (hour)	up (knot)	down (knot)	90% (person)	of Ship
Yangon-Phyarpon	Every day	64	9.3 1day	8.3 1day	5.9	6.6	450	2
Yangon – Laputta	3day/week	168	27.8 2day	26.9 2day	5.2	5.4	400	2
Yangon - KyonemaNgay	3day/week	118	18.3 1day	18.3 1day	5.6	5.6	350	1

New Ship

Route	Trip	Distance	Time		Ave.Speed		Capa. of less 24h	Min. Nos of Ship
		(mile)	up (hour)	down (hour)	up (knot)	down (knot)	(person)	
Yangon-Phyarpon	Every day	64	7.0 0.5day	6.0 0.5day	7.9	9.2	150	**3**
Yangon – Laputta	3day/week	168	18.0 1day	17.0 1day	8.1	8.5	150	**3**
Yangon - KyonemaNgay	3day/week	118	13.0 1day	13.0 1day	7.8	7.8	150	**2**

Source: The Study Team

Therefore three ships for the Phyarpon route, three ships for the Laputta route and two ships for the KyonemaNgay route, a total of eight ships, should be procured.

(2) Cargo Barge

The route between Yangon and Mandalay has the potential to be in high demand, but this inland water transport is not economic. This route would benefit from operating with new cargo transportation with mechanical cargo handling, which would also introduce an effective inland water transportation with suitable port management.. It will contribute to future container handling. Considering this purpose, this project must be a pilot project and have limited support in order to allow Myanmar to be responsible for it in the future.

It is 597 miles and takes a five day voyage from Yangon to Mandalay on the river. Two sets of new ships for one shuttle schedule from Yangon to Mandalay per a week with one day for loading and unloading is suggested.

6.6.2 Schedule for Building New Ships

In accordance with this survey, eight passenger ferries and two sets of cargo barge and pusher tug boats, a total of twelve ships are proposed for procurement. To that end, the schedule includes building those twelve ships in Japan and transfer from Japan to Myanmar.

(1) Shipbuilding Dock Yard

It is easy to surmise that the critical point for this procurement is the reservation for a shipbuilding berth. It is very difficult to shorten the building schedule per one ships in automatic shipbuilding management shipyards in Japan. If more shipbuilding berths can be reserved at the same time, the building schedule can be reduced. But it is very difficult for the management of quality by using parallel shipyards, and so building in one shipyard is proposed.

It is possible to build twelve ships in one berth at a major Japanese shipyard, however there is no guarantee that the berth occupancy, management and labor can also be reserved. This is a big risk in the plan, and so it is suggested that using two berths and having two ships built in parallel would be better.

(2) Transportation from Japan

After building in Japan, it is presumed that two kinds of transportation, by cruise by itself or towing, or carried by big cargo will be decided on for transporting the ships to Myanmar.

1) Transportation by Cruise by Itself or Towing

Passenger ferry must be rigged for international voyage and also arrange permission for a special ocean voyage license. Additional rigging is loads additional fuels by drum to avoid fuel shortage. In an ocean voyage the weather forecast must be assumed, and unforeseen accidents may occur, and the ships would not go one by one, but in parallel with other ships. Therefore it is proposed that two ships each four times with reserve transportation crews and stability for each two ships.

Cargo barges consist of one set of pusher tug boat and cargo barge. Their design is for very calm rivers compared with the ocean, but the hull for ships can stand up to ocean going. However there are possibilities that the connection between them might be released by 2m to 3m high waves and the cargo barge will be set adrift. In addition, fuel tanks for pusher tug boats are too small for ocean going so that they must load additional fuel tanks. But they can not cruise by themselves because of there is no spare space for additional fuel tanks. Therefore both the pusher tug boats and cargo barges will be towed by ships.

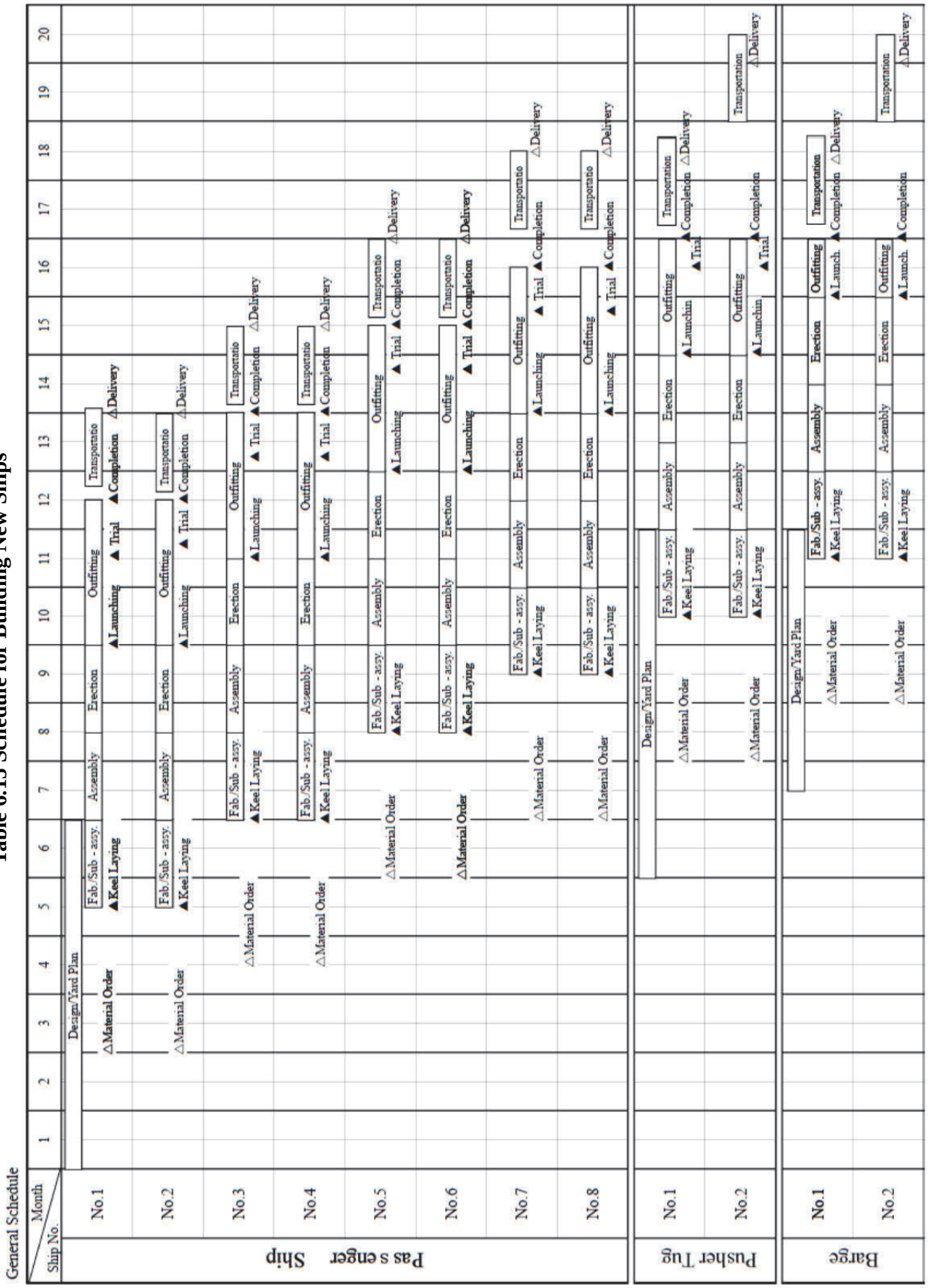
2) Transportation by Carried with Big Cargo Barge.

This system is that the new ships are loaded onto a barge and towed by another ship. This barge ship is supposed to be a big crane type and/or a semi-submergence type. The barge with the big crane type will have a problem for loading capacity and limited storage space, and it is very difficult to procure. The semi-submergence type is advantageous, but they are difficult to procure and so the possibility of using one is low.

Also, the semi-submergence type of barge ship will need to be more than ten meters in draft, which will be difficult to use at the loading site in Myanmar because of the depth of the river.

Therefore it is better if the ships cruise by themselves and/or are towed for this project.

Table 6.15 Schedule for Building New Ships



Source: The Study Team

6.6.3 Building Cost for New Ships

In accordance with the estimation for the number of ships, building costs for the new ships are as follows:

Table 6.16 Rough Estimation Cost for New Ships
Based on Unit Price of 31 October, 2013)

Building cost Estimated (Unit price :1,000JPY)

Main Item	Item	Passenger Ferry	Pusher Tug	Barge
Hull	Matrial	15,000	11,000	30,000
	Man-hour	60,000	40,000	20,000
	Piping	7,000	5,000	
Machinery	Main engine	32,000	40,000	
	Generater	8,000	5,000	
	Shaft	10,000	15,000	
	Machine	9,600	9,000	
	Piping	6,000	5,000	
Outfitting	Mooring equipment	4,000	4,000	4,000
	Deck equipment	18,720	10,000	
	Navigation equipment	14,120	4,000	
	Lamplight equipment	1,600	1,200	
	Safety equipment	2,500	1,000	
	Fire extinguishing equip.	500	300	
	Catering equipment	200	200	
	Sanitary equipment	1,000	800	
	Interior	5,000	3,500	
	Reclining seat	15,000		
	Pussher equipment		2,500	2,500
	Lashing equipment			1,500
	Electric Devise	5,000	5,000	
	Administrative cost	5,000	3,000	2,000
Total Cost		220,240	165,500	60,000

Source: The Study Team

Cost for the procurement of the ships do not include transportation costs from Japan, the related general expense and consumption tax is as follows:

Passenger ferry：220,240 Thousand JPY per ship

Cargo barge with pusher tugboat：165,500 Thousand JPY + 60,000 Thousand JPY

= 225,500 Thousand JPY per 1 fleet

Thus, in view of the required number of ships, costs of new ship construction are listed in the following table:

Table 6.17 Rough Estimation Cost for New Ships

type	unit price (million JPY)	number of ships	cost (million JPY)
passenger ferry	**220**	**8**	**1,760**
Cargo barge and pusher tugboat	**220**	**2**	**440**
total		**10**	**2,200**

Notes 1: This price is rounded down less than million Japanese Yen, and not include tax.
Notes 2: This price doesn't include transportation cost and related expenses (fitting out cost and custom clearance cost)
Notes 3: This price is based as of October, 2013 and no escalation cost.

Source: The Study Team

Regarding the above chart, the total cost for the procurement of ships is **2,200 million JPY**.

6.6.4 Summary of Building Cost

(1) Objective of Cost Estimate

Total of twelve ships: two Cargo fleets (1 fleet: 1 pusher boat + 1 barge x 2 = 4 ships) and eight passenger ships

Assumptions of Cost Estimate:

The cost estimate of shipbuilding for this study was based on the market prices at 31st October 2013 and the following conditions

1) Currency Exchange Rate

JICA common rates for 2013 as under are applied.

- ✓ USD 1 = JPY 99.7
- ✓ USD 1 = Kyat 975.0
- ✓ JPY 1 = Kyat 0.1

2) Price Escalation

The following escalation rates are applied for foreign/local currencies in accordance to the proposed construction schedule.

- ✓ Foreign Currency Portion: 1.3% p.a.
- ✓ Local Currency Portion: 3.7% p.a.

3) Contingency

Contingency is calculated multiplying 5% to the sum of construction cost and price escalation.

4) Commercial Tax

There is no Value Added Tax (VAT) for Myanmar, instead, a Commercial Tax is applyed to import goods and services imposed by the Government. The rate of the Commercial Tax varies depending on the kind of goods. In this report, the Commercial Tax is assumed at 5% for average to apply all of material and services for construction.

5) Import Tax

Import Tax is not counted to the project cost estimate in this study because it is commonly exempted based on the mutual agreement between Japan and Myanmar for an ODA financed project.

6) Consulting Service Cost

Consulting service cost is assumed at 8% applying to the sum of construction cost, price escalation and contingency.

(2) The Result of the Cost Estimate

The project cost is estimated at 195,788,211Kyat for the local currency portion and 3,837,998,623Yen for the foreign currency portion, where the total is estimated at 3,857,965,000Yen (Yen conversion price).

The summary of the cost estimate is shown in Table 6.18, detailed breakdown is shown in Table 6.19 and scheduled yearly consumption is shown in Table 6.20.

Table 6.18 Summary of the Cost Estimate

ID.	Item No.	Work Description	Unit	Q'ty	Local Portion (Kyat)		Forein Portion (JPY)		TOTAL in JPY	Remarks
					Unit Rate	Amount	Unit Rate	Amount		
A		*Fabrication & Procurement*								
	1	Fabrication of passenger ferry	no	8	0	0	242,616,384	1,940,931,072	1,940,931,000	including spare parts
	2	Fabrication of pusher tug and barge	set	2	0	0	248,410,800	496,821,600	496,821,000	including spare parts
	3	Transportaions etc	LS	1	18,440,296	18,440,296	552,108,518	552,108,518	553,989,000	including VAT in Japan
	4	General Expenses	LS	1	0	0	219,397,740	219,397,740	219,397,000	9% of fabrication cost
		Total construction expenses (A)				18,440,296		3,209,258,930	3,211,138,000	
B		**Price escalation**	%	-		2,746,000		94,156,000	94,436,000	Local: 4.9%, Foreign: 1.3%
C		**Physical contingency (5%)**	%	5		1,059,315		165,170,747	165,278,000	
		Sub total (A+B+C)				22,245,611		3,468,585,677	3,470,852,000	
D		**Consulting Service**	LS	1		0		208,950,000	208,950,000	
E		**Administration Cost**	%	0.5		173,542,600			17,701,000	
F		**Commercial Tax**	%	5				160,462,947	160,462,000	
		GRAND TOTAL				195,788,211		3,837,998,623	3,857,965,000	

Note: TOTAL amount in Japane Yen is the amount of rounddown below 1,000 JPY

Source: The Study Team

Table 6.19 Detailed Cost Breakdown

No.	Description	Unit	Q'ty	Local Portion (Kyat)		Forein Portion (JPY)		Remarks
				Unit Rate	Amount	Unit Rate	Amount	
1	**Fabrication of passenger ferry**							
1.1	Fabrication	no	8	0	0	242,616,384	1,940,931,072	including VAT in Japan
	Summ				0		1,940,931,072	
2	**Fabrication of pusher tug and barge**							
2.1	Fabrication	set	2	0	0	248,410,800	496,821,600	including VAT in Japan
	Summ				0		496,821,600	
3	**Transportaions etc**							including VAT in Japan
3.1	Transportation (Japan to Yangon)	LS	1	0	0	505,980,000	505,980,000	
3.2	Lashing Cost	LS	1	0	0	15,179,400	15,179,400	
3.3	Shipping insurance	LS	1	0	0	15,769,718	15,769,718	
3.4	Transportation (Yangon to Mandalay)	LS	1	17,903,200	17,903,200	0	0	
3.5	Other cost	LS	1	537,096	537,096	15,179,400	15,179,400	
	Summ				18,440,296		552,108,518	
4	**General Expenses**							
4.1	General expenses	%	9	0	0	-	219,397,740	
	Summ				0		219,397,740	
	GRAND TOTAL				18,440,000		3,209,258,000	

Source: The Study Team

Table 6.20 Scheduled Yearly Consumption

ID.	Item No.	Work Description	Unit	Quantity	Base year in 2013				2014		2015		2016		TOTAL in JPY
					Unit Rate (Kyat)	Amount (Kyat)	Unit Rate (JPY)	Amount (JPY)	Local	Foreign	Local	Foreign	Local	Foreign	
		Price in 2013		**1.00**					**1.05**	**1.01**	**1.10**	**1.03**	**1.15**	**1.04**	
A		*Construction Expenses*													
	1	Fabrication of passenger ferry	no	8	0	0	242,616,384	1,940,931,072			0	1,940,931,072	0	0	1,940,931,000
	2	Fabrication of pusher tug and barge	set	2	0	0	248,410,800	496,821,600			0	248,410,800	0	248,410,800	496,821,000
	3	Transportation etc	LS	1	18,440,296	18,440,296	552,108,518	552,108,518			1,844,030	55,210,852	16,596,266	496,897,666	553,989,000
	4	General expenses	%	9	0	0	219,397,740	219,397,740			0	197,457,966	0	21,939,774	219,397,000
		Yearly construction expenses (A)				18,440,296		3,209,258,930			1,844,030	2,442,010,690	16,596,266	767,248,240	3,211,138,000
B		**Price escalation**	%	-		2,746,000		94,156,000			185,142	63,904,978	2,560,858	30,251,022	94,436,000
C		**Physical contingency (5%)**	%	5		1,059,315		165,170,747			101,459	125,295,783	957,856	39,874,963	165,278,000
D		**Consulting Service**	LS	1		0		208,950,000	0	125,370,000	0	83,580,000	0	0	208,950,000
E		**Administration Cost**	%	0.5		173,542,600		0			86,771,300	0	86,771,300	0	17,701,000
F		**Commercial Tax**	%	5				160,462,947			0	122,100,535	0	38,362,412	160,462,000
		GRAND TOTAL				195,788,211		3,837,998,623			88,901,931	2,836,891,986	106,886,280	875,736,637	3,857,965,000

Source: The Study Team

6.7 Economic and Financial Analysis

6.7.1 Introduction

Feasibility of the "Procurement of Ships for Inland Water Transport" is analysed from financial viability and contribution to the national economy. Internal Rate of Return of Finance (FIRR) and Internal Rate of Return of Economy (EIRR) calculated from annual cash flow are employed as evaluation indicators in this section. If FIRR and EIRR could not be calculated, figures of the Net Present Value would be calculated by use of the interest rate of soft loan (0.01%) for financial analysis and the social discount rate (12%) for economic analysis.

(1) Pre-conditions

The following pre-conditions are utilised for financial and economic analysis:

1) "With-project" Case and "without-project" Case

Producing and procuring new passenger ships and cargo ships is defined as the "with-project" case and not producing and procuring those ships is defined as "without-project," respectively. In the "with-project" case, the existing passengers of passenger ships continued to use inland water transport for passenger ships, and bulk cargos which did not have a pressing time limit would be shifted from truck transport to cargo vessel transport.

On the other hand, the passengers of existing passenger ships would shift to buses and bulk cargoes would be transported by trucks in the "without-project" case.

2) Calculation of Revenue and Maintenance Cost

Revenue and maintenance costs which are generated from the operation of passenger ships and cargo vessels by IWT are calculated annually. It is assumed that the transport volume of a cargo vessel would be limited to 80% of its capacity (1,000 tons) because cargo vessels are operated within a rotation, and that a passenger ship would work at its full capacity (150 passengers).

3) Project Implementation Schedule

Engineering service will be commenced in January 2014. A selected consultant team will conduct the basic design and detailed design of the new vessels and prepare bidding documents in the first 12 months, and the selection of a contractor will be processed in the following 12 months.

Production of passenger ships and cargo vessels will start in January 2016, and the construction of the port facilities and procurement of loading and unloading machines will be completed within 24 months. Operation of the new vessels will be started in January 2018.

4) Project Life and Replacement Investment

Economic and financial analysis will be conducted from 2014, the timing of starting the engineering service, to 2037, the 20^{th} year of the operation.

Major components of passenger ships and cargo vessels, which consist of pusher tugs and barges, are set as below:

- The body of a ship: 30 years,
- An engine: 20 years,
- Rigging and electrical equipment (mooring arrangement, deck machinery, nautical instruments, sanitary facilities and interior furnishing, etc.): 20 years

Since the project life is 20 years after starting operation, any replacement investment will not be made in this project. The lifetime of civil work is set at 20 years, therefore, the residual value of the body of the

ships which will account for 33% of the cost is listed in the cash flow table in 2037, the final year of the project.

5) Price and Exchange Rate

The price level as of September 2013 is employed in this economic and financial analysis, and the exchange rate is set as 1 US Dollar = 99.2 Japanese Yen = 970.9 Myanmar Kyat.

6.7.2 Financial Analysis

(1) Investment Cost

The costs for the production and procurement of vessels are indicated in Table 6.18. However, price escalation is not considered in this financial analysis. As a result, annual costs for the production and procurement are tabulated as Table 6.21. On the other hand, administration costs which are set as 0.5% of the construction and procurement cost is included in the investment cost.

Table 6.21 Investment Cost of the Procurement of Ships for Inland Water Transport

Unit: million Kyat

	2014	2015	2016	2017	Total	Remarks
Administration	43	43	43	43	174	0.5% of construction and procurement
Consultant service	614	410	512	512	2,049	8% Production and procurement
Construction and procurement	0	0	26,337	8,282	34,629	Including contingency and taxes
Total of investment	658	453	26,893	8,847	36,851	

Source: JICA Study Team

(2) Operation and Maintenance Cost

Items of operation and maintenance cost for passenger and cargo vessels and these conditions are identified as below:

1) Maintenance Cost

Maintenance cost is set as 1% of production cost. The cost includes painting the bodies of the vessels, annual inspections and small-scale repair work. Regular maintenance and repair work at a dock is conducted every five years. 3% of the production cost is needed for that.

2) Cost for Diesel Fuel

Cost for diesel fuel is calculated in the following way.

- Annual consumption volume of diesel fuel per vessel is calculated from consumption volume of diesel fuel per hour times navigation time times annual navigation, and times per vessel. The 2nd, 3rd and 4th columns of Table 6.22 show the consumption volume of diesel fuel per hour by routes, navigation time times and annual navigation times per vessel.
- Annual consumption volumes by routes are calculated from the annual consumption volume of diesel fuel per vessel times number of vessels by routes.
- Cost of one gallon of diesel fuel was 3,500 Kyat as of November 2013. The 6th columns of Table 6.22 shows annual cost of diesel fuel by routes.

Table 6.22 Cost for Diesel Fuel by Routes

Routes	Consumption volume of diesel fuel per hour (gallon)	Navigation time	Annual navigation times per vessel	No of vessels	Annual cost for diesel fuel (million Kyat)
Yangon–Phyarpon (passenger)	11.0	17.0	730	3	548
Yangon–Laputta (passenger)	8.8	11.0	156	3	252
Yangon– Kyonema Ngay (passenger)	7.5	1.4	156	2	106
Yangon–Mandalay (cargo)	24.0	7.6	52	2	1,048

Source: JICA Study Team

3) Personnel Cost for Crew

A passenger ship is operated by a captain and nine crew members, and a cargo vessel is operated by a captain and four crew members, respectively. The same levels of personnel cost are provided to captains and crews (120,000 Kyat per month for a captain and 85,000 Kyat per month for crews).

4) Total Operation and Maintenance Cost

Annual disbursement of the total operation and maintenance cost is indicated in Table 6.23.

Table 6.23 Operation and Maintenance Cost

Unit: million Kyat

Period	Maintenance cost	Cost of diesel fuel	Personnel cost	Total
2022, 2027, 2032, 2037	717	1,955	94	2,766
Other years	238	1,955	94	2,288

Source: JICA Study Team

(3) Project Revenue

1) Passenger Tariff

Table 6.24 indicates existing travel time, number of operations per week, and tariffs of passenger ships. It is expected that the operation of new passenger vessels will improve the convenience for passengers in terms of travel time and an increase in the number of journeys. It is also necessary to cover the operation and maintenance costs which is explained in the previous section. Therefore, the JICA Study Team proposes to increase the passenger tariff by around 50% as indicated in Table 6.25.

Table 6.24 Existing Travel Time, No. of Operation and Tariff of Passenger Ships

Route	Travel time		No. of operation per week	Tariff (Kyat)	Distance (mile)
	To Yangon	From Yangon			
Yangon–Phyarpon	9.3	8.3	14	1,500	64
Yangon–Laputta	27.8	26.9	6	3,500	168
Yangon–KyonemaNgay	18.3	18.3	3	2,000	118

Source: MPA

Table 6.25 Travel Time, No. of Operation and Tariff of Passenger Ships after Project Implementation

Route	Travel time		No. of operation per week	Tariff (Kyat)	Distance (mile)
	To Yangon	From Yangon			
Yangon–Phyarpon	7.0	21	21	2,300	153
Yangon–Laputta	18.0	9	9	5,300	151
Yangon–KyonemaNgay	13.0	6	6	3,000	150

Source: JICA Study Team

2) Cargo Tariff

IWT has not operated cargo vessels directly but leased out the vessels to private companies. Therefore, tariffs for cargo vessels are proposed from the existing tariff table for passenger-cum-cargo vessels.

Table 6.26 Existing Cargo Tariff of Passenger Cum Cargo Ships

Route	Distance (mile)	Unit cargo tariff (Kyat/ton/mile)
Yangon-Phyapon	64	70.00
Yangon-Lattputta	171	60.00
Yangon-Pyay	263	35.00
Mandalay-Pyay	334	36.00

Source: IWT

Table 6.26 indicates the existing unit cargo tariffs of passenger-cum-cargo by route. The unit tariffs are different by route. For example, the tariff levels are 60 Kyat/ton/mile for the Yangon–Phyapon route and 70 Kyat/ton/mile for the Yangon–Lattputa route which go around the Ayeyarwady Delta. On the other hand, the price levels are 35 Kyat/ton/mile for the Yangon–Pyay route and 36 Kyat/ton/mile for the Mandalay–Pyay route which connects Yangon with towns along the Ayeyarwady River. The JICA Study Team set unit tariff of cargo vessels which connect Yangon to Mandalay as 29 Kyat/ton/mile since it could be possible to operate cargo vessels with lower prices than cargo-cum vessels.

3) Total Project Revenue

Project revenue from the procurement of ships for Inland Water Transport is tabulated in Table 6.27. Total project revenue from 2018 to 2037 amounts to 27 billion Kyat.

Table 6.27 Project Revenue from Procurement of Ships for Inland Water Transport

	No of passengers (persons)	No of vessels	Annual operation per vessel (times)	Tariff (Kyat)	Revenue (1,000 Kyat)
Passenger ships					
Yangon–Phyarpon	150	3	730	2,300	755,550
Yangon–Laputta	150	3	156	5,300	372,060
Yangon–KyonemaNgay	150	2	156	3,000	140,400
Total of passenger revenue					1,268,010
Cargo vessels					
Yangon–Mandalay	800	2	52	17,313	1,440,442
Total project revenue					2,708,452

Source: JICA Study Team

(4) Calculation of Financial Internal Rate of Return

Table 6.28 shows the annual cash flow of the procurement of ships for Inland Water Transport from 2018 to 2037. Figures from the 2nd column to 5th column are cash outflow items, and the 6th column is a cash inflow item. Figures of the 7th column are annual net cash flow.

Table 6.28 Cash Flow of Procurement of Ships for Inland Water Transport (Both of Passenger Ships and Cargo Vessels)

Unit: million Kyat

Year	Administration cost	Consultant cost	Investment	Operation and maintenance	Project revenue	Net cash flow
2014	43	615				-658
2015	43	410				-453
2016	43	512	26,337			-26,893
2017	43	512	8,292			-8,847
2018				2,288	2,708	421
2019				2,288	2,708	421
2020				2,288	2,708	421
2021				2,288	2,708	421
2022				2,766	2,708	-57
2023				2,288	2,708	421
2024				2,288	2,708	421
2025				2,288	2,708	421
2026				2,288	2,708	421
2027				2,766	2,708	-57
2028				2,288	2,708	421
2029				2,288	2,708	421
2030				2,288	2,708	421
2031				2,288	2,708	421
2032				2,766	2,708	-57
2033				2,288	2,708	421
2034				2,288	2,708	421
2035				2,288	2,708	421
2036				2,288	2,708	421
2037			-536	2,766	2,708	479
					FIRR	-11.5%

Source: JICA Study Team

Financial Internal Rate of Return which is calculated from annual net cash flow is minus 11.5%. Annual cash inflow is 16% higher than cash outflow but the cash flow is 2% lower than cash outflow when regular maintenance works at dock are conducted every 5 years. In addition to that, the total project revenue could not be enough to cover the initial investment.

Table 6.29 shows major interest rates in Myanmar to consider a discount rate. If a soft loan is used for the project, a 0.01% discount rate is appropriate, and if a domestic financial resource is used for the project, a 10% discount rate is appropriate, respectively.

Table 6.29 Major Interest Rates in Myanmar

Kind of interest	Level of interest rate	Timing and source
Central Bank Rate	10%	As of November 2013 Central Bank of Myanmar Web site
Maximum Bank Lending Rate	13%	As of November 2013 Central Bank of Myanmar Web site
Government Treasury Bonds (5 years)	9.5%	As of November 2013 Central Bank of Myanmar Web site
JICA ODA Loan	0.01%	Effective from October 2013 JICA Web site
Inflation rate	2.8%	Average of 2012/13 (estimation) IMF Article IV Consultation Report

(5) Sensitivity Analysis

Table 6.30 compiles the result of the sensitivity analysis. Figures in the 2nd column are FIRR in each case. 10% increase of the investment cost drops FIRR by only 0.4 points but a 10% increase of operation and maintenance cost decreases FIRRby 5.3 points. When the project revenue is decreased by 10%, FIRR cannot be calculated. If the discount rate is set as 0.01%, NPV amounts to minus 35 billion Kyat.

Table 6.30 Result of Sensitivity Analysis

Unit: Percent

Cases	FIRR	Net Present Value (NPV, million Kyat)
Base case	-11.5	-29,813
10% increase of investment cost	-11.9	-33,444
10% increase of operation and maintenance cost	-16.8	-34,573
10% reduction of project revenue	NA	-35,222

Source: JICA Study Team

(6) FIRR of Passenger Ships Only and Cargo Vessel Only

Table 6.31 and Table 6.32 show the results of financial analysis when only passenger ships are produced and operated (the former table) and only cargo vessels are produced and operated (the latter), respectively. In the case where only passenger ships are produced and operated, FIRR cannot be calculated. If the discount rate is set as 0.01%, NPV account for minus 30 billion Kyat.

Table 6.31 Cash Flow of Procurement of Ships for Inland Water Transport (Passenger Ships Only)

Unit: million Kyat

Year	Administration cost	Consultant cost	Investment	Operation and maintenance	Project revenue	Net cash flow
2014	22	341				-364
2015	22	341				-364
2016	22	341	23,780			-24,144
2017	22	341	5,735			-6,098
2018				1,180	1,268	88
2019				1,180	1,268	88
2020				1,180	1,268	88
2021				1,180	1,268	88
2022				1,561	1,268	-293
2023				1,180	1,268	88
2024				1,180	1,268	88
2025				1,180	1,268	88
2026				1,180	1,268	88
2027				1,561	1,268	-293
2028				1,180	1,268	88
2029				1,180	1,268	88
2030				1,180	1,268	88
2031				1,180	1,268	88
2032				1,561	1,268	-293
2033				1,180	1,268	88
2034				1,180	1,268	88
2035				1,180	1,268	88
2036				1,180	1,268	88
2037			-405	1,561	1,268	113
					NPV（0.01% of discount rate）	-30,322

Source: JICA Study Team

If only cargo vessels are produced and operated, the result of FIRR amounts to minus 2.8%. Annual amounts of the net cash flow continue to be positive including the timing that regular maintenance work at the dock are conducted every 5 years. However, the surplus of the net cash flow is not enough to cover the initial investment.

Table 6.32 Cash Flow of Procurement of Ships for Inland Water Transport (Cargo Vessels Only)

Unit: million Kyat

Year	Administration cost	Consultant cost	Investment	Operation and maintenance	Project revenue	Net cash flow
2014	21	171				-192
2015	21	171				-192
2016	21	171	3,308			-3,500
2017	21	171	4,829			-5,021
2018				1,108	1,440	333
2019				1,108	1,440	333
2020				1,108	1,440	333
2021				1,108	1,440	333
2022				1,205	1,440	235
2023				1,108	1,440	333
2024				1,108	1,440	333
2025				1,108	1,440	333
2026				1,108	1,440	333
2027				1,205	1,440	235
2028				1,108	1,440	333
2029				1,108	1,440	333
2030				1,108	1,440	333
2031				1,108	1,440	333
2032				1,205	1,440	235
2033				1,108	1,440	333
2034				1,108	1,440	333
2035				1,108	1,440	333
2036				1,108	1,440	333
2037			-131	1,205	1,440	366
					FIRR	-2.8%

Source: JICA Study Team

6.7.3 Economic Analysis

(1) Calculation of Economic Benefit

As defined in the section 6.7.1(1), the existing passengers of IWT would shift to bus transport and bulk cargo between Yangon and Mandalay would continue to be transported by trucks. Those situations are treated as opportunity costs of "without-Project," and an economic benefit of the procurement of ships for Inland Water Transport.

Table 6.33 indicates number of IWT passengers and the revenue of bus companies if the passengers would shift to bus transport. There are bus transport services available at Yangon–Phyarpon and Yangon–Laputta currently but the service is not available between Yangon and KyonemaNgay. Therefore, bus tariffs between Yangon and KyonemaNgay are estimated from the relations of distance and bus tariffs of Yangon–Phyarpon and Yangon–Laputta. In addition to that, transport cost is added to each bus tariff because Dagon Ayar Highway Bus Station, which is the terminal of these routes, is located 15 miles (24 kilometers) from downtown Yangon, and IWT passengers are complaining about the accessibility. Therefore, 500 Kyat of transport cost from downtown to the terminal is included in each bus tariff. If the existing IWT passengers would shift to bus transport, the annual revenue of bus companies would account for 2.4 billion Kyat.

Table 6.33 Revenue of Bus Companies if Passengers of Inland Water Transport Shift to Bus Transport

Routes	Distance (mile)	No of vessels	No of passengers per vessel (persons)	No of operation per vessels	Annual no of passengers (persons)	Bus tariff (Kyat)*	Revenue (1,000 Kyat)
Yangon–Phyarpon	60	2	450	365	328,500	3,500	1,149,750
Yangon–Laputta	140	2	400	156	124,800	7,500	936,000
Yangon–KyonemaNgay	101	1	350	156	54,600	5,600	305,760
Total							2,391,510

Note: Bus tariff includes transport cost from downtown of Yangon to Dagon Ayar Highway Bus Station (500 Kyat).
Source: Collected at Dagon Ayar Highway Bus Station Compiled by JICA Study Team

Cargo tariffs of truck (17 tons of transport capacity) transport between Yangon and Mandalay are 36,000 Kyat per ton. One fleet (combination of a pusher tug and a barge vessel) can transport 800 tons of cargo, and the annual operation per fleet is 52 per year. Therefore, the annual transport volume of two fleets accounts for 83,200 tons per year. If the cargo volume were shifted from inland water transport to truck transport, the expected revenue of truck companies would amount to 3 billion Kyat per year. As a result, revenue of bus companies and truck companies, which is the economic benefit of the procurement of ships for Inland Water Transport, is 5.4 billion Kyat per year.

(2) Calculation of Economic Cost

The costs for the production and procurement of vessels are indicated in Table 6.18. However, price escalation, physical contingency and taxes are not included in this investment cost with an economic price basis. As a result, the annual costs for the production and procurement are tabulated as Table 6.34. On the other hand, administration costs which are set as 0.5% of the construction and procurement cost is included in the investment cost. Since percentages of the local currency portion is only 0.5% of the total investment cost, correction of the distortion between the domestic price (price for non-tradable goods) and the international price (price for tradable goods) is not made in this analysis.

Table 6.34 Investment Cost of Procurement of Ships for Inland Water Transport (Economic Price)

Unit: million Kyat

	2014	2015	2016	2017	Total	Remarks
Administration	43	43	43	43	174	0.5% of construction and procurement
Consultant service	615	410	512	512	2,049	8% Production and procurement
Construction and procurement			22,313	6,997	29,310	Not including contingency and taxes
Total of investment	658	453	22,869	7,553	31,533	

Source: JICA Study Team

Regarding the operation and maintenance costs of the port facilities, the cost introduced in the financial analysis is employed as it is.

(3) Calculation of Economic Internal Rate of Return

Table 6.35 tabulates the annual cash flow of the procurement of ships for Inland Water Transport with economic price basis. Figures from the 2nd column to the 5th column of the table are cost items and figures in the 7th column which are calculated from economic benefit minus the cost items are the annual net cash flow.

Table 6.35 Cash Flow of Procurement of Ships for Inland Water Transport (Economic Analysis, Both of Passenger Ships and Cargo Vessels)

Unit: million Kyat

Year	Administration cost	Consultant cost	Investment	Operation and maintenance	Project revenue	Net cash flow
2014	43	615				-658
2015	43	410				-453
2016	43	512	22,313			-22,869
2017	43	512	6,997			-7,553
2018				2,071	5,387	3,315
2019				2,071	5,387	3,315
2020				2,071	5,387	3,315
2021				2,071	5,387	3,315
2022				2,116	5,387	3,270
2023				2,071	5,387	3,315
2024				2,071	5,387	3,315
2025				2,071	5,387	3,315
2026				2,071	5,387	3,315
2027				2,116	5,387	3,270
2028				2,071	5,387	3,315
2029				2,071	5,387	3,315
2030				2,071	5,387	3,315
2031				2,071	5,387	3,315
2032				2,116	5,387	3,270
2033				2,071	5,387	3,315
2034				2,071	5,387	3,315
2035				2,071	5,387	3,315
2036				2,071	5,387	3,315
2037			-434	2,116	5,387	3,704
					EIRR	7.6%

Source: JICA Study Team

Economic Internal Rate of Return which is calculated from net cash flow is 7.6%. The level is under 12%, which is recognized as the social discount rate, an indicator of economic analysis. The level is normally utilised in infrastructure development projects in developing countries. The project is not feasible from the point of view of the national economy.

(4) Sensitivity Analysis

Table 6.36 compiles the result of the sensitivity analysis. Figures of the 2nd column are EIRR under different changes of conditions. Decrease of economic benefit is the most significant impact on EIRR, and a 10% decline of the economic benefit would drop EIRR by 2.0 points. A 10% increase of investment cost would drop EIRR by 1.1 points, and a 10% increase of operation and maintenance cost would drop EIRR by 0.7 points, respectively.

Table 6.36 Result of Sensitivity Analysis

Unit: Percent

Cases	EIRR
Cases	7.6
Base case	6.5
10% increase of investment cost	6.9
10% increase of operation and maintenance cost	5.6

Source: JICA Study Team

(5) FIRR of Passenger Ships Only and Cargo Vessel Only

Table 6.37 and Table 6.38 show the result of economic analysis when only passenger ships are produced and operated (the former table) and only cargo vessels are produced and operated (the latter), respectively. In the case where only passenger ships are produced and operated, the result of EIRR is 1.1%. The level is below 12% which is set as a social discount rate in this analysis.

Table 6.37 Cash Flow of Procurement of Ships for Inland Water Transport (Economic Analysis, Passenger Ships Only)

Unit: million Kyat

Year	Administration cost	Consultant cost	Investment	Operation and maintenance	Project revenue	Net cash flow
2014	43	512				-556
2015	43	512				-556
2016	43	512	19,388			-19,944
2017	43	512	3,017			-3,573
2018				1,008	2,388	1,381
2019				1,008	2,388	1,381
2020				1,008	2,388	1,381
2021				1,008	2,388	1,381
2022				1,044	2,388	1,345
2023				1,008	2,388	1,381
2024				1,008	2,388	1,381
2025				1,008	2,388	1,381
2026				1,008	2,388	1,381
2027				1,044	2,388	1,345
2028				1,008	2,388	1,381
2029				1,008	2,388	1,381
2030				1,008	2,388	1,381
2031				1,008	2,388	1,381
2032				1,044	2,388	1,345
2033				1,008	2,388	1,381
2034				1,008	2,388	1,381
2035				1,008	2,388	1,381
2036				1,008	2,388	1,381
2037			-328	1,044	2,388	1,673
					EIRR	1.1%

Source: JICA Study Team

If only cargo vessels are produced and operated, the result of EIRR amounts to 9.9%, lower than the social discount rate. The result is higher than the case of only passenger ships and contributes to raise EIRR of the whole production and procurement of passenger ships and cargo vessels. However, EIRR of the only cargo vessels is under 12%.

Table 6.38 Cash Flow of Procurement of Ships for Inland Water Transport (Economic Analysis, Cargo Vessels Only)

Unit: million Kyat

Year	Administration cost	Consultant cost	Investment	Operation and maintenance	Project revenue	Net cash flow
2014	21	171				-192
2015	21	171				-192
2016	21	171	2,781			-2,973
2017	21	171	4,122			-4,314
2018				2,053	2,995	942
2019				2,053	2,995	942
2020				2,053	2,995	942
2021				2,053	2,995	942
2022				2,062	2,995	933
2023				2,053	2,995	942
2024				2,053	2,995	942
2025				2,053	2,995	942
2026				2,053	2,995	942
2027				2,062	2,995	933
2028				2,053	2,995	942
2029				2,053	2,995	942
2030				2,053	2,995	942
2031				2,053	2,995	942
2032				2,062	2,995	933
2033				2,053	2,995	942
2034				2,053	2,995	942
2035				2,053	2,995	942
2036				2,053	2,995	942
2037			-106	2,062	2,995	1,039
						9.9%

Source: JICA Study Team

6.7.4 Conclusion

The procurement of ships for Inland Water Transport is not feasible from a financial aspect and to the contribution of the national economy. EIRR of the project is 7.6%, which is under 12% of the social discount rate in this analysis.

FIRR of the project is minus 11.5%. Annual project revenue exceeds annual operation and maintenance cost by 16% normally but the annual project revenue is 2% smaller than annual operation and maintenance cost every five years when regular maintenance and inspection is conducted.

Such low levels of EIRR and FIRR come from expensive production costs and transportation costs. All vessels are produced in Japan and transported from Japan to Myanmar. It is necessary to consider producing these vessels in a third country to reduce production and transportation costs.

6.8 Management and Operation

For the operation of ships, IWT has enough experience in the field, and has several dock yards which can serve their ships. At present, Japanese grant aid project of ferries which crosses the Yangon River to Dalla is going on, and IWT is considered to manage and operate inland ships.

Ships made in this project will need periodic inspection every year because they will be classified as sea-going ships. It is necessary to set up a system that assures regular maintenance.

6.9 Environmental and Social Considerations

6.9.1 Evaluation of Environmental Impacts

Ship building will be conducted in Japan; therefore the building ship work in a dock shall meet Japan's standards.

Environmental impacts likely caused by ship operation in Myanmar are expected as follows:

Table 6.39 Possible Environmental Impacts by Ship Operation

Environmental Impact	Scale	Description
Air Quality	C	• Air pollution generated by exhaust gases from ships
Noise	C	• Noise generated from engine of ships
Water Quality	B	• Water pollution by leakage of oil from engine, human waste from toilets, bulk materials (ex. soil)
Waste	B	• Human waste, spread of bulk materials

Note: B means "moderate impact is expected"; while C means "less impact is expected"

Source: JICA Study Team

One of the positive impacts is to expect the reduction of CO_2 emissions by using more efficient modern technology in building ships.

Condition on estimation of CO_2 reduction is as below.

Annual cargo volume was estimated based on the followings

Cargo transportation route is between Mandalay and Yangon. Number of convoys will be formulated at three, which can convey 800 tons each. Round trip time between Mandalay and Yangon is estimated as approximately 2 weeks. Therefore, Annual cargo volume is estimated 62,400 tons (one way)

With case: this cargo will be conveyed by ship.

Without case: the cargo will be conveyed by truck.

CO_2 reduction by the Project is summarized in table below.

Table 6.40 CO_2 Reduction by the Project

	Year 2030
Cargo Handling Volume (tons)	62,400
Distance (km) Water way Road way	 956 660
CO_2 Emission Rate (gCO_2/ton-km)	
Ship [1)]	46.6
Truck [2)]	158
Annual CO_2 Emission ($tonCO_2$/year)	
Ship	5,560
Truck	13,014
Percentage vessel / truck (%)	42.7

Note:
1) Calculation based on DWIR (fuel consumption) and IPCC (CO2 emission ratio)
2) Environment and Transportation, Foundation for Promoting Personal Mobility and Ecological Transportation, 2011

Source: JICA Study Team

Procurement of new ships can contribute to the reduction of CO_2 emissions, to 43 % decreasing comparing land transportation (truck).

6.9.2 Environmental Management

Although Myanmar has not yet established guidelines/standards for the emissions of gas, noise and effluent water from ships, it is recommended to appropriately design and build ships with achieving adequate international design standard based on MARPOL73/78, Japan Standards, and e.g.

The following table summarises environmental mitigation measures in the ship operation.

Table 6.41 Proposed Mitigation Measures

Environmental Impact	Mitigation Measures
Air Quality	• To regularly maintain and keep ship condition
Noise	• To regularly maintain and keep ship condition • To prevent unnecessary whistle
Water Quality	• To install adequate toilet to avoid direct discharging of human waste • To cover bulk materials to prevent spreading in to river • To compartment engine room to prevent oil
Waste	• To place garbage cans, e.g. • To enlighten passengers / crew to follow the rules

6.10 Contribution of Japan's ODA

(1) Importance to Procure Passenger Ship & Cargo Vessel

The policy of the Japanese government (2013) on official assistance to Myanmar is explained as follows.:

"In order to assist the movement of Myanmar toward democratization and peacefulness of the nation, the Government of Japan will contribute the infrastructure development for the local agricultural development, the peace with minority races, improvement of people's life, improvement of social weakness, and personal capacity building. Japan will also support infrastructure development as well as the establishment of laws/rules for Japanese private firms' business in Myanmar, such as Thilawa SEZ development project. For the purpose to achieve these successful developments, the Government of Japan will forward the official development assistance to the target amount scaled 20 billion J¥ from budget of 2013 FY, consists of grant aid and yen loans. (MOF Japan)"

With respect to the above policy of Japan, the importance of Mandalay Port development is summarized as follows:

1) The Procurement should contribute to enhance living level of Myanmar (to fulfill BHN)

Myanmar is categorized as a Least Developed Country (LDC) as well as African poverty countries according to the World Bank/United Nations. In some part of the Delta area in Myanmar, there are people who have a lower living level than average people in Myanmar, and have to depend on inland water transport to go to Yangon due to undeveloped roads or other transport networks. Although there is a high need for inland water transport for these people, no private vessels have gone into service because there is no expectation to get profits from these lines, therefore only IWT is maintaining and supporting the lines with high publicness. However, most of the passenger ships of IWT are decrepit and the time to renew the ships has come. Considering these situation, it is significant that the Japanese government supports Myanmar through the procurement of passenger ships to secure a transport mode for the lower income people of the region, that is, to support to fulfill Basic Human Needs (BHN) to these people in Myanmar.

2) Inland water transport has potentially very important role on logistics of Myanmar（Necessity of project forming as a pilot project）

Although it is a world major river, the Ayeyarwady River, which is running across the nation in north-south direction, the inland water transport in Myanmar is still undeveloped even in the key route between Yangon and Mandalay, and 80% of cargo transport of the whole Myanmar is depending on road transport. The major reason why water way is not used is that almost all of the port activities of the inland water transport is still pre-modernized and cargo handling depends only on manpower without any machines. The port facilities so is not effective on port operations and modern port activity has not begun in Myanmar, therefore, the necessity of a development project for Mandalay Port is proposed as the top priority. To make the Mandalay Port project more effective and to implant modern mechanized inland water transport, new cargo vessels corresponding to modern machinery cargo handling should be introduced, but on a limited scale as a pilot project. The reason why this procurement should be a pilot project is that the procurement has trial characteristics to implant modern cargo transport to Myanmar. If modernized cargo transport is introduced in Myanmar inland water transport, the time for cargo handling will be dramatically shorter, planning of cargo transport will get high loading ratio in each cargo vessel, and as a result, the punctuality of cargo transport will come true and it will invite more cargo to waterway. Finally, these improvements on waterway logistics will contribute to the higher economic growth of Myanmar. For this trial, the most effective route must be between Yangon and Mandalay because Myanmar will develop in between these two business capitals.

3) Cost performance compared to road and railway net works

Initial investment related to ships/vessels procurement is US$ 17 million in case of two cargo fleets according to the result of this study. If the construction cost of Mandalay Port is US$ 35million, the total initial investment is approximately US$ 52 ~ 55 billion. On the other hand, road and railway networks need 10 ~ 100 times of the above cost due to their development characteristics that all along the line between regional core cities should be developed, e.g. pavement for road & rail installation, although the water way needs basically ports and ships only, it is not necessary to improve the waterline itself if the waterway is good enough for ship navigation. Myanmar has wide national area so the above cost difference between the water way and road/railway tends to become larger. Consequently, the initial investment for inland water transport needs a relatively cheaper cost compared to road/railway development, and, considering the potential benefit supposed to be gined from the improvement of the waterline between Yangon and Mandalay, it can be said that water way improvement has higher cost performance.

4) Know-how of Port Operation and Management (personal capacity building)

In the river ports of Myanmar, there are no cargo facilities where only manual handling is carried out at natural riverbank, therefore there is no port management body too. Technical assistance in the field of port management will be needed at the same time to build the new modern port facilities. The use of Japan's port management know-how and technology is important.

5) Connectivity to Thilawa SEZ development project (infrastructure development for Japanese private firms' business in Myanmar)

Currently the Japanese ODA is put into the infrastructure development for Thilawa SEZ and national gate port project. When an inland water transport system is established, the container transport will become possible on the routes between river ports and the gate port. The development of river ports will contribute the national economic growth by establishing waterway routes by which import container cargoes can be carried directly from the gate port to the river ports, or contrarily, industrial goods or agricultural products produced in inland areas can be carried from the river ports to the gate port for export.

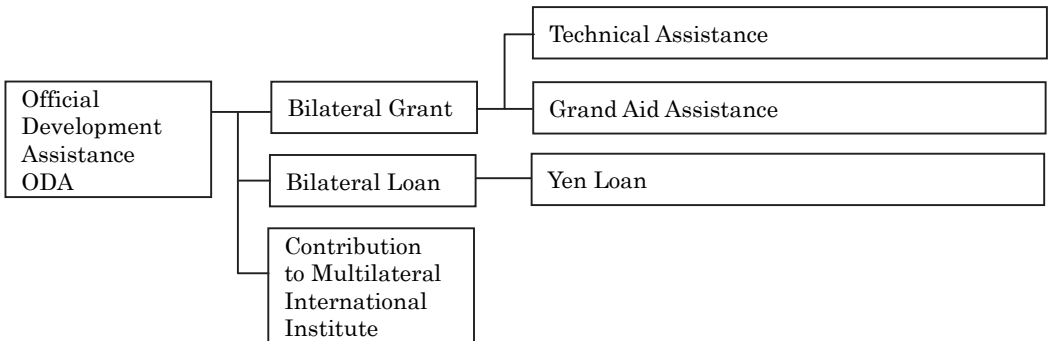
In addition, Myanmar is anticipated to become a fruitful consumer market as the country holds approximately 60 million people on wide national land with 680 thousand km2, the second largest among the ASEAN countries. When Japanese private firms invest and go into business by using Thilawa SEZ, the inland waterways will play a very important role as the transportation route of products manufactured in the industrial park in Thilawa.

6) Promotion of inland waterway will contribute global environment by reducing emission of greenhouse gas

It is generally well known that the use of waterway transport reduces environmental burdens created by transportation traffic compared to road transport. Although the heavy cargoes are not carried by waterway at present because only manual loadings are available in the river ports, the port will be able to handle such cargoes when the system of equipment handling is established. For instance, cars whose selling demand is rapidly growing in Myanmar are currently transported from Yangon to Mandalay by being driven. If the waterway can carry the cars by barge, the emission of exhaust gas by their being driven will be much reduced.

(2) The Forms and Aims of Japan's ODA

In this part, it is discussed on the matter what sort of form of Japan's ODA is suitable for Mandalay Port development project. The considerations are made on three forms of ODA, i.e., Grand Aid Assistance, Yen Loan, and Technical Assistance. Figure 6.20 shows the categories of the forms of Japan's ODA.



Source: JICA

Figure 6.20 Forms of Japan's ODA

These forms are explained briefly as follows (Source: MOF Japan)

1) Grant Aid Assistance

Grant Aid Assistance is a form of ODA in which the fund is granted to the developing country. The fund is used for the procurement of goods/equipment, facilities or services for the purpose of the economic/social development of the developing country.

The major applicable fields of the assistance are 1) basic human needs (BHN) such as health and sanitation, water supply, education, and agricultural development, 2) development of social infrastructure, 3) protection of the environment, and 4) human capacity building. In recent years, the applicable fields are extended to 5) protection and restoration for disasters, 6) assistance for peace keeping, 7) removal of land mines, 8) measures against terrorism and maritime safety, etc.

2) Yen Loan Assistance

Yen Loan Assistance is a form of ODA in which the fund is lent to the developing country. The low interest and long return period of the Loan is applied with the aim to assist developing countries.

In order for the developing countries to achieve economic growth by their own effort in view of a longer time period, it is important to build the economic/social infrastructure for the constant and sustainable growth of the developing country. It is however not easy for the developing countries to raise sufficient funds from the free money market. The Yen Loan plays important role by offering very gentle conditions to the developing countries.

By placing the obligation for the developing country to return the loan, the lender country is encouraged to have a self-effort to keep proper financing conditions, which puts a good effect on the development of the country.

The applicable fields of the assistance are determined taking into account the structure of the economy of the lender country, a national development master plan and a government policy on the allocation of budget, etc. The amount of applied Yen loan for "economic infrastructure" such as for the projects of road, rail, bridge, port, and power generation, shared 66.7 % (E/N based) of total amount in 2009 FY.

3) Technical Assistance

Technical assistance is a form of ODA in which Japanese advanced technology and knowledge is transferred to the developing country in order to develop human resources who should be capable to undertake social/economic development projects. The aim of the Technical Assistance extends to assist local engineers to develop technology complying to the local conditions, and to the field of regulations and organizations.

The applicable fields of the assistance are very wide expanding from the field of BHN such as health and sanitation to the field of industrial engineering.

(3) Suitable Form of Japan's ODA for Procurement of Passenger ship/ Cargo Vessels

1) "Grant Aid Assistance" or "Yen Loan Assistance"

This study had commenced to seek a possibility aiming to form the ship procurement with applying the Japanese Yen Loan, but at the same time, a possibility to apply Grant Aid was also within consideration. After some discussions, the procurement purport of passenger ships and cargo vessels evolved and became different from what was discussed in previous chapters. Based on these discussions, further examinations whether or not this procurement should be a Yen Loan Project or Grant Aid are continued in the following.

Case 1: Procurement of eight passenger ships only

EIRR = 1.1 % FIRR = Error (impossible to calculate)

As for passenger ships, the objective user has a lower income level and therefore the fee should be at a minimum. On the other hand, the initial cost is a big burden to Myanmar at present. As the result of this big gap, it cannot be feasible as a Yen Loan Project on the view point of financial/economic analysis. However, the project has a purport to secure only one transport mode to Yangon for the people having a lower income level, and this characteristic has a possibility to apply Grant Aid.

Case 2: Procurement of two fleets of cargo vessels only

EIRR = 9.9 % FIRR = -2.8 (base case)

As for cargo vessels, EIRR shows a relatively higher figure but it could not reach to 12% which is generally recognized as the social discount rate, an indicator of economic analysis. If this attitude is preceded, it has to say that the project is not feasible from the point of the national economy. As for FIRR, the value shows minus 2.8% and it means the initial cost is too high to cover the project.

Present inland water transport in Myanmar is depending on manpower cargo handling only and implanting a new mechanized system which will be usable for future development of the Country. It will discover a new demand for inland water transport and the first candidate as an objective route must be between Yangon and Mandalay, because Myanmar will develop from these business capitals. From this point of view, a Grant Aid project, as a pilot project, seem to be suitable.

Case 3: Procurement of 8 passenger ships and 2 fleets of cargo vessels (above 1 + 2)

EIRR = 7,6 % FIRR = -11.5 (base case)

An initial purpose of this study was to review the request from IWT and it contained the procurement of 37 ships with a Yen Loan. In this opportunity, a proposal from reviewing the request is to procure eight passenger ships and two cargo fleets and the EIRR is 7.6 %. This figure is short of 12% and if the same attitude in case two is preceded, it becomes not feasible to apply a Yen Loan. With regard to FIRR, the annual revenue is 16% over annual operation and maintenance costs but the annual revenue is 2% smaller than the annual operation and maintenance cost for every 5 years when regular maintenance and inspection is conducted. So it can be said that initial investment cost is too high to cover the project.

Also, the total initial cost for both passenger ships and cargo fleets procurement are about US$ 38 million and it must be the biggest procurement project ever taken before in Grant Aid projects.

2) "Technical Assistance"

In addition to the above implementation of the pilot project, the task of Japan's "Technical Assistance" will be important. The following items of Technical Assistance should be applied together with the execution of the Grant Aid project:

- Technology transfer regarding ship handling and operation and maintenance
- Knowledge/know-how transfer regarding port operation and management
- Technical transfer regarding navigation vessels

6.11 Recommendations

As a premise of this study, examination on this ship procurement itself had commenced to aim a Japanese Yen Loan project however the possibility of applying Grant Aid was also eyed. Also, another important key was to implant Japanese advanced technology into this procurement project for contributing further development of Myanmar. As is widely well known, Japanese shipbuilding is at the top level in the world but a point is how we could introduce this technology into the project with aiming to apply Japanese ODA.

At this time, the Counterpart of this ship renewal was IWT. Although IWT is an organization under MOT and they are a public company. Also, they are operating inland water transport businesses, that is, their business competes with private companies in most of all cases. As is very well-known, an ODA project cannot assist to disturb existing private business and must have high publicness.

(1) Passenger Transport

On the above mentioned view point, the premise of applying ODA should be limited in selection of the routes, where no private operators have any business or it's impossible to make business on the view of gain and loss, but essential for local people. That is, the demand of passenger transport exists but there is no alternative transport mode, e.g., road to the major city is still undeveloped. Although there is a possibility that present water transport user will shift to road transport when road network is developed, three routes are nominated as the result of this study, and the proposed number of new ships is eight.

Economic/financial analysis were computed based on demand forecasting, initial investment cost and other required elements however, the project seems to be not feasible as a Yen Loan project.

However, these three routes have high needs, high publicness, and the objective passengers are in a lower income class in Myanmar and the Country is presently categorized as LDC, most destitute country according to World Bank/United Nations, that is, this situation seems not to fill Basic Human Needs. Therefore, considering these elements, this procurement seems to deserve to apply Grant Aid project.

(2) Cargo Ship Transport

As the result of the Economic/Financial analysis, cargo fleets procurement also seems to be not feasible to Yen Loan but the core problem of the present inland water transport system in Myanmar is not caused by the transport method but that there are no port facilities. If the present pre-modernized manpower cargo handling is improved to modern machinery cargo handling with appropriate facilities, many of small cargoes also can be carried at one time, that is, the cargo handling efficiency is enhanced. In this case, the inland water transport will have the possibility to get competitive transport costs in a part, compared to road transport which is major transport in Myanmar and almost 80% of whole cargo is transported. If it comes true, cargoes already shifted to road transport will be back to inland transport in a certain part, probably the route between Yangon and Mandalay, most expected part to get dramatic development in Myanmar. If so, basically heavy and massive cargo such as: logs, rice, used/brand new cars, and construction materials like cement, structural steels, will be shifted back to inland water transport. Those items are likely to be largely demanded to be carried in between two prime business cities, according to the development of the Country.

Considering these surroundings, the procurement of cargo ships seems to support the new Mandalay Port development and that the combination will make the efficiency of inland water transport higher. It is recommended that the project scale is limited and the procurement number of the cargo fleets, comprised of pusher tugs and barges in a fleet, are only two. The reason is that the project has the characteristics as a pilot project to newly introduce a modernized punctuality water transport between Yangon and Mandalay, and further development should be expected by the self-help of Myanmar people.

There is not a rich experience of such a modernized inland water transport in Myanmar so Japanese experience and technology will be beneficialness for the Country.

In any of these case, the initial invest cost is a big burden and especially the transportation cost is very high because the distance is from Japan, about 7,000km, to Myanmar. To minimize the cost, the procurement should be from a closer third country, but for further investigation, another study is necessary to confirm the possibility.

(3) Japanese Technology on Ship Renewals

It is a premise that Japanese ships come into use by Myanmar people in order to get their understanding of the merit of Japanese technology. However, it is important to maintain the new devices in good condition for a long time otherwise those merits will be soon in vain, and in the worst case, the life of the procured ships will be dramatically shorter. On the other hand, maintenance for these advance technologies is not easy to depend on using not only maintenance manuals but also the direct technical transfer by experts are necessary. Besides, experience, higher skills and techniques by experts need some supplemental material/equipment therefore comprehensive assistance like the combination of dispatching Japanese experts and material/ repair machines and so on will be valid together with the procurement. Also, related to this, acceptance of trainees to Japan should be considered.

As for the procurement of cargo ships, the proposed pilot project needs technical assistance mainly for the operation field such as: how to manage cargoes in stock yard, what kind of organization is necessary on port management etc., therefore dispatching experts for port management and creating training courses on port management are necessary so the technical cooperation project seems to be effective in this part.

In case that the inland water transport in Myanmar is developed smoothly, the traffic of ships will increase as a matter of course against background of high economic growth in Myanmar. Although at present the small traffic volume of the inland water transport system can be managed without advanced technology, high technology of ship navigations will be needed in near future. On this point, Japanese technical assistance will be needed.

Chapter 7 Recommendations for Total Project

7.1 Modernization by Port & Ship Development

This study covers the following items as the themes on the modernization of the inland water transport sector.

1) Mandalay Port development
2) Passenger ship procurement for routes in the Delta region
3) Cargo barge & tug procurement assuming a shuttle transport service between Yangon and Mandalay

In this section, a recommendation on the combined development of port terminal operation with shuttle barge transport service is described. The combined development means the coordinated development between the following two items. Shuttle transport service means the fixed time scheduled service between two ports, in which the route is assumed to be developed between Yangon and Mandalay where the transport demand, including road and railway, is high.

1) (Port): receiving, storage and delivery services of cargo by the function of the port terminal operation
2) (Barge): fixed time schedule service of large transport barges

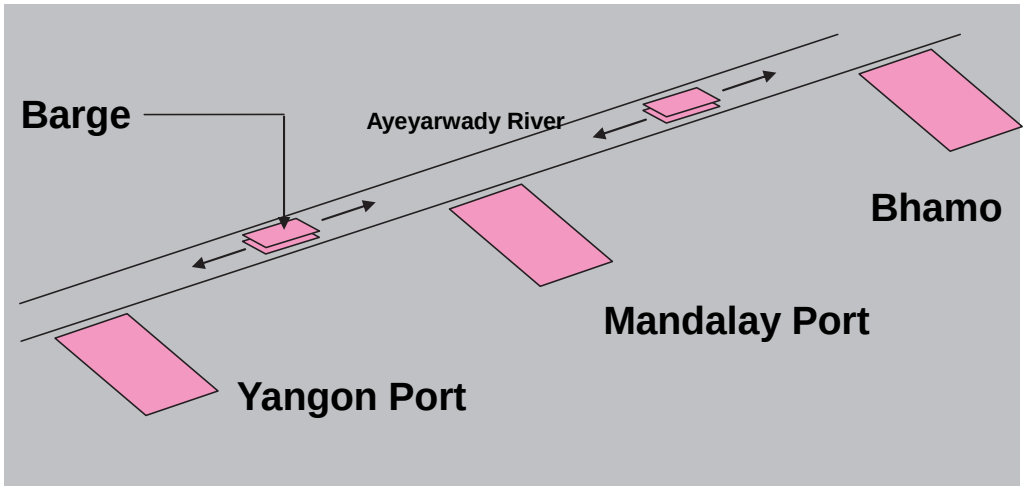


Figure 7.1 An Image of Shuttle Transport Service between Yangon and Mandalay

The advantages of the combined development are explained as follows:

1) Cost-down for unit cargo transportation due to filling the barges for the return trip

(Existing Problem)

The existing services are provided by an indeterminate time schedule, where every ship owner operates his barge upon receiving an order from a cargo owner. In this case, there is a risk that the ship owner is not able to receive an order for the return trip of the barge. If the return trip is operated with the barge

empty, the cost for return trip shall be charged to the cargo owner of the outward bound cargo. This is an obstruction to reduce the transportation cost.

(Solution)

Applying the function of a port terminal operation service, the terminal will call for and receive the order of cargo transport independently.

(Effect)

Because the port terminal gathers the departure cargo, the ship owner does not have to call for the order of a return trip. The occupancy of the barge carrying capacity becomes high which reduces the unit cost of transportation.

2) Cost-down for unit cargo transportation due to receiving small cargo customers

(Existing Problem)

In the existing service, the cargo owner has to search for a barge with a sufficient size for his volume of cargo. Because the variation of barge sizes is limited, cargo owners are not always able to get the suitably sized barge.

(Solution)

By applying a port terminal operation, the operator receives the order from not only the large-volume customers but also the owners of small-volume. The gathered cargo from many owners can be loaded onto one barge by the port operator.

(Effect)

Consequently the barge occupancy rate will be raised which makes effective use of barges possible. The increase of barge occupancy causes the reduction of the unit cargo transport cost. In addition, getting the business of small-cargo owners will push up the total transport demand of inland water transport.

3) The additional demand due to the improvement of services

(Existing Problem)

In the existing transport system, the forwarder (mostly warehouse owners at the origin of the cargo) arranges barges & tugs, laborers for loading and unloading, and trucks between the port and warehouse. The work of these arrangements is generally complicated. Unless the preparations are well organized, the total travel time tends to be extended.

(Solution)

Terminal operation and shuttle service make the preparation of transport very simple. Barges move on their time schedule, and cargo handling is carried out by the port terminal operator. The cargo owner should only carry or receive cargo at the port terminal while no complicated preparation is needed. The shuttle service will make the whole travel time between origin and destination shorter.

(Effect)

Due to a simple arrangement service, the cargo owner feels it’s easy to use the waterway transport. It is assumed that the modal shift from road/rail to waterway will be encouraged. The system of shuttle and port operation service is also effective for raising the demand of waterway transport because the travel time will be shorter.

7.2 Management Structure and Privatization

7.2.1 Port Management and Privatization

The recommendations on port management are described as follows:

(1) Management on Port Construction

Implementation authority of port construction of this project is scheduled to be undertaken by DWIR. It is considered to be appropriate that DWIR takes this obligation taking into account the authority has undertaken part in the river channel management in the past. The following points are important for DWIR during the management of construction work:

1) DWIR has no experience to build full-scale river port facilities such as this project in the past. It is recommended that DWIR should establish an exclusive project team and put the obligations of management on its construction work on that team.

2) It is important to have excellent coordination between this management team and the headquarters of DWIR. In particular, the rules for decision making for each step of the work shall be prepared so that the work should be carried out suitably and without unexpected delay.

(2) Management on Maintenance & Repairing

The owner of the reclaimed land and facilities to be built is assumed to be the Government or DWIR. It is considered to be appropriate that the maintenance and repairing tasks should be undertaken by DWIR. One of the following two ways should be selected as the management method:

1) DWIR directly carries out the maintenance and repairing of facilities

2) DWIR entrusts a private port operator with the task of periodical maintenance and repairing

The former option 1) is the case that the port owner directly contracts the inspections or repair work with private firms. Though training for its own staff and the allocation of a budget are needed, it has the advantage that the port owner can hold and accumulate technology and know-how which is effective to make future port development plans.

The latter option 2) is the case that the port operator carries out the inspections or repair work by contract with private firms. The port operator takes the task of inspections and permission of the maintenance works. As the port operator uses the facilities every day, it should be easy to understand the real conditions of the facilities, thus maintenance can be achieved.

It is important to discuss among government authorities about what method should be selected.

(3) Management of Port Terminal Operation

From the discussions in the Ministry of Transport, the obligation of port terminal operation is assumed to be undertaken by IWT. It is considered to be appropriate that IWT takes this obligation because IWT has conducted public transport of cargoes and passengers, while port users are IWT's usual ship owners and cargo owners. The one of the following two ways should be selected as the management method:

1) IWT directly carries out the port terminal operation

2) IWT entrusts a private port operator with the task of port terminal operation

The former option 1) is the case that IWT employs all staff and workers, and then manages the cargo handling work by IWT's workers. The latter case is that IWT contracts with a private operator and entrust the works to them.

It is important to discuss among the government authorities about what method should be selected. For both cases, it is necessary to enhance IWT's port management capability. The following points are important for such capacity improvement:

1) to amend laws or regulations to decide the roles and responsibilities of IWT
2) budget and auditing systems for port management
3) realizations of proper maintenance and management of port facilities
4) realization of safe and efficient cargo handling operation
5) acquiring knowledge on safety and environmental aspects
6) acquisition and arrangement of cargo and passenger throughput
7) training of staff in charge of port management

For the above enhancement of the ability of IWT, Japanese assistance through JICA will be helpful.

(4) Privatization of Port Operation and Management

As aforesaid, privatization of a part or the whole tasks for maintenance and operation of the port is valuable from the viewpoint to keep the transportation fee to a suitable level and to raise the efficiency of operation. It is important to discuss among government authorities about what part should be privatized in particular.

7.2.2 Management of Ships Operation and Privatization

IWT provides public transportation services on inland waterways including the operation of dockyards for repairing ships. At present, there is an on-going project for a ferryboat crossing the Yangon River which is supported by grant aid assistance from Japan, in which some ferry boats are granted to IWT. It is assumed that IWT will continue to undertake the operation and management of its own river ships in the future. However, there are some navigation routes where both IWT's and private services are running. It is recommended for IWT to make a clear policy for public transport, and to reorganize in order to provide more appropriate public services.

(1) Management of Passenger Ferries Operation and Privatization

IWT's passengers are reduced when the route faces competition from private operators or the route competes with newly developed roads with the same destination. It is quite natural that as income of the people increases according to the national economic growth, with passengers will select quick transportation modes with a higher fee. On these routes, road transport by busses or private boat service is available. It is recommended that IWT should concentrate its capacity to the waterway routes in which road networks are not extended. IWT's services should be reduced or closed where the numbers of passengers decline.

(2) Management of Cargo Barges Operation and Privatization

At present, most of the cargo barges owned by IWT are leased to private operators. Taking this fact into account, the practice of cargo transportation along river channel has been already privatized. It is recognized that IWT is playing a role as a public authority by providing barges to private operators with a low rental fee to support the industry which suffers weak financial ability. However, recent situations show that private operators who have new barges are increasing, which represents the fact that the role of the public sector on cargo transport services is disappearing.

In this study, the introduction of a shuttle service between Yangon and Mandalay is proposed. The barge and tugs proposed in this study are capable for this service. For the future, IWT should take a position as a public authority for this new system's implementation, and encourage the private sector to enter similar businesses from the viewpoint of government policy.

7.3 Effect of Environmental Load Reducing and Modal Shift

In earlier times when road networks were undeveloped, inland water transport was the main transport mode. However, the popularization of vehicles and trucks and the related development of a road network shifted the transportation mode from inland water transport to road transport and this movement was a worldwide trend. Mainly there are two reasons why this shif happened: lower costs and a more convenient means of transportation compared to inland water transport. This trend is seen in Myanmar as well, especially between Yangon and Mandalay, concretely, National Road 1 & 2 and the New Highway are the main transport modes instead of inland water transport, and presently 80 % of domestic cargo in Myanmar is transported by road.

On the other hand, a big merit of inland water transport is to have a much lower impact on the environment compared to road transport, and usually it is regarded that CO2 emissions by ship transport is only about 20% that of road transport on the basis of per ton kilometer. Therefore, it is gradually recognized as the broad benefit for human beings that this merit should be affirmatively used under the circumstance of which the environmental issue is a big concern in the world, and the transport mode should be selected not only by cost and convenience aspects, but also considered with eco-friendliness for sustainable development.

Under these circumstances, many developed countries are starting to reexamine the use of inland water transport, and some plans, including shifting road transport to inland water transport or railway, have been commenced. Such movements on modal shift *1 are active, especially in Europe, and one of them is the “Marco Polo Plan”.

Observing inland water transport only, a U turn of transport mode (inland water transport →road transport →inland water transport again) is happening and some of the past invested cost is getting wasted in developed countries.

*1: shifting into multi-modal transport. A part of road transport is shifted to mode(s) having lower Co2 emission such as inland water and/ or railway transport.

Marco Polo Plan and the surroundings

From 1992 to 2001, Pilot Action for Combined Transport (PACT Plan: total budget was Euro 53 million and 167 projects were executed to reduce truck transport) was done to support a modal shift in European logistics and after that, the Marco Polo Plan was proposed in 2001 and it became a funding plan aiming to improve European transport sustainably and effectively in 2003. From 2007, the scale of the plan got larger as the Marco Polo Plan II and the objective area was also expanded to include Russia, Belarus, Ukraine, and the Balkan Peninsula.

Table 7.1 Target and Budget of Marco Polo Plan/ II

	Marco Polo	Marco Polo II
	Year 2003~2006	Year 2007~2012
Budget	€100 million	€740million
Target (from road transport to inland water/ railway transport)	Co2 reduction: 12 billion ton kilo/year	Co2 reduction: 23 billion ton kilo/ year, total reduction: 8.4 billion kilograms

Source: http://ec.europa.eu/transport/marcopolo

After 1992, as a result of the European markets integrating into the Euro, truck transport increased dramatically. The increased ratio from 1998 to 2010 was 50% or over and the situation forced a reduction on truck transportation from the aspect of environmental conservation. Under this situation, the Marco Polo project was proposed to break traffic jams in Europe, to reduce the impact against the environment, to improve logistics in Europe especially on the view point of promoting an east-west European logistic network, and furthermore, to enhance the efficiency of logistics systems in European companies and make logistics smoother.

As mentioned above, to create a sustainable logistics system based on the concept of a modal shift is recognized as the issue to be solved urgently. However, railway and waterway transport has several demerits such as: it is impossible to make door to door service, scheduling is not flexible, there is no cost merit if a transport has small lot, and so on. Considering these demerits, it can be generally said that railway and water transport have no flexibility on transport. To overcome these negatives, countermeasures to enhance function at junction points along each transport mode are necessary e.g. the railway is built into a logistics center directly, the logistics center is built into a port area, or a railway is connected to a port area, and so on. For those countermeasures, heavy investment is required so the promotion of this modal shift is not easy.

Furthermore, even if heavy investment is done, it is not so easy to match contemporary needs like supply chain management and just in time transport, and moreover, the needs are getting higher day by day. Therefore, a combined logistics system has to be carefully built based on the balance of cost, convenience, and environmental merit comprehensively.

As a rough indication to introduce lower carbon transport, cost merits on a modal shift from road to railway and/or inland water transport appears from a distance of approximately 300 ~ 500km. Also, in considering the cost merit of water transport, bulk transport is not effective compared to container transport so shifting from bulk to container transport is included in the Marco Polo Plan.

As mentioned before, reducing the impact on the environment is important in the present world so the eurozone is returning to water transport, although the main transport was shifted from water transport to road in the past. It is necessary for heavy investment in order to return to water transport, and the heavy burden is a big concern for promoting the modal shift. In this paragraph, the European case is introduced but many developed countries are facing similar cost problems related to environmental conservation.

Presently Myanmar is under the process of making ground designs of nationwide logistics. For making a future development plan, Myanmar should study the past experiences of developed countries and should not consider the cost and convenience of the short term, but build sustainable logistics with a view of environmental conservation.

On the other hand, presently Myanmar does not even have two issues on river transport, neither accurate river survey information nor enough river management and channel dredging, so in the dry season, relatively large vessels owned by IWT (passenger-cum-cargoes) cannot operate in the nationally important interval between Yangon and Mandalay, and the water distance is over 900km. According to the experience of the modal shift in Europe, the distance is attractive to implant a modal shift and it has a great potential to have inland water transport with lower cost compared to road transport.

On this view point, first a river survey should be done to understand the present river and second, being capable of using river transport all year long should be examined.

7.4 Utilization of Japan's Technologies

Japan is a leader in the technological world and its technologies and experiences will highly contribute to the future development of Myanmar. In this study, many examinations on various possibilities to utilize Japanese technology have been done. The core discussions on this issue is whether or not the requested items proposed by the Counterpart are a match to the requirements of Japanese ODA, and the results of these discussions are sorted in the following items:

(1) Construction of Port Facilities

In the Japanese construction field, various construction technologies have been researched, developed and matured, especially from the 1950's until now. The following items will be beneficial to apply Japanese technology for the Mandalay new port development:

1) Structural Steels (Steel Pipe Pile and so on)

Recently Chinese and Korean steel manufacturers are developing dramatically, however Japanese quality and accuracy are still on the top level in the world. Japanese manufacturers are expanding their business especially in ASEAN countries like Indonesia and Vietnam, and as a result, the procurement cost is getting more competitive within ASEAN countries.

2) Pontoon

There are many pontoons in Myanmar but almost all are based on an old English type, originated from about 100 years ago.

3) High Level Construction Management

For the construction project, the most important element is construction management and it is generally recognized that there are four keys for it such as: scheduling, quality, cost, and safety management.

In Japanese constructions, a detailed schedule is planned in advance of the commencement based on the site condition and past experiences, and the project is managed with sensitive monitoring and adjustment therefore basically no project becomes delayed. On quality management, a ISO9000 management system is strategically introduced so the level is getting higher. Cost and safety management is also on a high level based on the utilization of new systems and lessons learned from past experiences. On the whole of these, Japanese construction management, sometimes called as experience engineering, is kept at the top level of the world.

If this high quality management can be introduced in Myanmar, it will largely contribute to improve the present Myanmar management. On the other hand, the present status of business penetration into Myanmar by Japanese constructors has had no acceleration and their corporation activities in the country are very slow although the activities of business trip bases are gradually being activated. The main reason is assumed that the business custom is different and the registration procedures in the country are complicated for them. Considering this situation, it seems preferable for Japanese companies to start their businesses from a Grant Aid project which is generally recognized with a lower risk on overseas business compared to the Japanese Yen Loan project.

(2) Ship/ Vessel Procurement

Japanese Ship/Vessel manufacturing had a top share in the market in the past but now price competitive countries like China and Korea are dramatically expanding their business. However, there were many people related to the inland water transport sector in Myanmar who wished to use the high quality Japanese built ship/vessels.

1) Passenger Ship

In this preliminary design, a way could not be found to introduce particular Japanese technology but especially high quality marine equipment incorporated in the design will meet Myanmar's high

expectations. To maintain the original good quality, a certain level of maintenance is essential so dispatching Japanese experts and the other related support e.g. training in Japan, providing spare parts/maintenance equipment, etc., are necessary therefore the combination of a technical support project with new ship/vessel procurement will be highly effective. This comprehensive support is a Japanese strong point.

2) Cargo Vessel

Proposed cargo vessels in this study also have no unique Japanese devices however, from the same point of view on the passenger ships mentioned above, technical support for operation and maintenance will be necessary. As for cargo transport, it is a problem that no port facilities have been developed in the first place, so several technical supports on port operation and management are essential when the advanced mechanical cargo handling is introduced.

(2) Navigation Safety of Inland Water Transport

Present Status on Navigation Safety of Inland Water Transport

Presently, there is almost no navigation safety in Myanmar inland water transport. As discussed in Chapter 3, current countermeasures are nothing more than rough identification of constraining points in the Ayeyarwady and Chindwin Rivers and the installation of simple navigational indications at only some of those points, according to DWIR.

Necessity of a Detailed River Survey

It is essential to get detailed river survey information prior to the implementation of a study for navigation safety. Concretely, both results from a sounding survey and aero photographic survey have to be done and combined together to complete a 3D drawing of the river. As for the navigational constrain points in the dry season, detail data, per 10cm unit, is necessary.

DWIR, an organization who is in charge of river management, is trying to collect basic information focused on the constraints and they can only roughly confirm the river trend. Furthermore, a master plan study in 1988 by the World Bank/United Nations is still being used now, although almost all of data are useless because it's over 25 years old.

There are three reasons why the river survey has not been conducted recently: 1) it is acceptable to depend on a shipman's skill only because the present vessel traffic volume is small, 2) the lack of advanced survey skills, and 3) the cost burden is too heavy for Myanmar.

Under these circumstances, there is no choice but to face river flood disasters annually and it's impossible to make effective agricultural irrigation plans.

DWIR deeply understands the critical situation so they first requested a renewal of the master plan from 1988 by the World Bank/United Nations and then at the JCC meetings held in December 2012 and February 2013. The concrete meaning of renewal is to execute a high accurate river survey and to propose countermeasures on river management matching contemporary and future needs.

Present Status by Foreign Donors related to River Study

According to DWIR, a project by the Flanders state in Belgium, which aims at river management to construct weir dams along Ayeyarwady, was started in April 2013 but it will be concluded without result due to the lack of survey information.

Also DWIR said that river improvement plan at upper the Ayeyarwady near the border with China is being undertaken by China.

Future Support

Myanmar is expected to develop quickly and related to this, demand of inland water transport on the Ayeyarwady will be increased, especially in between Yangon and Mandalay, the first and the second business cities in Myanmar. In addition, the Chindwin route is recognized as important as well because

the area, which is in the northwest of the country, has presently less road networks due to development difficulty caused by steep mountains. However, this region is expected to develop border trade with India and Bangladesh therefore there will be a need for safe navigation routes as the volume of inland water traffic increases. Prior to those needs, it is preferable that a navigation safety study should be implemented.

7.5 Priority Projects to be Formed in Near Future

As a wrap up to the discussions, priority projects are in the following.

(1) Mandalay New Port Development

Mandalay New Port Development is expected to be a hub port of Myanmar and the port development has been requested by the Government of Myanmar. In reply to the request, a pilot port construction project should be formed as soon as possible with a limited port development scale by ODA Grant Aid, and higher efficient machinery port activities should be created. It is important that Myanmar helps itself for further development after this pilot project, and the expansion should be planned and executed with an increase in the cargo handling volume in the near future.

For the implementation of the Mandalay Port development, additional study of the feasibility study is required. The items for additional study are as follows:

- Soil investigation survey at the port location (this study covers only 3 boreholes)
- Bathymetric/topographic survey of the river before and after a flood season
- Detailed riverbed deformation analysis for the selection of a jetty type
- Study on the cost estimate of a jetty (mainly a study on the possibility of locally manufacturing a floating jetty)
- Basic design and revised cost estimate of the selected jetty structural type.

(2) Other New Port Development Project

Also, there are five (5) other important river ports according to MOT. Although the democratization movement in Myanmar has just begun, the development needs of these ports will get higher with the economic growth of the country. Therefore the situation should be monitored carefully with the purview of Japanese assistance.

It is required to develop other river ports in order to develop the total transport system. The following port development projects are recommended to be implemented following the Mandalay Project:

- Yangon Port (River Port, along Yangon River or Bago River)
- Bhamo Port (Ayeyarwady River)
- Monywa Port (Chindwin River)
- Magwey Port (Ayeyarwady River)
- Pakokku Port (Ayeyarwady River)
- Kalaywa Port (Chindwin River)

(3) River Channel Improvement

With increasing traffic volume on inland water transport, it is clear that the navigation safety should be enhanced. DWIR has confirmed that navigation safety is lacking and navigational difficulties should be urgently surveyed in order to understand the river. Considering the distance between Yangon and Mandalay is so long, over 700km, a certain scale of study is necessary.

Once again, the importance of a river survey is discussed here. Myanmar has no river survey information even on the most important route between Yangon and Mandalay. This lack of information is not only on inland water transport but also on other important issues like river control to prevent flood disasters or water utilization for irrigation, and so it is difficult to make a plan that takes in all of these issues.

Almost all of the rivers in Myanmar have flood disasters every year during the rainy season. Even the Ayeyarwady River, which runs through the country from the north to the south and is recognized as the most important river in Myanmar. The change in the river level at Mandalay is over 8m on average between the rainy season and the dry season. On the Chindwin River, the level change is greater than 15m at Kalaywa. However, there is no effective countermeasure in these major rivers and many people suffer from the disasters. Assuming this situation, a system on water utilization on irrigation might be vulnerable as well.

DWIR, the organization on river management, has recognized the problem and acknowledges that it is impossible to develop Myanmar without solving these issues. However, presently their power is limited on technical and financial aspects. As a result, DWIR requests JICA to update the Master Plan of River management on the Ayeyarwady and Chindwin rivers, which was performed in 1988 by the World Bank/United Nations.

The Ayeyarwady River has over 1,600km and Chindwin has 500km of major route waterways and it requests a comprehensive study. A study of this magnitude will probably cost over USD 10 million and last for three or more years. Such a large task is daunting, but it is possible to only study the river between Yangon and Mandaly for the benefit for this project.

To provide basic survey information to several fields is out of the scope of this study, however all related persons should recognize the importance of this issue. If the study is executed, a proposal of countermeasures against flood disaster, especially for those areas that urgently need to be managed, should be done.

(4) Navigation Safety

At present, passenger services are operated during the day and night, but there are no safety navigation facilities.Cargo barge services are not operated during the night. In line with the modernization of the inland waterways system, installation of navigation aids and the development of a vessel traffic service system (VTS) will be required in the future.

(5) Ship/ Vessel Procurements

Procurement of 8 Passenger Ships

Eight passenger ships for three routes which desperately need new ships in the view of BHN and high publicness without disturbing private business seem to match the Grant Aid requirements.

Procurement of 2 Cargo Vessel Fleets

Related to the new Mandalay Port development, the pilot cargo vessels procurement aiming to implant mechanization cargo transport with punctuality between Yangon and Mandalay is recommended. As the result of the discussions, it is recommended that two fleets of cargo vessels should be procured.

Technical Assistance

Related to these ships and vessels procurement, Japanese technical assistance, to enhance ship/vessel operation and maintenance and to introduce effective port management, will be needed. It is recommended that assistance for both should be formed as a Technical Cooperation Project including dispatching expert(s), training, and providing spare parts/equipment as necessary.

Establishment of Ship Procurement Association (with middle term view)

In the near future after a certain amount of development of the inland river transport system, many private companies will wish to introduce effective new ships and vessels, but the initial cost will still be a big concern for them. Most of the inland water operators in Myanmar are financially vulnerable and the situation will not improve dramatically even if they have a certain business plan. So the concern will remain in the near future within a middle term view. An idea to support local companies is to establish a ship procurement promotion association which should be led by reputable Japanese ship builder(s) in association with Myanmar company(s), and it will aim to fund the local companies with support by the

Japanese Two Step Loan. However, presently Japanese companies are not responsive to this idea because of risks in Myanmar and differences in business customs.

Packaging Deal (with middle term view)

From the 1970's to early 2000's, Comprehensive Yen Loan schemes were implemented mainly in Indonesia. The characteristics of this scheme is that ship procurement is combined with reusing existing ship drawings and with dispatching expert(s) as necessary to the aid the receiving country. The concrete merits are; 1) it is not necessary to pay for a design due to the reuse of existing ship drawings so the time for design is also omitted, 2) Japanese expert(s) can lend their support so shipbuilding will take less time for a higher quality product, 3) local shipbuilding skills can be increased by direct instruction from Japanese experts, 4) basically the cost for building the ships locally can be cheaper than building them in Japan. On the other hand, some considerations prior to applying are: 1) it is preferable to use Japanese existing ships, 2) a certain level of shipbuilding facilities is necessary, 3) Publicness is necessary.

This package is comprised of providing drawings, dispatching Japanese expert(s), and local shipbuilding and those are combined into one Yen Loan project. However, the present condition of docks in Myanmar does not match the requirement. Although improvement of dock facilities is out of the scope of this study, basically the improvement of dock facilities should be in advance of or at the same time of ship procurement.

Appendix 1
Constrains
on
Ayeyarwaddy and Chindlwin Rivers

Appendix 1 Constrains on Ayeyarwaddy and Chindlwin Rivers

1. Current status of Ayeyarwaddy and Chindlwin Rivers Improvement

Despite their importance in the transport of goods and passenger for Myanmar, many navigational constrains has been identified on both Ayeyarwaddy and Chindlwin Riversd. By the support of UNDP, "The Irawwady and Lower Chindlwin Rivers Study" had been carried out in 1988 and the master plan for the improvement of both rivers was prepared. However, it hasn't been implemented due to the insufficient budget. The outline and present conditions of those constrains are explained in this Appendix.

2. The updated master plan for Ayeyarwaddy and Chindlwin Rivers improvement

DWIR has recently updated the master plan by UNDP based on the latest bathymetric survey result. Total of 46 and 37 locations have been identified as constrains for Ayeyarwaddy and Chindlwin Rivers respectively. DWIR has already started to improve those constrains partially, but the progress is slow again due to the insufficient budget. The summary of master plan is shown below.

3. Type of constrains

The identified constrains are categorized into below five types.

1) Shallow: Insufficient draft (less than 2.0m below water level) in dry season
2) Narrow: Insufficient width for navigation (the proposed width in the updated master plan is minimum 200m according to DWIR)
3) Braided channel: The channel is not stable and keeps changing its route
4) Sharp bend: Difficult for navigation
5) Rocks on river bed and river bank: Dangerous for vessel to navigate

4. Proposed measures to improve rivers

The proposed measures in the updated master plan are explained below. In most locations, construction of groynes and dredging are proposed together.

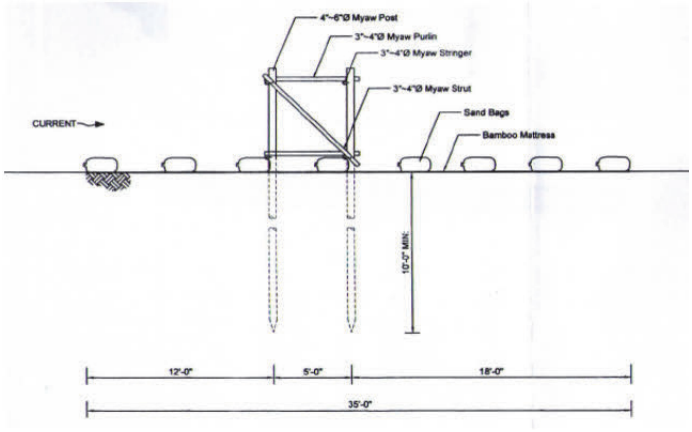
1) Construction of Groynes

There are three types of groynes and top elevation is maximum 2.0m above the lowest water level.

- ✓ Type-A (Wooden groyne): It is the cheapest type and can expect the sand sedimentation at downstream, but usually requires maintenance/repair a few years after constructed.

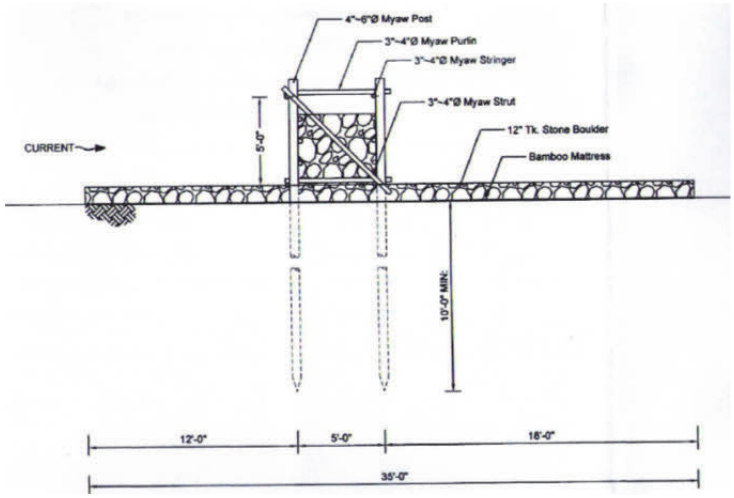
- ✓ Type-B (Wooden groyne with rock-fill): It is more rigid than wooden groynes.

- ✓ Type-C (Stone groyne): It is the most expensive type, and used at where riverbed is not suitable for driving wooden piles. It is also used when the sand sedimentation is necessary in upstream.



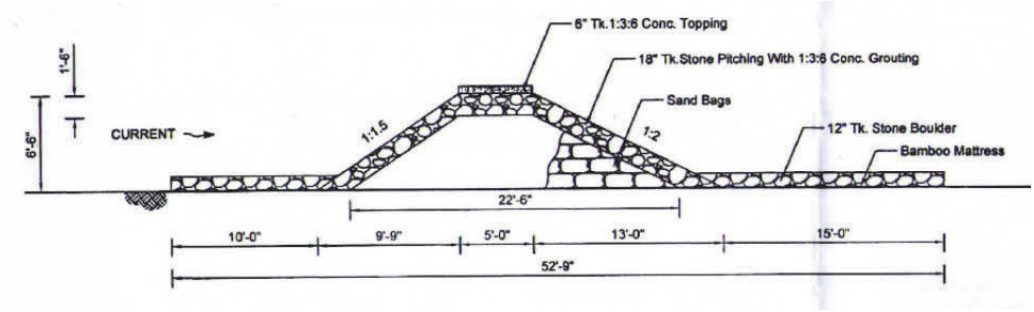
Source: DWIR

Figure 1: Typical Section of Wooden Groyne (Type-A)



Source: DWIR

Figure 2: Typical Section of Wooden Groyne with Rock Fill (Type-B)



Source: DWIR

Figure 3: Typical Section of Stone Groyne (Type-C)

2) Dredging by cutter suction dredger

DWIR currently owns six cutter suction dredgers (CSD), one side trailing suction dredger, one side cast grab dredger and one backhoe dredger. In addition, they have already purchased five CSDs and two backhoe dredgers by the loan from Chinese supplier, which were in trial operation at the time of this study. Once the trial operation is completed, they are planned to be mobilized different places in order for the river improvement works. There are two types of dredging as the measures to improve constrains, i.e. 1) Dredging of shallow spot to secure draft, and 2) Dredging of new channel for better alignment and stabilization of waterways.

5. Summary of constrains

The detail of constrains and proposed measures are summarized in below tables.

Table 1: Detail of 46 Constrains on Ayeyarwaddy River

No	Location name	Type of constrain	Proposed measure in updated MP
1	Bhamo channel	Braided and shallow	Groynes and dredging
2	Sawadi	Braided and shallow	Groynes
3	Myalae	Rock on both sides of river bank, narrow	Groynes and dredging (potentially blasting)
4	Yepyantlay channel	Narrow	Groynes and dredging
5	Kyaukkyi	Shallow and narrow	Groynes and dredging
6	Minkyaunggon	Shallow and narrow	Groynes and dredging
7	Moda	Shallow and narrow	Groynes and dredging
8	Wegyi	Braided and shallow	Groynes and dredging
9	Katha	Shallow	Groynes and dredging
10	Kyaukpon	Shallow and narrow	Groynes and dredging
11	Maunggon	Braided, shallow and narrow	Groynes and dredging
12	Innet	Braided	Groynes
13	Kyanhnyat	Braided and shallow	Groynes and dredging
14	Sabanago-Male	Shallow	Groynes and dredging
15	Singu-Shwehle	Braided and shallow	Groynes and dredging
16	A-hmaw-U	Braided and shallow	Groynes and dredging

No	Location name	Type of constrain	Proposed measure in updated MP
17	Shinhla Aleywa	Braided and shallow	Groynes and dredging
18	Mingun	Braided	Groynes
19	Warchat channel (Mandalay-Sagain)	Braided and shallow	Groynes and dredging
20	Letsaungyu	Braided and shallow	Groynes and dredging (one groyne already constructed in 2012)
21	Ywarthitkyi	Narrow and shallow	Dredging
22	Natsinkyauk (Myittha)	Braided, Rock on high sand bank	Groynes to cover the rock layer with sand
23	Yuwathit-Myinmu	Shallow	Groynes and dredging
24	Mayagon	Braided and shallow	Groynes and dredging
25	Kyunu	Braided and shallow	Groynes and dredging
26	Htacaukpin	Braided and shallow	Groynes and dredging
27	Sale-Pakhannge channel	Braided and shallow	Groynes and dredging
28	Sinbyugyun	Braided and shallow	Groynes and dredging
29	Thapyayyo	Braided	Groynes to close existing channel and dredge new channel
30	Wetmasut	Braided	Groynes
31	Magway	Braided and shallow	Groynes and dredging
32	Kanni	Braided	Groynes
33	Dagonmaw	Both side shallow, channel alignment is crossing and difficult to navigate	Groynes
34	Thayetmyo	Shallow, channel alignment is not straight	Groynes and dredging
35	Kama	Rock on the right bank	Groynes and dredging
36	Letkokpin (Pyay)	Rock on left bank	Groynes
37	Shwedaung-Padaung	Shallow	Groynes and dredging
38	Thaledan	Shallow	Groynes and dredging
39	Hlaygyizu	Braided and shallow, 2 channels	Groynes to close one channel and dredge shallow spot on the other
40	Gwema-Kyangin	Shallow, 2 channel in wet season, left bank erosion	Groynes and dredging
41	Myanaung	Shallow	Groynes and dredging
42	Kanaung	Shallow	Groynes and dredging
43	Thonze kyun	Shallow	Groynes and dredging
44	Patakwe	Shallow and narrow	Groynes and dredging
45	Kunthi-tabin	Shallow and narrow	Groynes and dredging
46	Thayutwa (Hinthada)	Shallow, narrow and sharp bend	Groynes and dredging

Source: JICA Study Team based on the hearing from DWIR and their updated Master Plan

Table 2: Detail of 37 Constrains on Chindlwin River

No	Location name	Type of constrain	Proposed measure in updated MP
1	Kadogyi (Khamti)	Shallow, narrow and sharp bend	Groynes and dredging
2	Ngote ta htaung waterway	Shallow, sediment from creek	Groynes
3	Heinsun	Shallow and sharp bend	Groynes and dredging
4	Linhpa	Shallow, narrow and sharp bend	Groynes and dredging
5	Anaukkauktaung	Shallow and narrow	Groynes and dredging
6	Kaunghein	Shallow and narrow	Groynes and dredging
7	Naukpe	Shallow, narrow and sharp bend	Groynes and dredging
8	Namsabi	Shallow and narrow	Groynes and dredging
9	Nanooti	Shallow and narrow	Groynes and dredging
10	Maingwe	Shallow and narrow	Groynes
11	Kawnghkan	Shallow and narrow	Groynes and dredging
12	Kettha (Homalin)	Shallow, narrow and braided in wet season	Groynes
13	Mokkali	Shallow, narrow and sharp bend	Groynes and dredging
14	Natsat	Shallow	Groynes
15	Yapin	Shallow	Groynes and dredging
16	Mauksapha	Sharp bend	Groynes
17	Manuna	Shallow	Groynes and dredging
18	Shabin	Shallow	Groynes
19	Mawlaik	Shallow	Groynes and dredging
20	Manpagale	Shallow	Groynes and dredging
21	Kywenan	Shallow	Groynes and dredging
22	Ingongyi (downstream of Kalewa)	Shallow	Groynes and dredging
23	Mingin	Shallow, sediment from creek, channel is on the other side of town	Groynes to close existing channel and dredge new channel (planned in 2013)
24	Nawinchaung	Shallow	Groynes and dredging
25	Maukkdadaw	Shallow and narrow	Groynes and dredging
26	Thindaw	Shallow and narrow	Groynes and dredging
27	Medin	Shallow	Groynes
28	Kani	Shallow, sediment from creek	Groynes and dredging
29	Alon	Shallow and narrow	Groynes and dredge new channel
30	Monywa	Shallow	Groynes
31	Amyint	Braided and shallow	Groynes to close existing channel and dredge new channel
32	Shwehle	Braided and shallow	Groynes
33	Minywa	Shallow	Groynes and dredging
34	Mau	Shallow and braided in wet season	Groynes and dredging
35	Kyauktan	Shallow	Groynes and dredging
36	Chinya	Shallow	Groynes
37	Confluence	Shallow	Groynes and dredging

Source: JICA Study Team based on the hearing from DWIR and their updated Master Plan

6. Detail Map of Constrains

Detail map of constrains showing the location and proposed measures for the improvement for both Ayeyarwady and Chindlwin Rivers area attached.

Appendix 2
Environmental and Social Considerations
for
Mandalay Port Development
(Detailed Report)

Appendix 2 Environmental and Social Considerations for Mandalay Port Development (Detailed Report)

A2.1 Introduction

2.1.1 Background

The Union of Myanmar has been enjoying a remarkable economic growth since the turning point toward democracy in 2012. Infrastructure improvement is urgently needed to effectively raise its economy. Inland water transportation improvement is expected to encourage economic improvement in both local areas and the whole of Myanmar. Modal shift to those mass shipment systems can contribute reduction of GHG (Green House Gas) as well as saving energy.

On the other hand, components of the Project contain civil works which may generate a notable environmental impact. Also land reclamation, where temporary cultivation has been taken place during the dry season, may require land clearance. It is important to assess those environmental and social impacts in order to develop environmental management and mitigation measures. Therefore a survey on the environmental and social considerations (hereinafter referred to as “the Survey”) was conducted in the feasibility study

2.1.2 Purposes of the Survey

Purposes of the Survey:

- to identify the natural and social environmental conditions in the subject area;
- to estimate the negative and positive impacts of the project on the natural and social environments;
- to propose appropriate ways to avoid, minimize, or compensate for the negative impacts based on an analysis on the nature and magnitude of the impacts estimated and the socio-natural, political, economic, and other circumstances in the subject area;
- to prepare a plan to monitor the impacts of the project during and after implementation of the project

- to explain to, and gain consent from, the stakeholders that would be directly affected by the project through means of public consultation/involvement

A2.2 Legal Basis in Relation to Environment

(1) Environmental Conservation Law

The principle law stipulating the environmental management in Myanmar is the Environmental Conservation Law issued in March, 2012 (The Pyidaungsu Hluttow Law No. 9/20/2130rh). The law stipulates government bodies in charge of environmental conservation as well as their roles and responsibilities. It touches on water, noise, vibration and solid waste qualities but does not provide specific standards to be met. It also mentions environmental and social impact assessments. In the context of project development, it is important to note that the law adopts the notion of 'polluter/beneficiary pays principle' as it implies that the project promoters are responsible for covering all environmental and social costs generated by the project. The law serves as the basis of founding the Environmental Conservation Department (ECD) under MOECAF both of which will be explained later.

Following the Environmental Conservation Law are two legal arrangements: Environmental Conservation Rules; and EIA Procedures.

(2) Environmental Conservation Rules

Environmental Conservation Rules is expected to provide a platform to bridge Environmental Conservation Law and more specific and practical rules and guidelines including EIA Procedures and environmental quality standards. Yet, only limited data is available with regards to the content of the Rules.

(3) EIA Procedures and Environmental Quality Standards

EIA Procedures is expected to stipulate the conditions under which EIA is required and the steps that need to be followed in conducting and assessing the EIA. Under the Procedures, the Ministry, as the Executing Agency, sets an EIA Review Committee and is considered to give recommendations from an environmental point of view whether to approve the EIA reports or not. Composition of the EIA Review Committee will be selected by the Minister of MOECAF yet need to include persons from the industry, academia, and civil society as well as government officials. EIA includes an environmental management plan and a social impact assessment report.

The Procedures also includes a clause for public participation in implementing Initial Environmental Examination (IEE), EIA and Environmental Management Plan (EMP) yet only if deemed necessary by the Ministry. It may also mention to the notion of a precautionary principle and touch on climate change but does not include Strategic Environmental Assessment.

Concrete steps for undertaking EIA are stipulated in the EIA Procedures. While it is yet to be finalized, a draft of the document and results of the interview to ECD staff members reveal the EIA process in Myanmar to be generally as follows:

1) All development projects in Myanmar are subject to an environmental screening process through which, projects will be judged if they require any environmental review and if so, at which level (i.e. IEE or EIA).

2) EIA includes an environmental management plan and a social impact assessment report.

3) Public participation is required, when deemed necessary, for Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) and preparation of an Environmental Management Plan (EMP).

4) The project's executing agency forms an EIA Review Committee [1], which gives recommendations to the Minister of MOECAF from an environmental point of view whether to approve the EIA reports or not. The Minister makes the final decision based on this recommendation. The review period is 50 days for IEE and 90 days for EIA.

5) Members of the EIA Review Committee will be selected by the Minister of MOECAF and includes persons from the industry, academia, and civil society as well as government officials.

6) Involuntary resettlement is carried out under the responsibility of respective regional governments and hence will not be included in the EIA Procedures.

7) Costs involved in conducting EIA are to be covered by the project proponent.

8) EIA can be carried out in Myanmar only by firms that are registered under ECD/MOECAF.

The other environment-related laws and regulations are shown in the following table.

[1] An Interim Review Committee will be formed until relevant legislations are enacted.

Table A2.12 Environmental Laws and Regulations

Name of the Legislation (year issued)	Description
(Natural Environment)	
The Protection of Wildlife and Conservation of Natural Areas Law (1994)	・ Designates national parks and other protected areas to be: Scientific Reserve; National Park Marine National Park; Nature Reserve; Wildlife Sanctuary; Geo-physically Significant Reserve; or Other Nature Reserve designated by the Minister ・ Specifies acts prohibited and subject to a fine
Myanmar Forest Policy (1995)	・ Shows general direction of the government for sustainably managing forest resources and carefully exploiting them for socio-economic purposes
The Forest Law (1992)	・ Aims at implementing Forest Policy and Environmental Conservation Policy
(Social Environment)	
Land Acquisition Act	・ Stipulates that the government holds rights to take over land provided that compensation is made to the original land owner ・ States that no private ownership of land is permitted and that all land must be leased from the Union State
The Land Nationalisation Act (1953)	・ With some exceptions, stipulates that all types of agricultural land are owned by the President ・ Mentions that in case of a breach of the regulations, even the land exempted from government confiscation will be forfeited to the country without compensation ・ States that the President reserves rights to decide the crops to be gown on agricultural lands
Farmland Bill (2011)	・ Calls for suitable compensation and indemnity in case of repossession of farmland in the interest of the Union State
Farmland Rules (2012)	・ Stipulates for farmers right to work on the farmland ・ States that when farmlands are converted into different forms of land based on the interest of the Stale or Public, the State or Public needs to make compensation to the farmers without delay

Source: JICA Study Team

A2.3 Project Description

A brief description of the project including works with environmental implications is shown in Table A2.2.

Table A2.2 Description of the Project

Item	Description
Objectives	・ To develop new port facilities along the Ayeyarwady River in Mandalay ・ To modernize port cargo handling (operation of jetty and equipment) ・ To increase port capacity (initially to 240,000 t/year)
Location	Inland port in Mandalay and its periphery (Mandalay region)
Land Area	30,000 m^2 of land reclamation for cargo terminal, 40,000 m^2 of temporary reclamation for material storage and floating jetty assembly during construction stage
Project Components	・ Development of cargo terminal including warehouse, office, workshop and yard ・ Development of jetty ・ Development of access bridge (bridge + piled concrete deck) ・ Development of access road ・ Development of sidewalk

Major Works Involved	(Design Stage) ・ Land clearance (Construction Stage) ・ Mobilization and operation of heavy equipment ・ Transportation of construction materials ・ Land clearance (mainly farm and empty land) ・ Reclamation ・ Pavement (asphalt) ・ Revetment ・ Transportation and disposal of construction waste (O&M Stage) ・ Loading/unloading of passengers and cargo ・ Ship maintenance and inspection

Source: JICA Study Team

A2.4 Alternatives

The following three locations were compared and evaluated in terms of environmental and social viewpoints.

Source: JICA Study Team

Figure A2.1 Locations of Alternatives

Table A2.3 Comparison of Alternatives

	Option 1	Option 2	Option 3
Pollution	-	-	+/-
Natural Environment	+/-	+/-	-
Social Environment	- -	- -	-

Note: significant positive impact: + +, moderate positive impact: +
significant negative impact: - - , moderate negative impact: -
neutral: +/-

Source: JICA Study Team

1) Option 1

The area of option 1 is located near downtown; the opposite side of the road is congested by residential and commercial areas. Also a notable number of residents have resided in the river bed. Therefore direct impact affected to people, such as pollution, traffic disturbance, may be higher than that in option 3.

The most critical environmental issue is related to land occupation in the river bed where many residents have illegally resided. As shown in Figure A2.2, more than 100 HH were counted as of July 2013. Even though their possession is illegal; it can raise social conflict unless adequate compensation and social support for improving or restoring their life.

2) Option 2

Situation in option 2 is similar to that in option 1. The most critical issue is on resettlement. This area is also occupied by a notable number of illegal residents.

3) Option 3

The area in Option 3 has mostly been for agricultural purposes during the dry season. Because this area is flooded in the rainy season, no residents have resided in this area. Therefore social problem caused by resettlement will be not significant even though farmers have cultivated it.

On the other hand, the area in option 3 might be relatively easier to have sedimentation due to shallower depth and lower river flow.

Source: JICA Study Team

Figure A2.2 Results of Household Counting Survey

Comparing the three alternatives, option 3 is recommendable because resettlement is not required. In addition, option 3 can be harmonized with the Mandalay city plan; and also this area has sufficient capacity to expand the port area.

A2.5 Scoping

2.5.1 Method of Scoping

The scoping process is based on literature review, interview surveys, and site observation among which, site observation and interviews were the most informative. Under the scoping process three alternatives were also evaluated.

The survey is summarized in Table A2.4. And the results of scoping are summarized in Table A2.5.

Table A2.4 Description of the Environmental Condition Survey

Methodology
・ Site observation ・ Interview with residents, business enterprises, local government, etc.
Items Observed
Observation ・ Houses, shops and other establishments along in around project site ・ Land use (type; location) ・ Local business condition especially in the river bed ・ Natural environmental condition ・ Fishing activity Interview ・ Socio economic condition of residents in river bed ・ Perception on land occupy by illegal residents ・ Land status hearing from both residents and government side. ・ Agricultural production ・ Fishing production

Source: JICA Study Team

Table A2.5 Scoping Results

Impacts			Phase		
			Pre construction	Construction	Operation
Social Environment:	1	Involuntary Resettlement	-B	D	D
	2	Local economy such as employment and livelihood, etc.	-B	+B	+B
	3	Land use and utilization of local resources	D	D	D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D
	5	Existing social infrastructures and services	D	D	D
	6	Traffic Congestion	D	-B	D
	7	Split of Community	D	D	D
	8	Indigenous and ethnic people	D	D	D
	9	Misdistribution of benefit and damage	-B	D	D
	10	Natural / Cultural heritage	D	D	D
	11	Local conflict of interests	-B	D	D
	12	Water Usage or Water Rights and Rights of Common	D	D	D
	13	Sanitation	D	-B	-B
	14	Hazards (Risk) Infectious diseases such as HIV/AIDS	D	D	D
Natural Environment	15	Topography and Geographical features	D	D	D
	16	Soil Erosion / sedimentation	D	-B	-B
	17	Groundwater	D	D	D
	18	Hydrological Situation	D	-B	-B
	19	Coastal Zone	D	D	D
	20	Flora, Fauna and Biodiversity	D	D	D
	21	Meteorology	D	D	D
	22	Landscape	D	D	D
	23	Global Warming	D	D	+B
Pollution	24	Air Pollution	D	-B	D
	25	Water Pollution	D	-B	-B
	26	Soil Contamination	D	-B	-B
	27	Waste	D	-B	-B
	28	Noise and Vibration	D	D	D
	29	Ground Subsidence	D	D	D
	30	Offensive Odor	D	D	D
	31	Bottom sediment	D	D	D
	32	Accidents	D	-B	-B

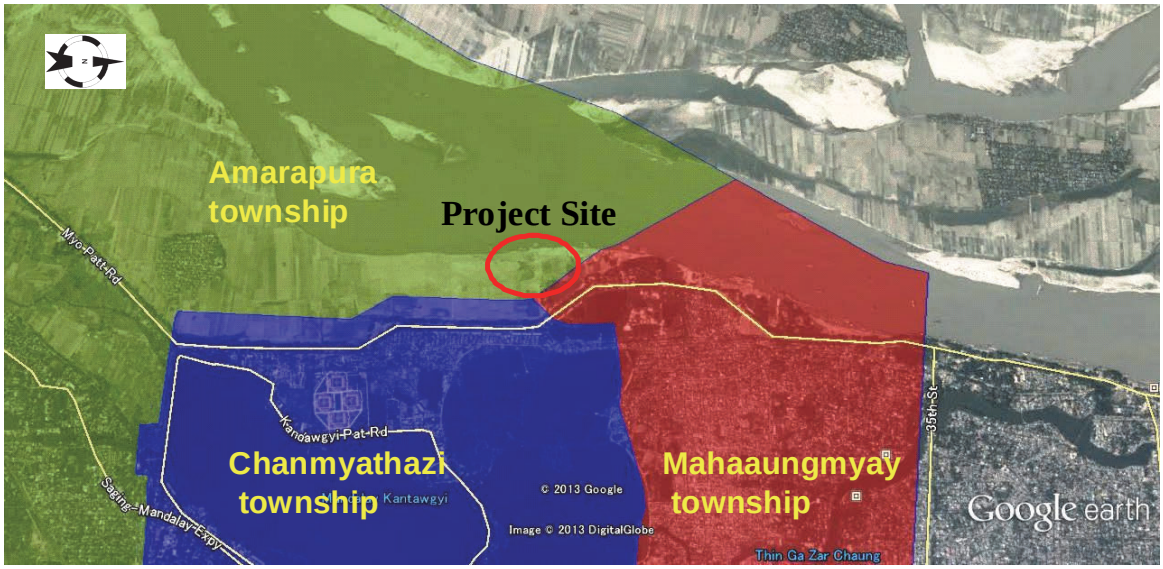
Rating:
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown (Examination is needed. Impacts may become clear as study progresses.)
D : No impact is expected.
Source: JICA Study Team

A2.6 Social and Natural Environmental Conditions

2.6.1 Social Environment

(1) Demographic Condition

The Ayeyawady River bank of Mandalay, the project site, is located in three townships namely Maha Aung Myay, Chan Mya Thar Zi and Amarapuya Townships.



Source: JICA Study Team

Figure A2.3 Location of Town ships

As per Township Health Profile 2011, Department of Health Planning, Ministry of Health, the population of the four townships is described in the table below. Two townships, Chanmyathazi and Mahaaungmyay, are high dense area; the area functions as a center of Mandalay. Population density in these townships ranges from 18 to 39 thousand persons /km^2.

Table A2.6 Population in Each Township

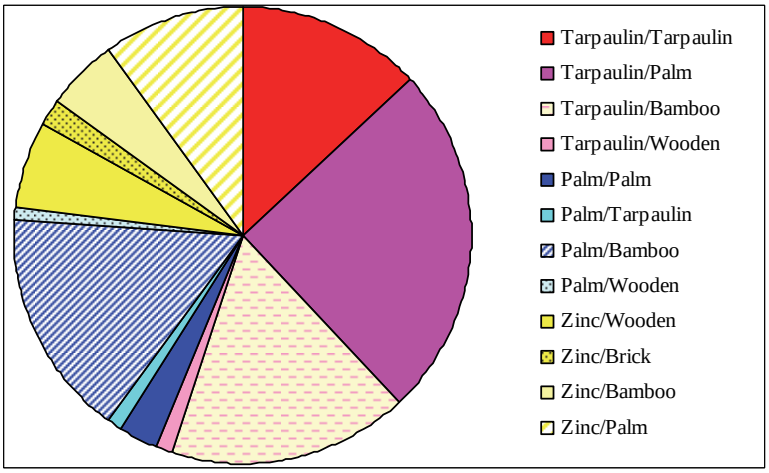
Township's Name	Population in Sex			Population Density (peson/km^2)
	Total	Male	Female	
Chanmyathazi	196,065	93,447	102,618	18,497
Mahaaungmyay	223,338	105,859	117,479	39,182
Amarapura	185,997	89,906	96,091	896
Total / Average	605,400	289,212	316,188	2,704

Sources: Township Health Profile 2011, Department of Health Planning, Ministry of Health

In order to identify the demographic condition and living style of the residents who reside nearby the Project site, a social survey was conducted. The total number of households interviewed was 100 HH covering the river bed.

1) Housing Condition

Residential houses are mostly built of simple materials such as tarpaulin, bamboo and plastic. The size is smaller than 10 m^2 in average. Because the river bed is under government (DWIR) control their occupancy is officially illegal. However the residents have resided there since long time ago; some of them have stayed there for more than 30 years.




Typical House: palm/bamboo

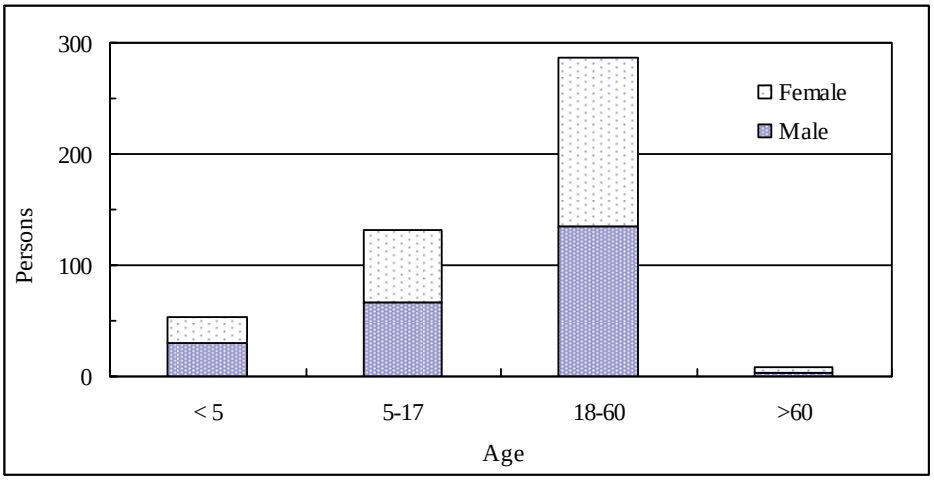

Food shop

Source: JICA Study Team

Figure A2.4 Types of Housing Structure

2) Family Structure

Figure below shows family structures of households who reside in the river bed.

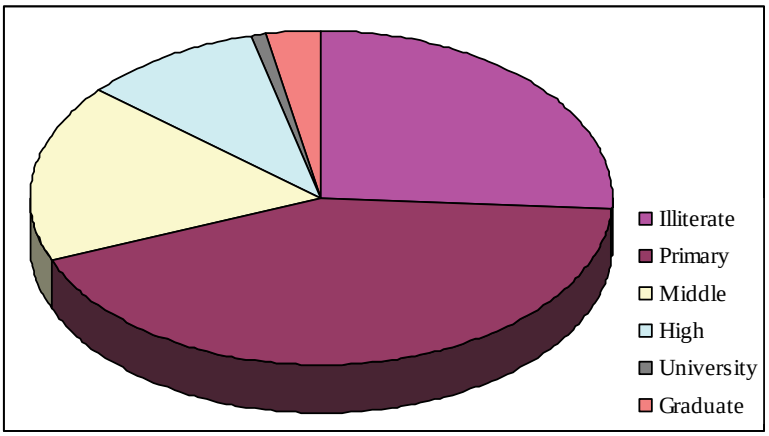


Source: JICA Study Team

Figure A2.5 Family Structure

The total number of residents was 478 persons in 100 HH that were surveyed, therefore the average number of family members were counted at 4.8 persons per HH. Approximately 60 % of persons ranged between 18 to 60 years old (productive ages); while 11 % of residents are below school age.

While as shown in the figure below, 43 % of residents (household head or person who interviewed) were educated only in primary class; and 26 % of them were not educated.

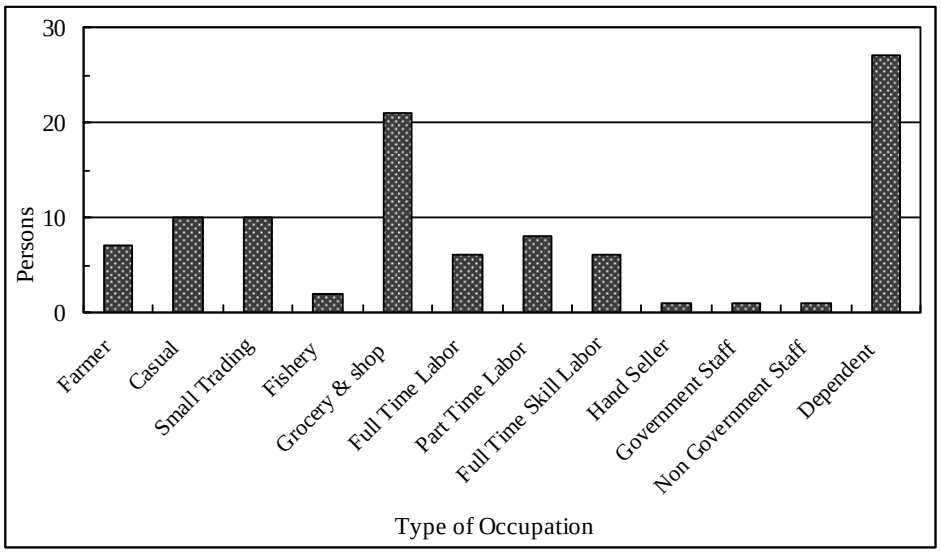


Source: JICA Study Team

Figure A2.6 Education Level

3) Occupation, Income

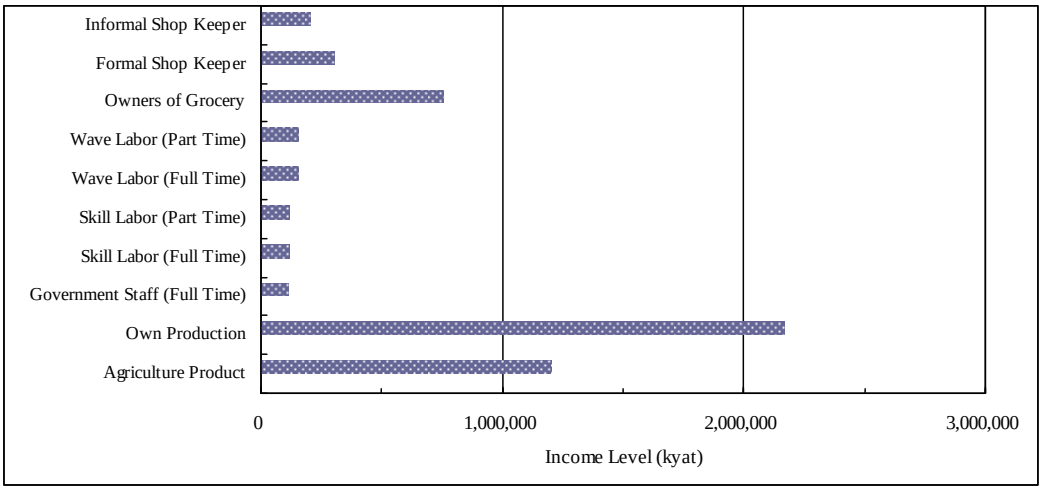
The major occupation of the residents who reside in the river bed is grocery/shop and labourers. Labourers are mostly recruited for port activities. Farmers have cultivated the land in the Project site (former the area of option 3) for peanut production.



Source: JICA Study Team

Figure A2.7 Type of Occupation

Monthly income level is shown in table below;



Source: JICA Study Team

Figure A2.8 Income Level by Occupation

Monthly income (income of an individual family member, not household) ranged from 21,000 to 6,720,000 kyat; its average was around 380,000 kyat. It seemed that farmers especially who individually owned his production got a relatively higher income. Although residents have illegally resided in and used the river bed, and their house facilities look simple and small, their income level is at the average level.

(2) Social Infrastructure

In the Project site (former area of option 3) there are three monasteries, two religious buildings and three pagodas; however those facilities are not located adjacent to construction area, so the impacts to them are minor. The community in Shan Lay Kyun Village has cultivated roughly estimated over 100 acres of agriculture land.

(3) Land use

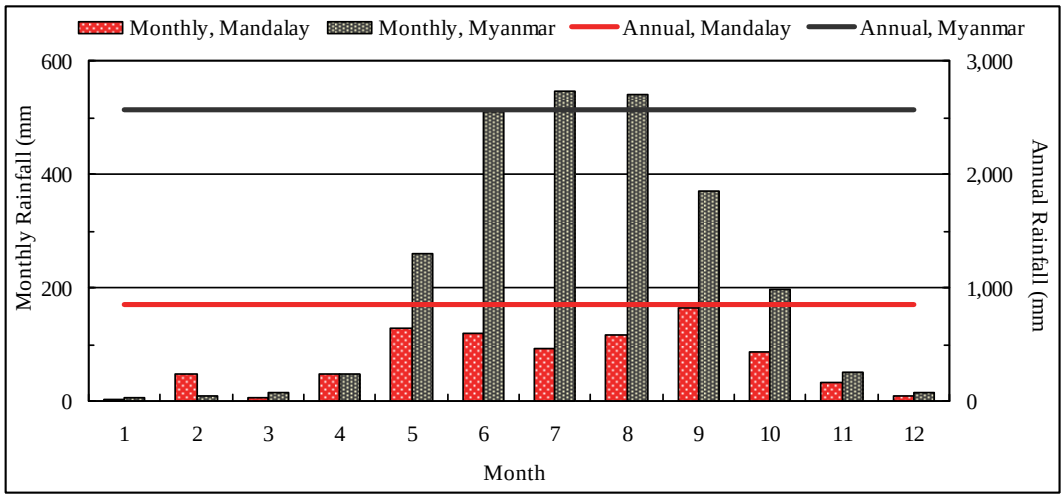
Although the Project site is officially controlled by the government (DWIR), the actual land status is complicated and there are very complex issues among the stakeholders. From interview surveys with residents and the local government, local community in Shan Lay Kyun village has traditionally used this land for agricultural purposes in the dry season. Some monks have owned the land and lease it to farmers. Moreover trading companies have (land brokers) purchased the land from the community and farmers.

It was assumed that the current land price had ranged from 4 to 10 million kyat/acre; those prices have fluctuated by land demand triggered by brokers. Even though those land transactions are not official or legal it will be difficult to solve the issue of land ownership..

2.6.2 Natural Environment

(1) Climate

Myanmar appreciates a tropical monsoon climate with a distinct rainy season (May to September) and dry season (October to April). The central area, including Mandalay, is considered a "dry area" where rainfall is smaller than in other areas. The figure below shows rainfall in Mandalay compared with other areas. Annual rainfall in Mandalay was 858 mm; its value was only 30 % of the annual average in the whole of Myanmar.

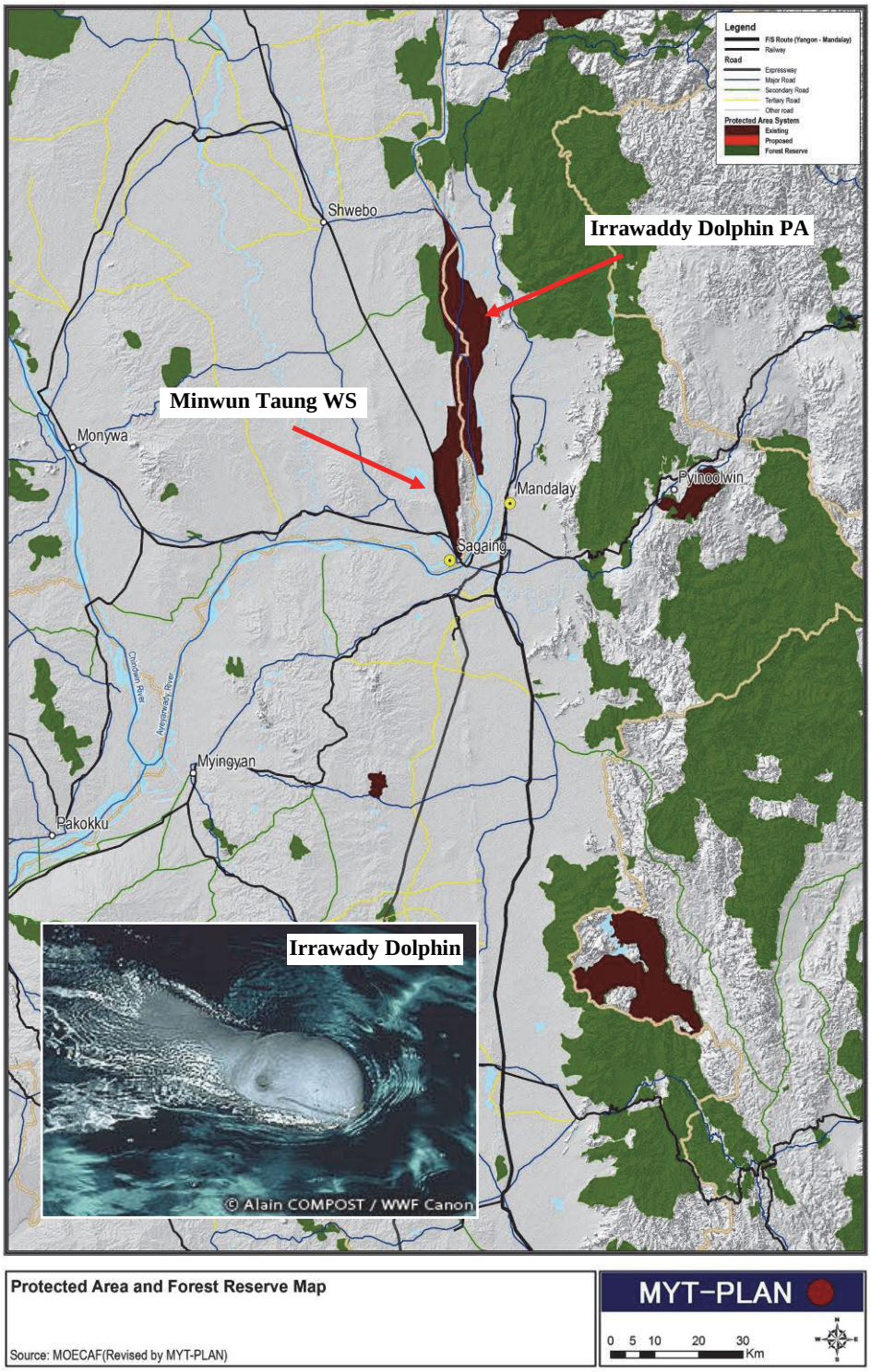


Source: WMO

Figure A2.9 Rainfall Condition

(2) Biodiversity, Ecosystem

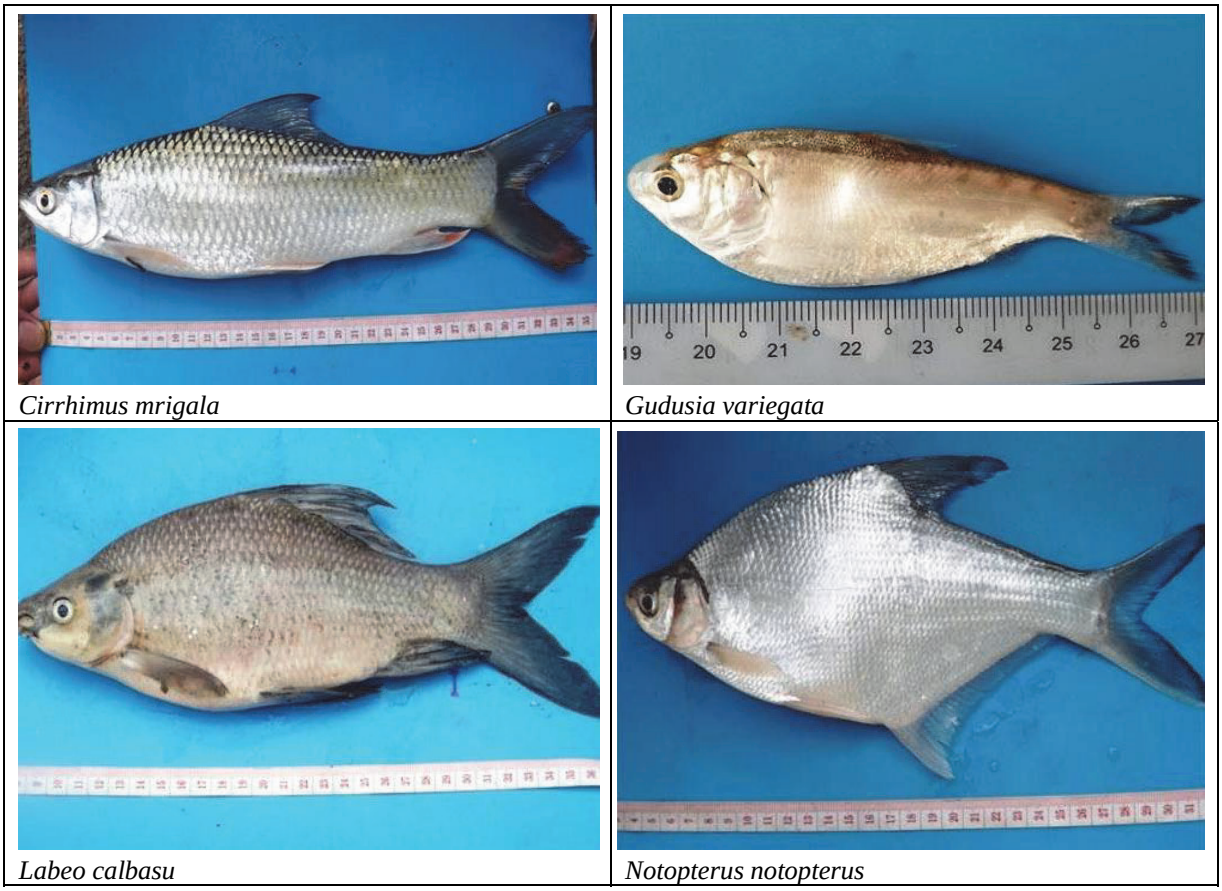
There are two protected areas are registered; one is Minwun Taung Wildlife Sanctuary located on the opposite side of the Ayeyarwady River. The other is located upstream, namely the Irrawaddy Dolphin Protected Area where a rare freshwater aquatic mammal named the "Irrawady Dolphin" has lived. Because the Project site is located downstream of their habitats; the Project cannot affect this area.



Source: JICA Study Team based on WNO and WWF

Figure A2.10 Location of Protected Areas

Aside from vulnerable aquatic fauna, approximately 70 fishermen have caught fish in and around the Project site. In the field survey, around 66 species of freshwater fish belonging to 19 families were recorded with different population abundances. Most of the recorded fishes were known as common species consumed by local people. Typical fish observed in the Project site is shown in the figure below:



Source: JICA Study Team

Figure A2.11 Typical Fish in/around the Project Site

2.6.3 Pollution

(1) Air Quality

Air quality survey was conducted in the bagoda which was located between the areas of option 2 and 3.

Air quality level of CO, NO_2 and SO_2 met the World Bank Standard level as well as WHO guidelines; while dust pollution (PM10 and SPM) exceeded permissible levels.

Table A2.7 Results of Air Quality Survey

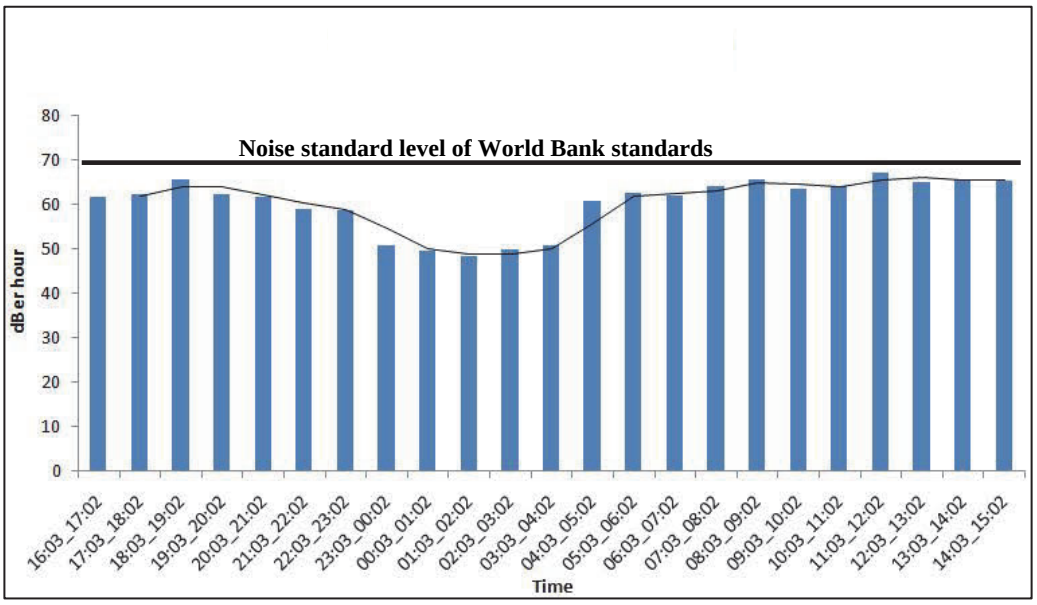
	NO2 (ppb)	SO2 (ppb)	CO (ppm)	PM10 (ug/m^3)	SPRM (ug/m^3)
Mandalay	38	ND	0.3	102	404
World Bank	150	125	NA	NA	NA
WHO	40	20	NA	50	100

Note: NA: not available, ND: not detected
Source: JICA Study Team

It was noted that during the survey, the weather condition was windy. It is supposed that the soil type around the Project site has a predisposing factor to generate dust especially during dry conditions.

(2) Noise

Figure A2.12 shows noise level (hourly average) of measuring 24 hours in week day.



Source: JICA Study Team

Figure A2.12 Results of Noise Level Survey

Noise level showed below 70 dBA which is World Bank noise standard level of commercial zone.

(3) Water Quality

River water was contaminated by soil. Concentration of COD which indicate domestic organic pollution was not so high comparing with high contamination by soil that ranging from 7.2 to 10 mg/L. Oil content was also very low, below detectable level; oil content in river sediment was not also detected. It is concluded that water pollution by port activity as well as other human activities is not significant.

A2.7 Impact Evaluation

2.7.1 General

Major impacts caused by the Project are summarized below:

(i) Increasing Job opportunity and Related Business Chance (Positive Impact);

(ii) Land acquisition (Negative Impact);

(iii) Change water condition for aquatic ecosystem (Negative Impact);

(iv) Water Pollution (Negative Impact);

Evaluation impact matrix table is described in Table A2.8

Table A2.8 Environmental Check List

Environmental Parameters		Pre-construction	Construction							Operation & Maintenance				
		Land Clearance	Mobilization of materials & equipment	Construction of cargo terminal, land reclamation	Construction of jetty	Construction of access road	Construction of access bridges	Operation base camp, if necessary	Facility building	Passenger loading / unloading	Cargo loading / unloading	Dredging	Ship maintenance	Overall
Pollution	Air Pollution	C	-B	C	C	C	C	C	C	C	C	C	C	C
	Water Pollution	C	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B
	Waste	-B	C	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B	-B
	Soil/Sediment Contamination	C	C	C	C	C	C	C	C	C	C	C	C	C
	Noise and Vibration	C	-B	-B	C	C	C	-B	-B	C	C	C	C	C
	Odor	C	C	C	C	C	C	C	C	C	C	C	C	C
Natural Environment	Ecosystem	C	C	-B	-B	-B	-B	C	C	C	C	C	C	-B
	Topography and Geology	C	C	C	C	C	C	C	C	C	C	C	C	C
	Subsidence / Erosion	C	C	C	C	C	C	C	C	C	C	C	C	C
	Global Warming	C	C	C	C	C	C	C	C	+B	+B	C	C	+B
	Landscape	C	C	C	C	C	C	C	C	C	C	C	C	C
Social Environment	Land Acquisition, Resettlement	-B	C	C	C	C	C	C	C	C	C	C	C	-B
	Living and Livelihood	-B	-B	C	C	C	C	-B	C	+B	+B	C	C	+B
	Local Economy	-C	+C	+C	+C	+C	+C	+C	+C	+B	+B	+B	+B	+B
	Historical / Cultural Heritage	C	C	C	C	C	C	C	C	C	C	C	C	C
	Land Use	C	C	C	C	C	C	C	C	C	C	C	C	C
	Vulnerable Groups	C	C	C	C	C	C	C	C	C	C	C	C	C
	Local Conflict	-B	C	C	C	C	C	C	C	C	C	C	C	C
	Water Use / Right	C	C	C	C	C	C	C	C	C	C	C	C	C
	Social Infrastructure / Services	C	C	C	C	C	C	C	C	C	C	C	C	C
	Gender, Right of Children, Disabilities	C	C	C	C	C	C	C	C	C	C	C	C	C
	Infectious Diseases	C	C	C	C	C	C	-B	C	C	C	C	C	C

Remark: positive: +, negative: -
A: Significant impact is expected, B: Moderate impact is expected, C: No / negligible impact is expected
Source: JICA Study Team

2.7.2 Environmental Impact in Pre-Construction Stage

(1) Resettlement

The Project site is located in the river bed which is officially controlled by DWIR. Although land use/own by farmers as well as private companies (brokers) is not eligible, social complaints can rise unless adequate land acquisition is conducted.

The size of the land occupied is estimated around 3 ha, plus additional 4 ha of land will be temporary required for a temporary storage site and assembly of floating jetties.

Due to a seasonal flood area, no residents have resided there, so that resettlement will not be required. This land is mostly cultivated for peanut production during the dry season.

2.7.3 Environmental Impact in Construction Stage

(1) Recruitments

Recruitment for construction activity will involve relatively many and various types of skills. Also construction activities need various type of related businesses, such as transportation service, trading, food services, etc. These are one of the most important positive impacts; many people, especially local residents, can get new jobs or have a possibility to increase their earning.

On the other hand, it is also possible to generate social jealousy in case the residents, as well as existing port workers residing the river bed, cannot be involved in the construction activities.

(2) Operation of Base Camp

The project site is located near the Mandalay urban city area so that most of the workers come from the city area; while workers who come from the city of Mandalay, they are also recruited. In this case a base camp contains the function of accommodation for workers. Location of the base camp has not yet been decided; it will be reasonable to build near construction site means in the river bed. If the base camp is built in river bed, impacts on noise, air pollution, and traffic disturbance can be avoided.

On the other hand the following impacts are generated by the operation of base camp.

a) Domestic Water Pollution

The workers will consume water and generate huge domestic wastewater estimated approximately 15 m^3/day in case of 100 workers working. If this wastewater is discharged to river as well as adjacent farmland without proper treatment, the river water and soil will be degraded.

b) Infectious Diseases

Improper operation of the base camp, especially non-control of domestic waste may degrade the sanitary conditions, which raises risk of water-boned infectious diseases. In addition to infectious diseases, it is possible to raise the risk of HIV/AIDS because increasing number of male workers who come from various areas and have a variety of customs that may raise a moral hazard.

(3) Mobilization of Equipments and Materials

Because the Project site is located on the river bed far from residential areas impacts on air quality, noise and traffic disturbances will be minor. While a mobilization route may pass adjacent to urban and residential areas, especially along Myo Patt Rd, that mobilization will generate some moderate impacts as follows:

a) Disturbance to Air Quality and Noise

Operation of heavy equipment and vehicles will generate air pollutants by exhaust gas especially dust pollution. Also these machines will accelerate noise disturbances. Therefore it is necessary to arrange a mobilization route that avoids sensitive zones such as hospitals, schools, etc. These two environmental impacts occurring together at the same time will disturb public health and amenities, and will increase the community's complaints.

b) Traffic Disturbance

Mobilization activity will accelerate traffic disturbance in the form of traffic congestion and traffic accidents. This impact will continue during the construction phase.

(4) Off shore Works

Off shore works will be reclamation for the cargo terminal and temporary storage site, construction of floating jetty and an access road (bridge). Since the construction site is located on the river bed, and far from residential area, air pollution and traffic disturbance caused by civil works can be minor.

a) Noise Disturbance

Excavation equipment generates noise an estimated around 111 dBA; that noise level will be attenuated below 70 dBA (temporary noise standard level based on WB) 100 m far from the construction site, and below 55 dBA (noise standard level for residential zone) 350m away. Residential areas are mostly located outside of this area as shown in Figure A2.13; while one religious facility (monk house) exists.

Source: JICA Study Team

Figure A2.13 Estimation on Noise Disturbance

When the excavation equipment as well as other construction machines are operated, the safe number of equipment that is to be operated at the same time will be considered, and a temporary barrier will be installed, if necessary.

b) Water Pollution

Although the river water condition has currently been turbid by soil, land reclamation work may concentrate turbidity by discharging soil. Significant impact is expected to be small and limited in duration because of the current muddy condition; however an impact to aquatic life can be evaluated in this time. Therefore it is necessary to monitor the relation between turbid conditions and fishery conditions.

In addition, it is possible to spread soil into the surrounding farmland; therefore reclaimed soil must be blocked to avoid spreading.

c) Aquatic Biota / Fishing Activity

According to the survey, approximately 100 fishermen with 50 boats have operated catching fish. Most of them operate not adjacent to port area but upstream or downstream. The water pollution by spreading soil mentioned above can affect aquatic biota. Therefore monitoring aquatic conditions must be required.

(5) On Shore Works

On shore work contains the construction of access roads and building facilities. On shore works are also operated in the river bed; that is why, significant impact related to air pollution and traffic disturbance will not occur.

On the other hand, noise disturbance by operation of construction equipment may affect the monk house; the situation will be similar to the case in off shore works.

2.7.4 Environmental Impact in Operation Stage

(1) Passenger and Cargo Handling

a) Water Pollution

Passengers as well as port workers generate domestic waste which causes water pollution and the degradation of sanitary condition. The volume of discharged water depends on the number of passengers. Adequate sanitary systems are required.

(2) Maintenance Dredging

a) Water Pollution

Although sedimentation is minimized by adequate port design based on river flow simulation, it will be required to dredge around the port area approximately once every 2~3 years. Dredging work will generate turbid water which has a risk to change aquatic condition; it can affect fishery activity.

By the way, approximately 90 sand collection companies (inc. no license operations) have operated to collect and sell sand along the river. The river sand in the Project site is not so polluted by oil (below detection limit); therefore the sand dredged can be re-used for construction materials, etc.

b) Aquatic Biota

Aquatic biota around the Project site is composed of common species only, no vulnerable species have been observed. Fishery production is mostly consumed in local purposes. Turbid water may affect aquatic biota; however its intensity is expected to be moderate; and it can be minimized by ordinary countermeasures.

(3) Maintenance and Inspection Works

Maintenance and inspection works in the dock may generate polluted water especially contaminated by oil and grease. In the current condition, it was observed to set drainage and sinks in order to avoid direct

discharging of polluted water. Since frequent maintenance and inspection works will raise the amount of discharged water, so that it shall be considered to inquire about the current drainage capacity.

2.7.5 Positive Impacts

The following positive impacts are highlighted:

(1) Local Economy

The Project can encourage increasing job opportunities and chances for local business. It is expected to recruit labours for construction work as well as for cargo loading and unloading in the operation phase. In addition, service business for passengers such as food shops, souvenir shops, land transportation services (taxi, bicycle-taxi, etc.) are enhanced. Those impacts can encourage the improving local economy.

(2) Global Warming (Reduction of GHG)

A modal shift of cargo transportation from truck to inland ship transportation can contribute to the reduction of CO_2.

Condition on the estimation of CO_2 reduction is as below

- Cargo handling volume from / to Mandalay is forecasted 240 thousand tons per year.
- With case: this cargo will be conveyed by ship.
- Without case: the cargo will be conveyed by truck.

CO_2 reduction by the Project is summarized in table below.

Table A2.9 CO_2 Reduction by the Project

	Year 2030
Cargo Handling Volume (thousand ton/year)	240.0
(million ton-km/year)	133.9
CO_2 Reduction Rate (gCO_2/ton-km) [1)]	
Ship	39
Truck	158
Annual CO_2 Emission ($tonCO_2$/year)	
Ship	5,221
Truck	21,151
Percentage vessel / truck (%)	24.7

Note: 1) Environment and Transportation, Foundation for Promoting Personal Mobility and Ecological Transportation, 2011
Source: JICA Study Team

Annual CO_2 emission by inland transportation in 2030 is estimated at 5,221 $tonCO_2$, which counts for 24.7 % of total CO_2 emission by truck transportation in the same year. It can lead to the result that inland water transportation is expected to reduce CO_2 emissions and to not contribute to global warming.

A2.8 Environmental Management Plan

2.8.1 General

The Environmental Management Plan (EMP) consists of two plans, one is the Environmental Mitigation/Protection Plan and another is the Environmental Monitoring Plan. The purpose of each plan can be described below:

1) Environmental Mitigation Plan

EMP shall be conducted in order to minimize and/or avoid negative impacts, and to strengthen positive impacts.

2) Environmental Monitoring Plan

The Environmental Monitoring Plan shall be carried out in order to find out environmental conditions, to ensure the mitigation plan is effectively functioned, and to specify adverse impacts before they expanding.

2.8.2 Environmental Mitigation Plan

The Environmental Mitigation Plan is summarized as below:

Table A2.10 Environmental Mitigation Plan

No	Activities	Environmental impact	Works and measures for environmental Protection	Responsibility for implementation	Responsibility for monitoring
I	**Preconstruction phase of the project**				
-	Land clearance,	Social complains	– Public consultation with affected persons (ex. farmers) – Installation of notification board concerning the project at the project site in order to prevent additional settlement. – Clear compensation process based on the public consultation – For farmland, acquisition of land and property (e.g. crops) after harvesting	MR supported by MORT, and local government (district administrator, etc.)	MR supported by third parties

No	Activities	Environmental impact	Works and measures for environmental Protection	Responsibility for implementation	Responsibility for monitoring
II	**Construction phase of the project**				
1	**Air pollution**				
	Mobilization of materials	Construction site is located far from residential area, so that air pollution can be minor. While the mobilization route may pass Myo Patt Road, and the community road near the monk house. Especially dust pollution which is caused by bulk materials transported by trucks shall be mitigated.	– Proper storage including covering of sand, gravel and other materials, which are easy to spread into the atmosphere – Covering bulk materials during transportation	Contractor under contract with the Employer	Consultant under contract with the Employer
2	**Noise disturbance**				
-	Operation of construction equipment and machineries	Operation of construction machineries will increase the level of noise generated, affecting to religious building (monk house)	– Routine maintenance of vehicles and construction equipment – Selection of low-noise emission machines and/or installation of silencers – Scheduling to avoid construction works taking place during rest hours and/or worship hours of the local people – Installation of barrier fence during construction to reduce noise disturbance if necessary – Development of working rules so as to, for example, avoid unnecessary use of air-horns, keep speed limit, turn off engines when not in operation and training drivers and operators to follow the rules – Scheduling to avoid too much equipment operating at the same time near sensitive receptors	Contractor under contract with the Employer	Consultant under contract with the Employer
3	**Water Pollution**				
	Operation of base camp and storage site	Activities in the base camp will degrade environmental sanitation by generating domestic wastewater by workers. Spilling of used oil and lubrication is also a potential source of water quality degradation.	– Proper collection and storage of used oil and lubrication in a drum – Development of rules for waste management and training to workers to follow them – Development of closed drainage canal to avoid wastewater from spreading to river and farmland	Contractor under contract with the Employer	Consultant under contract with the Employer

No	Activities	Environmental impact	Works and measures for environmental Protection	Responsibility for implementation	Responsibility for monitoring
			– Development of a contained storage area for oil, chemicals and others by ditching – Development of water treatment facilities (e.g. sedimentary sand tank to remove soil from wastewater) – Installation of proper temporary toilets		
-	Loading/unloading materials	Loading/unloading can be considered a major source of turbid water generation	– When watering (to mitigate dust pollution), collect turbid/discharged water into a drainage canal	Contractor under contract with the Employer	Consultant under contract with the Employer
4	**Traffic Disturbance**				
-	Mobilization of equipment and materials	Mobilization activities may disturb traffic flow and accelerate traffic congestion especially along Myo Patt Road	– To install traffic signs at the entrance and exit gates connecting Myo Patt Road – To provide adequate parking lots in the construction site, and to forbid vehicles from parking on the roadside – To appoint a staff in charge of traffic control – To train the drivers and operators of heavy equipment to work in conformity with the applied SOPs – To arrange schedule of mobilization of equipment to avoid accelerating traffic congestion, and to avoid busy hours. – To coordinate with local government and traffic police regarding permanent or temporary road improvement to minimize traffic disturbance. – To cover transport vehicles with canvas to avoid material dropping.	Contractor under contract with the Employer	Consultant under contract with the Employer
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5	**Local economy, livelihood**				
-	Recruitment and job opportunity	Job opportunities and related business chances are expected to increase by the project during construction. Meanwhile, it may create jealousy within the local communities	– Priority to local residents/communities, especially those that were significantly affected by the project, for employment – Provision of clear and objective information on the project as well as the number, types and skills of labor needed through local networks, advertisements media or any other source	Contractor under contract with the Employer	Consultant under contract with the Employer

No	Activities	Environmental impact	Works and measures for environmental Protection	Responsibility for implementation	Responsibility for monitoring
			that is available, appropriate and effective. – Priority to local materials, food – Reasonable wages or a salary level that is conformable with the types of skills and labor required in the area.		
-	Workers concentration	**Public Health** If sanitary management is poor in the construction site and it is highly populated by people coming from different places with different lifestyle and customs, risks of infectious diseases spreading, including that of HIV/AIDS, will generally rise. **Security and violation of order** Influence on construction workers, local communities, visitors may heighten insecurity and the risks of violation of orders	– Implementation of management measures including creating hygienic conditions, registration of temporary residence to workers and providing education to citizens – Propagandize against social evils to ensure security and order	Contractor under contract with the Employer	Consultant under contract with the Employer
6	**Waste management**				
-	Operation of base camp and storage site	Solid and liquid waste will increase by base camp operation some of which are categorized as toxic/hazardous waste	– Preparation of a temporary waste dumping site during storage – Development of a closed drainage canal for wastewater and prohibition of discharging from the base camp without adequate treatment – Installation of a signboard to prohibit waste dumping at inappropriate areas – Collection of residue of oils including lubricating oil	Contractor under contract with the Employer	Consultant under contract with the Employer
-	On and off shore works (civil works)	Civil works will generate a large volume of sand waste especially by foundation works and embankment	– Prohibition of placing materials (e.g. soil, gravel and sand) on road side or any other areas outside the project site – Installation of a fence to clarify the boundary between the Project site and beyond – Develop a rule for waste management, and nominate responsible person to	Contractor under contract with the Employer	Consultant under contract with the Employer

No	Activities	Environmental impact	Works and measures for environmental Protection	Responsibility for implementation	Responsibility for monitoring
			implement said waste management – Reuse of sand materials for road improvement and others		
III	**Operation phase of the project**				
1	**Accidents**				
-	Traffic disturbance, accident	Increase in passengers and cargo loading / unloading may also increase traffic flow. Accidents in the port area also may increase due to installation and operation of heavy equipment such as cranes. Frequency of ship operation may congest ship flow; hence river accident with fish boats may rise.	– Establish or improve ship traffic rules – Educate fishermen about safety management – Establish working rules in the port area, and educate port workers	IWT supported by DWIR	DWIR, traffic police
2	**Water Quality**				
	Passenger and cargo loading / unloading	Main port activity is passenger and cargo loading / unloading	– Provide adequate sanitation system with proper maintenance of treatment facilities, toilet, canteen etc. – Protect oil leakage from ships		
	Maintenance dredging work	Maintenance dredging work will generate turbid water which spread and affect to fishery condition	– Block turbid water to spread out by fence if necessary – Prior inform schedule of dredging to the fishermen		
-	Maintenance and inspection of ships	Maintenance and inspection works in the dock yard may generate oil, grease, garbage which has risk of water pollution	– Proper collection and storage of used oil and lubrication in a drum. Storage shall be set up at adequate locations to be protected from rain and water inundation – Development of adequate drainage canals and water treatment facilities to avoid wastewater being discharged directly – Development of a contained storage area for oil, chemicals and others by ditching – Training of workers so that they follow waste management rules	MR supported by MORT	MORT

Source: JICA Study Team

2.8.3 Environmental Monitoring Plan

Environmental monitoring plan is summarized as below:

Table A2.11 Environmental Monitoring Plan

Target Environmental Impact	Method of Monitoring Survey	Monitoring Period
Social Environmental Impact (Land Acquisition, e.g.)	Public hearing with stakeholders. Interview survey with residents, communities	Pre-Construction to Operation Phase One time a Year
Traffic Condition	Traffic Survey Interview with residents, communities	Construction to Operation Phase One time a Year
Water Quality	Water/sediment sampling and observation survey. River water pH, DO, COD, TSS Oil and Grease Sediment: Soil Condition, oil and grease	Construction Phase river water quality Survey; one time in a half year Sediment survey: one time in a year Operation Phase; one time a year.
	Turbid water by observation survey	Construction Phase One time a month during off shore works especially Operation Phase Every day during dredging work
Noise	Noise Level and Traffic Condition	One time a half year during construction to operation Phase
Waste and Garbage	Observation Survey or Interview Survey with Residents and Local Government.	One time a Year during Construction to Operation Phase
Biological Condition, Fishery Condition	Observation survey Fish sample collection Interview with fishermen	One time a year during construction phase One time in 2 years during operation phase.

Source: JICA Study Team

2.8.4 Rules on Environmental Management

Implementation of the Project environmental management involves many participants; these participants have different positions, responsibilities and interests. Especially the project proponent (DWIR and IWT for operator) and line-governmental agencies shall be key to protect environment and people who benefits from the environment.

Major players and rules for the Project are described below:

- DWIR: is a project proponent and leading executing body for the Project, and also has a responsibility to control environmental protection. Its function aims to conduct environmental management by DWIR or by representative (generally consultant is appointed).
- IWT: is the ship operator, major user of the new port. IWT is responsible for conducting environmental management and monitoring especially during the operation phase.

- MOT: functions as supervisor of DWIR as well as IWT. MOT shall act to coordinate with DWIR to implement environmental management plan, especially resettlement and social issues which need cooperation among various concerned bodies.

- The Engineer (Consultant): will be appointed by DWIR to design and to supervise the construction work. Also the Engineer shall consist of an environmental management section in who is in charge of monitoring the Contractor's activities on behalf of DWIR.

- The Contractor: will be appointed by DWIR to perform the construction work. Major executing body for environmental protection shall be under the Contractor's responsibility under DWIR's instruction through the Engineer. The contractor is obligated to implement and strictly follow the environmental plan which is based on the EIA and also has the consent of engineer.

- Line Agencies: mean local government (ex. district administrator for resettlement), ECD (Environmental Conservation Department, Ministry of Environmental Conservation and Forestry) will cooperate with DWIR for supervising management activities. Other line agencies such as MOAI (Ministry of Agriculture and irrigation for farmland and crop production) will also coordinate with DWIR. MCDC will also cooperate especially for land clearance of farmland.

- Communities, Other Stakeholders: Residents/Communities will be affected by the Project by both positive and negative impacts. The Project shall consider their life, and minimize negative impacts. Also the Project has the responsibility to ensure that the environmental management plan can be taken adequately. Therefore, the information concerning project implementation such as the construction schedule, results of monitoring survey and job opportunity shall be informed to public.