Ministry of Transport
The Republic of the Union of Myanmar

The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar

Final Report

Executive Summary

Feasibility Study on Inland Water Transport Facilities Improvement and Development Project

September 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

Oriental Consultants Co., Ltd.
International Development Center of Japan
ALMEC Corporation

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Exchange rate used in this Report

USD	1.00 =	JPY	99.2
USD	1.00 =	MMK	970.9
MMK	1.00 =	JPY	0.102

(As of October, 2013)

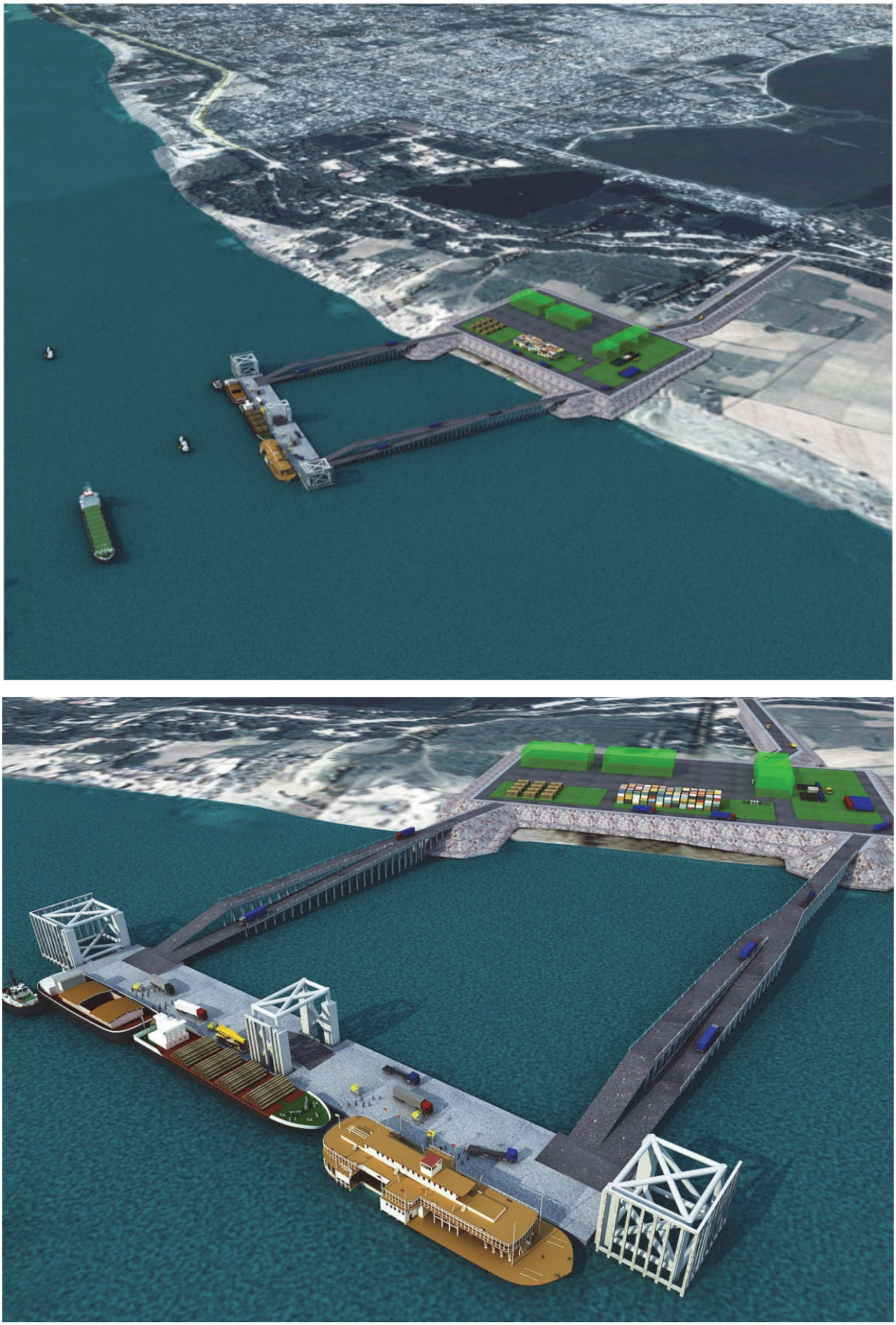

Image Bird's-eye View of Mandalay Port Development (The Case of Floating Pier)

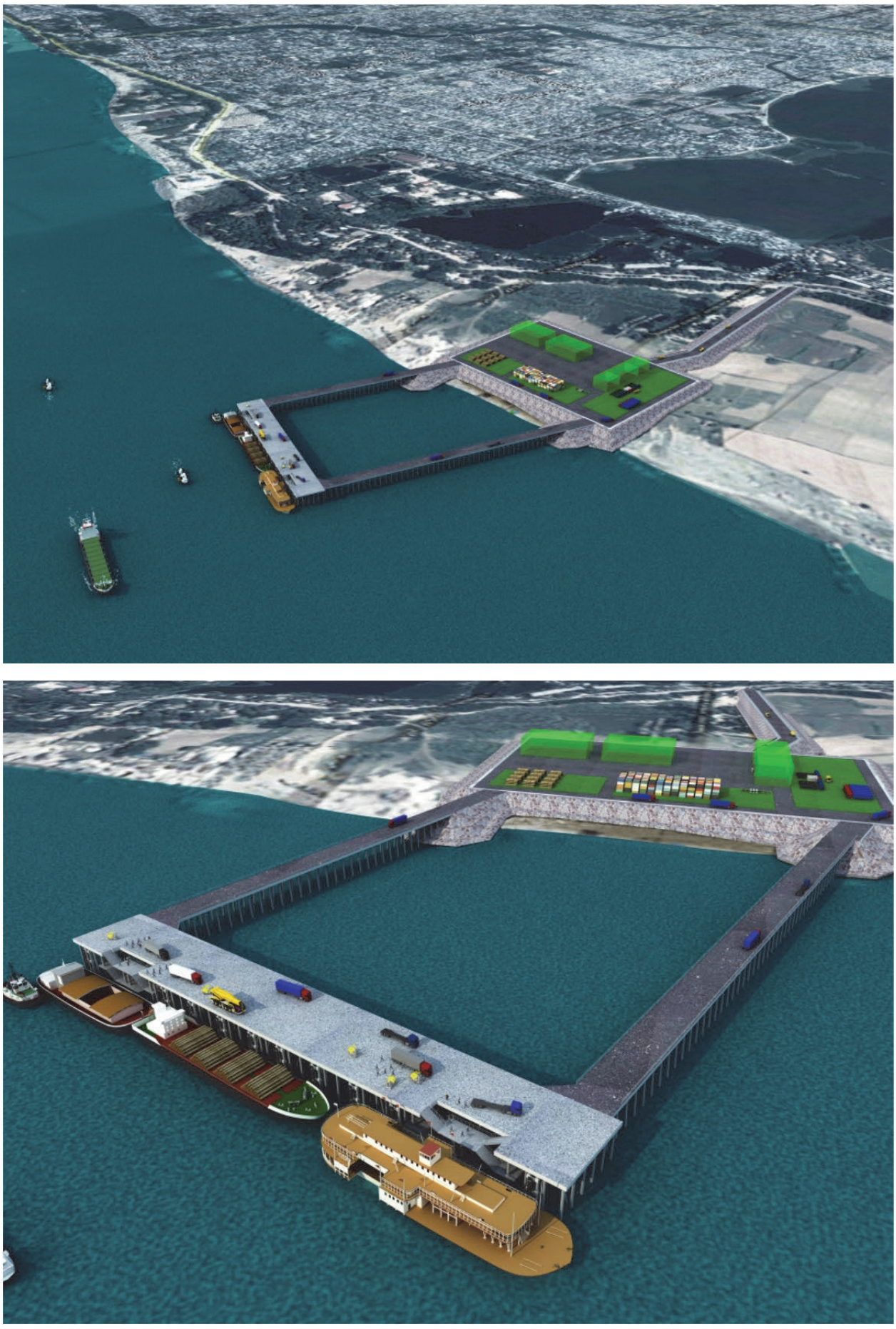

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Table of Abbreviations

No.	Abbreviations	Official Name
1	ACD	Above Chart Datum
2	BH	Borehole
3	BHN	Basic Human Needs
4	CD, CDL	Chart Datum, Chart Datum Level
5	CEO	Chief Executive Officer
6	DAC	Development Assistance Committee, OECD
7	DMA	Department of Marine Administration (Myanmar)
8	DOT	Department of Transport (Myanmar)
9	DWIR	Directorate of Water Resources and Improvement of River Systems
10	DWT	Dead Weight Tonnage (Ship)
11	E/N	Exchange of Notes
12	EIA	Environmental Impact Assessment
13	EIRR	Economic Internal Rate of Return
14	FIRR	Financial Internal Rate of Return
15	FY	Fiscal Year
16	G/A	Grant Aid Agreement
17	GDP	Gross Domestic Product
18	GNI	Gross National Income
19	Gr.	Grade
20	H.W.L	High Water Level
21	ha	hectare, 1 ha = 10,000 m^2
22	HQ	Headquoter
23	hr	hour
24	ICD	Inland Container Depot
25	IWT	Inland Water Transport
26	JICA	Japan International Cooperation Agency
27	kh	design horizontal seismic coefficient
28	kt, knot	knot, 1 knot = 0.514444 m/s
29	kv	design vertical seismic coefficient
30	L.W.L	Low Water Level
31	L/A	Loan Agreement
32	LDC	Least Developed Country
33	LOA	Length overall (length of ship)
34	M&R	Maintenance & Repairing
35	m/s	meter/second
36	MCDC	Mandalay City Development Committee
37	MLIT	Ministry of Land, Infrastructure, Transport and Tourism (Japan)

No.	Abbreviations	Official Name
38	MMID	Mandalay Myotha Industrial Development
39	MOC	Ministry of Construction (Myanmar)
40	MOF Japan	Ministry of Foreign Affairs Japan
41	MOT	Ministry of Transport (Myanmar)
42	MPA	Myanma Port Authority
43	N, N-value	N-Value, Standard Penetration Test
44	NGO	Non-Governmental Organizations
45	O&M	Operation & Management
46	ODA	Official Development Assistance
47	OECD	Organisation for Economic Co-operation and Development
48	PIANC	the World Association for Waterborne Transport Infrastructure
49	R/D	Record of Discussions
50	SCF	Standard Conversion Factor (Economic Analysis)
51	SEZ	Special Economic Zone
52	SPT	Standard Penetration Test
53	t, ton	tonnage
54	TEU	Twenty-foot Equivalent Unit
55	φ	Diameter

Executive Summary

1. Background

This study "Feasibility Study on Inland Water Transport Facilities Improvement and Development Project" was conducted as a part of the main study "The Survey Program for The National Transport Development Plan In the Republic of the Union of Myanmar (the Main Study)" which covers to formulate the national transport master plan of Myanmar. The main study was commenced in December 2012, in which the counterpart authority (Myanmar Government-MOT) and the Study Team discussed selecting projects with high priority and which needed to be executed urgently. Through the discussion, the MOT proposed to conduct a feasibility study on projects for river ports development and for replacing outdated public ships. Upon receiving this proposal from the government of Myanmar, the Study Team worked out the pre-survey on the requirement of the projects. As the result of the pre-survey, the Study Team proposed to conduct this feasibility study for the Mandalay port development and government procurement of new ships. In the study, the project feasibility was evaluated with the JICA yen-loan based formulation, and other financial sources such as ODA grand-aid were also taken into consideration.

2. Present Status of Inland Water Transport Sector

2.1 Inland Waterways

Inland waterways are an important transport route for Myanmar. The country has 6,650km of navigable waterways along major rivers. Ayeyarwady River, which has 2,170km long stream line, runs in a north-south direction in the middle of the country. The river, whose navigable channel length extends 3,938km, including many branch flows in the delta area, , provides waterways for cargo and passenger ships. The waterways connect Yangon city in the south to major northern cities such as Pyey, Mandalay, and Bhamo.

Along the Ayeyarwardy and Chindwin Rivers as the major waterway of Myanmar, river water level changes largely between the rainy season and the dry season. For instance, the water level becomes 8m in Mandalay and 9m in Monywa. The water depth in dry season is shallow; for example, the water depth downstream from Mandalay is 1.5m, while upstream from Mandalay to Bhamo is only 1.1m. The depth in the Chindwin River is shallower, generally less than 1.0m.

A regulation made by DWIR prohibits the navigation of cargo ships and barges during the night. Navigation routes are uncertain because of the large differences in water flow between the dry and rainy seasons, which are repeated every year. Although study reports issued in 1988 and 1993 by the UNDP recommended a river training plan for navigation channels in Ayeyarwady River and Chindwin River, the survey records are old, and should be updated. The government of Myanmar is constructing groynes in the rivers within the budget of the DWIR each year, but not enough have been completed to stabilize navigation routes. River training works and the improvement of channels are vital for transport efficiency and safe navigation. The inland transport sector in Myanmar requires not only modern port development and introduction of machine cargo handling, but also survey, planning, and improvement of the river channels.

2.2 River Ports

In river ports in Myanmar, all cargo handling is carried out by manual labor where no lifting crane is available

The river ports of Myanmar have no cargo jetties except for some small floating piers for passenger use. The cargo barges are anchored near the waterline of natural riverbanks, and wooden walkways are fixed between the sandbank and the ships, which are also erected by labor force. Cargos are carried by laborers by walking along the narrow wooden walkway.

Cargoes are placed on the inclined dusty riverside for temporary storage. There is no surface pavement on the riverside, where dust of fine soil is blown up by running cargo trucks and cargos are spoiled by the soil dust.

Every river port suffers large water height changes according to the seasons which is generally more than 6m ~ 10m. The cargo space during the dry season goes underwater during the rainy season, while cargo handling sites change every season. In port areas which have roads near the river, such as Mandalay Port, cargo is offloaded into the road in the rainy season, which causes traffic congestion.

One of the major reasons why building ports in Myanmar have not been successful is because of the extreme differences in water level between the dry and rainy seasons. Waterway transport is working as the transport mode carrying daily goods for life, nevertheless there is no barge docking jetty and flat cargo yard. The modern port facility development is a very important subject with the highest priority for the sector.

Because there is no other way to carry cargo except by manual labor, cargo is limited to light and small pieces which can be lifted and handled by manpower. Waterway transport is fundamentally suitable to carry large or heavy cargo which is unsuitable for truck transportation. These advantages which waterways provide have not been utilized because machines and equipment are not used for cargo handling. It is estimated that the current cargo handling efficiency is nearly 30% of machine handling. When a port facility is built, the suitable cargo efficiency should raise the revenue of port operations. Replacing manual labor with machines is a vital subject for the inland water transport sector.

In addition, the government has no experience in port operations because there is no facility to be managed. The government sector does not have a suitable organization to deal with river port operations. The IWT is the authority to provide public transport service by passenger-cum-cargo ships and to lease cargo barges to private shipping companies, and it has no port facilities except for small floating piers. Whilst DWIR is the authority to manage river channels, its main responsibility is flood control of the rivers, therefore it does not manage river ports in the practical sense. From the beginning of port improvement, the government should improve its organization in order to manage port operations from construction to administration of the ports when they are completed.

2.3 Ships for Inland Water Transport

Inland waterway services are decreasing in use because of recent motorization. On the other hand, there are many areas flooded during the rainy season which renders roads unusable, because disaster control in these areas is insufficient. Under this state of affairs, inland waterway service has a very important role to provide a stable transport mode for passengers and cargos in all seasons.

The ships owned by the IWT became older and older and a considerable number of ships are

too old to provide reliable public services. 50% of the IWT's ships are over 40 years old, and 18% are more than 60 years. In the case of passenger ships, there is a significant loss of speed and comfort for passengers because of their prolonged use. Barges and tugboats also fail to provide safe and reliable transport services due to their age.

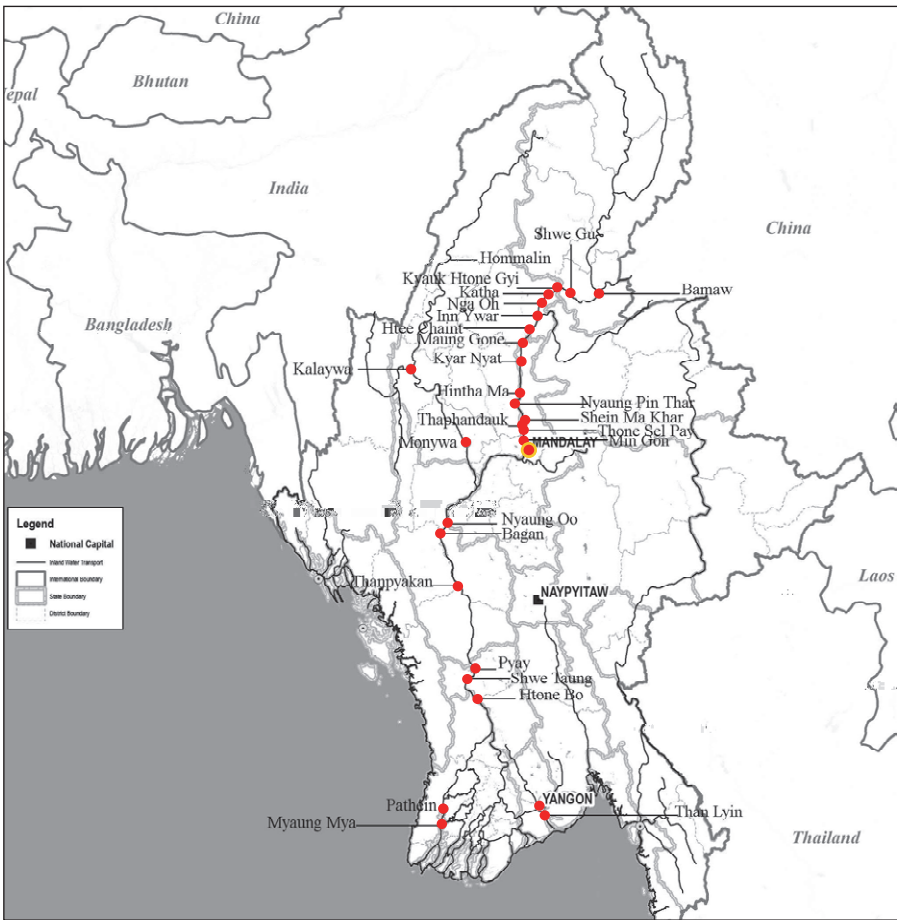
Even though the use of ships has decreased in general, users still expect a low cost in transport. The decaying ships must be replaced immediately to improve public services. Leasing barges and tugs at a low cost supports the domestic water transport industries, which usually has a weak financial background. In this view point, aged barges and tugs also have to be replaced.

3. Mandalay Port Development

3.1 Mandalay Port

Mandalay Port is recognized as approximately 6km of natural riverbank along the Ayeyarwady River located in the downtown area of Mandalay city, where there is no cargo port facility that is similar to other domestic river ports. The cargo barges are anchored near the waterline of the natural riverbank, and wooden walkways are fixed between the sandbank and the ships. Cargos are carried by laborers by walking along the narrow wooden walkway. Passengers also use this wooden walkway to get on and off the ships. Cargo trucks run to the riverbank from the riverside road where loading and unloading is carried out. The water height difference between the dry and rainy seasons is 8m, therefore the space on the riverbank changes according to the seasons. During rainy season, the riverbank becomes very narrow due to the rising of the water level, which causes traffic congestion because cargo handling works occupy part of the roadway.

Figure 1 shows the locations of river ports which is the origin or destination to and from Mandalay Port for cargos and passengers. Ports connecting to Mandalay distributes all over the country upstream and downstream of the Ayeyarwady and Chindwin Rivers.



Source: JICA Study Team

Figure 1 Location of River Ports Connecting to Mandalay Port

In the time period of April 2012 to March 2013, the IWT handled approximately 100,000 tons of cargo, and private operators handled approximately 500,000 tons of cargo through the Mandalay Port. (Table 1). Most cargo consisted of rice, beans and cement, which are usually carried in the form of 50kg-bags. Additional cargo consists of fertilizer, vegetable, steel material and consumer goods, etc.

Table 1 Monthly Cargo Volume of Mandalay Port

(1) IWT Handled Cargo

Month	By Passenger cum Cargo Ship		
	IN (t)	OUT (t)	TOTAL (t)
Apr-2012	4,203	5,171	9,374
May-2012	5,497	5,597	11,094
Jun-2012	4,717	5,486	10,203
Jul-2012	2,629	5,460	8,089
Aug-2012	2,122	4,713	6,835
Sep-2012	2,418	5,110	7,528
Oct-2012	2,068	4,970	7,038
Nov-2012	2,098	4,193	6,291
Dec-2012	2,309	4,238	6,547
Jan-2013	2,959	4,678	7,637
Feb-2013	4,473	5,804	10,277
Mar-2013	4,901	5,590	10,491
TOTAL	40,394	61,010	101,404

Source: IWT

(2) Private Operators Handled Cargo

Month	Passenger cum Cargo Ship			Cargo Barge			Total (t)
	In (t)	Out (t)	Total (t)	In (t)	Out (t)	Total (t)	
Feb-2013	343	11,490	11,833	33,291	1,155	34,446	46,279
Mar-2013	356	12,665	13,021	35,721	3,598	39,319	52,340
Apr-2013	651	10,478	11,129	20,838	2,985	23,823	34,952
May-2013	720	10,846	11,566	24,422	1,965	26,387	37,953
Jun-2013	621	12,898	13,519	32,547	1,685	34,232	47,751
Jul-2013	573	11,308	11,881	21,299	4,456	25,755	37,636
TOTAL	3,264	69,685	72,949	168,118	15,844	183,962	256,911

Note: Exclude liquid cargo, wooden logs, and sand/stone.
Source: DMA

3.2 Port Location

The port location was selected south of the commercial area of Mandalay City (shown in Figure 2), taking into consideration the Mandalay City development plan (issued by MCDC, MOC), future facility expansion, and numbers of households (squatter), etc.

Source: JICA Study Team Plots on GoogleEarth® Image

Figure 2 Port Location

3.3 Port Development Concept

The prime concept of the Mandalay Port Development is to build a modern port facility aiming to change the current handling of cargo by manual labor to machines. For the concept, first the current system of handling cargo at the natural river bank must be replaced by a fixed jetty facility, and second bringing in lifting cranes and carrying trucks and trailers is required. Looking at the existing situation of Mandalay Port, it is assumed to be very difficult to quickly replace the manual labor to machinery for 600,000 tons of cargo a year, from the viewpoints of government financial sources, the existing numbers of small ships only for manual labor, and requirements from the employment of existing port labors, etc. Therefore the port development project should be named as an initial pilot project for achieving modernization of port operations, in which a part of the manual handling volume is replaced with mechanized operations.

In this study, the port handling capacity was assumed at 250,000 tons per year, of which 100,000 tons for IWT's cargo is covered and additional capacity gradually including private port operators.

3.4 Natural Condition Survey

The following survey was conducted for the purpose to select a suitable port location and to design a port facility at the selected location.

1) Soil Investigation : 7 boreholes and laboratory testing for soil samples taken from the boreholes
2) Topographical Survey : Survey 6km of riverbank along the left side of the Ayeyarwady River
3) Bathymetric Survey : Survey 6km of riverbed with the width 100~200m along left side of the Ayeyarwady River
4) Cross-section Survey : Survey 8km along the Ayeyarwady River by 1,000m and partially 250m intervals
5) Soil Sample Test : Soil samples from 3 points and laboratory testing
6) Flow Speed : Flow speed was measured at 7 points

From the results of the soil borings, it was found that sandy soil is distributed at the port location. Founding strata with hard layer (N>30) was found approximately 20m below ground level. At the location of the access road, clayey soil strata was found with the thickness of 25m below ground surface.

From the bathymetric survey, the water depth was found at CDL-2.0m ~ -3.0m at the jetty location. The soil sample test shows the riverbed consists of sandy soil. The river flow speed was found to be 3 ~ 4 knots near the port location.

3.5 Cargo Demand Forecast

The result of the cargo demand forecast of the Mandalay Port is shown in Table 2. Demand was estimated by assuming the 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. A calculation model was prepared capable to evaluate the effect of travel time and travel cost of each transport mode, and the gross transport demand was distributed to each mode, i.e., waterway, road and railway. “With case” on the Table 2 means the case that the express road and railway between Yangon and Mandalay will be improved, in which the travel time of road and rail will be shortened.

Table 2 Cargo Demand Forecast of Mandalay Port

unit: ton/day

Year	without case			with case		
	In	Out	Total	In	Out	Total
2015	1,485	750	2,235	1,485	750	2,235
2020	1,796	984	2,780	1,610	906	2,516
2030	2,430	1,614	4,044	2,237	1,519	3,756
2040	3,649	2,464	6,113	3,449	2,341	5,790

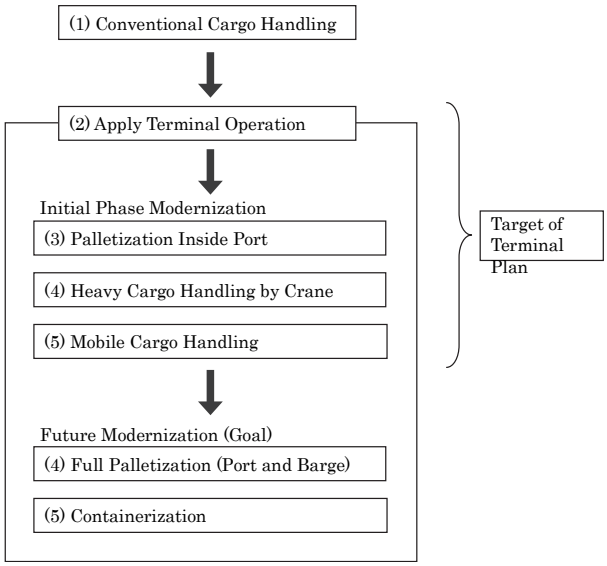
note1 : with case considers new express train & road will be developed

Source：Study Team

3.6 Terminal Plan

3.6.1 Planning Concept

The terminal plan of the Mandalay Port aims not only to improve the cargo handling efficiency of the existing operation pattern, but also to prepare for future handling patterns including the use of cargo pallets or containers. (Figure 3)



Source: JICA Study Team

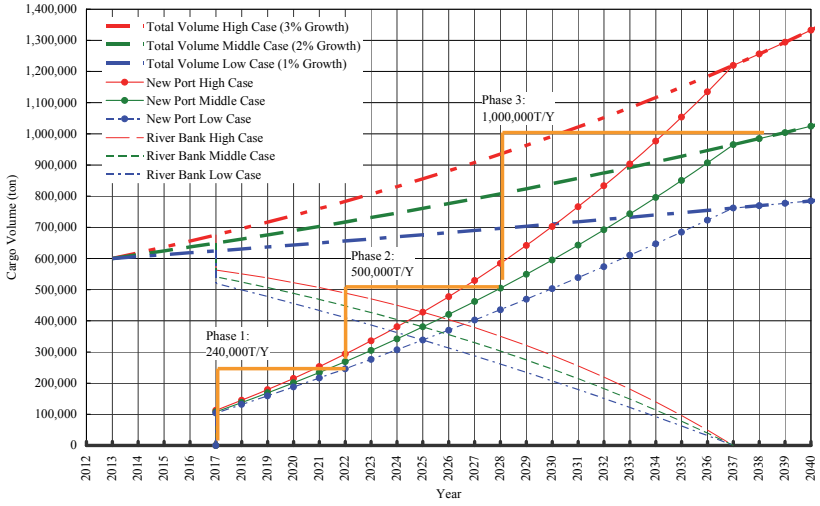
Figure 3 Concept of Terminal Plan

3.6.2 Assumed Port Capacity

The initial development of the Mandalay Port is aimed at the pilot project for the purpose to replace manual cargo handling to machine handling. The terminal plan is designed for middle-class scaled development and will be expanded in the future by monitoring the increase of cargo demand. Figure 4 shows the relationship between the port development capacity and an assumed curve of cargo demand. The following points are considered in designing port capacity.

- The present cargo volume of Mandalay Port (2013) is assumed at 600,000 tons/year (including IWT 100,000 tons/year)
- Future cargo demand is assumed to increase within the range of 1 ~ 3% per year
- New port will handle all IWT's cargo (100% of public transport)

- After port opening, yearly 5% of private operator's cargo is assumed to be shifted from riverside handling to the new port operation, then 100% cargo will be handled by new port within 20 years.
- Initial port capacity is designed at 250,000 tons per year, and the port will be expanded monitoring the future movement of cargo demand.



Source: JICA Study Team

Figure 4 Target Port Capacity and Assumed Deamnd

3.6.3 Scale of Terminal Development

Assuming 240,000 tons ~ 250,000 tons per year of cargo volume, design scales of terminal facilities are as follows. For the design, the share of machine handling in the initial period is assumed to be 50%, and cargo operation is assumed to be carried out by 8-workhours x 2-shift work cycles. For yard design, storage capacity was set to 300,000 tons/year, of which 200,000 tons are stored in warehouses and the remaining 100,000 tons are stored in an open storage yard.

Jetty :	Depth 2.0m, Length 164m
Cargo Yard :	3 ha
Warehouse :	47m x 24m warehouse x 2 (1 warehouse to be built for port opening period)
Open Storage Yard :	35m x 60m = 2,100m^2
Container Yard :	2,800m^2 (Approximately 10,000TEU/year)

3.6.4 Cargo Equipment

Cargo equipment required in the opening period is summarized as follows.

Crane (50 t)	2
Flatbed trailer and tractor head	1
Truck	3
Forklift (3 t)	3

3.7 Conceptual Design and Cost Estimate

The most important factor of the port design is to choose a structure type to cope with the 8m seasonal difference of water depth. This "executive summary" describes the details of the process through the study of structural type, design and cost estimate.

3.7.1 Example Review for Jetty Structural Type

Taking into account the existing cargo operation of Mandalay, it is assumed that both manual labor and the use of equipment will be intermixed during the port operation commencement period. Therefore the jetty structure should be designed for use by both operational types. The following four examples are discussed to apply to Mandalay Port.

1) Multi-deck Jetty — Multi-deck Jetty is a structural type that upper deck is used for high water season lower deck is used for low water season by installing 2 - 4 cargo decks with different elevations. Upper-lower decks are connected by slope-way where cargo trucks run up and down. This type of structure is applied for Kaladan River Project in Myanmar, and is under construction (2013).

2) Slope-deck Jetty — A gentle slope-way is constructed parallel to the river. Cargo operation is carried out by placing a lifting crane on the slope-way. Vientiane Port in Laos was constructed applying this type of structure, and is under operation.

3) Flat-deck Jetty — A flat-deck jetty is a common structure which is set with the deck level above the highest water level. For example Phnom Penh Port has this type of jetty and is under operation.

4) Floating Jetty — The jetty is built as floating deck, which moves up and down according to the water level change. This type of jetty for cargo operation is applied to the Jambi Port Indonesia and is under operation.

Multi-deck and Slope-deck is generally suitable for the ports which have a smaller volume of cargo handling, but these types are not appropriate for Mandalay Port which has a large quantity of cargo over 600,000 tons per year. During the transition period from manual handling to the equipment use, the most convenient type of jetty structure should be the floating type, which is easy to accommodate manual handling as well as crane handling. When the equipment handling becomes measure way, fixed flat-deck jetty is the most suitable.

If the floating type jetty is selected to apply Mandalay Port, there is a risk of the bottom of the jetty to touch the riverbed as the depth of water is rather shallow. In order to evaluate the rate of this risk, an analysis of river bed deformation was performed. In addition, the manufacturing method and cost estimate was executed for a large-scaled floating jetty structure.

3.7.2 Riverbed Deformation Analysis

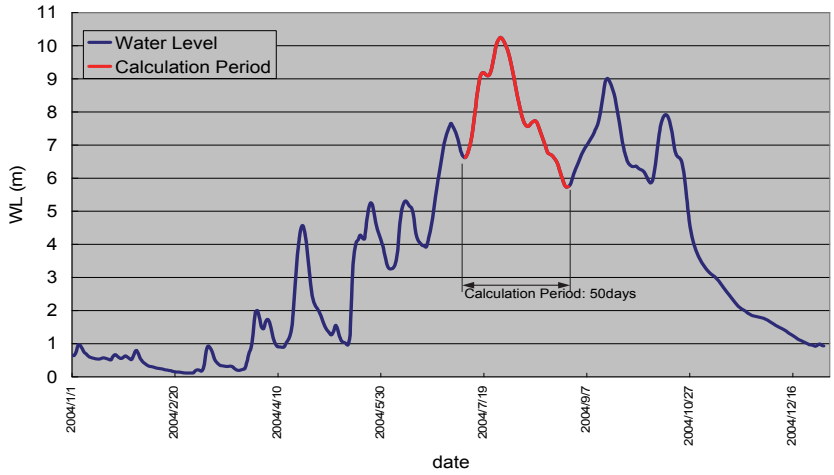
The two-dimensional plane analysis model was used to predict flow speed and riverbed deformation. The model was established by using topographic data, flow speed, and data from the riverbed material sample which were obtained from the natural conditions survey. The water level movement data (period: 50 days) of the past 10 years' maximum flood level was input to predict the deformation.

As the result of analysis, it was found that the riverbed material moves in the direction of river flow, and 1~2m of sedimentation is foreseen at the location of the planned floating jetty. The jetty location has a tendency to accumulate sedimentation as the flow speed becomes gentle.

The water depth of the jetty location is 1.9~2.7m. By assuming the draft of the jetty at 1.3~1.5m, the gap between jetty bottom and riverbed is 0.4m~1.4m at the time of initial installation. If 1m~2m sedimentation occurs at the jetty location, the floating jetty has the risk of sitting on the bed which causes damage to the jetty body during dry season.

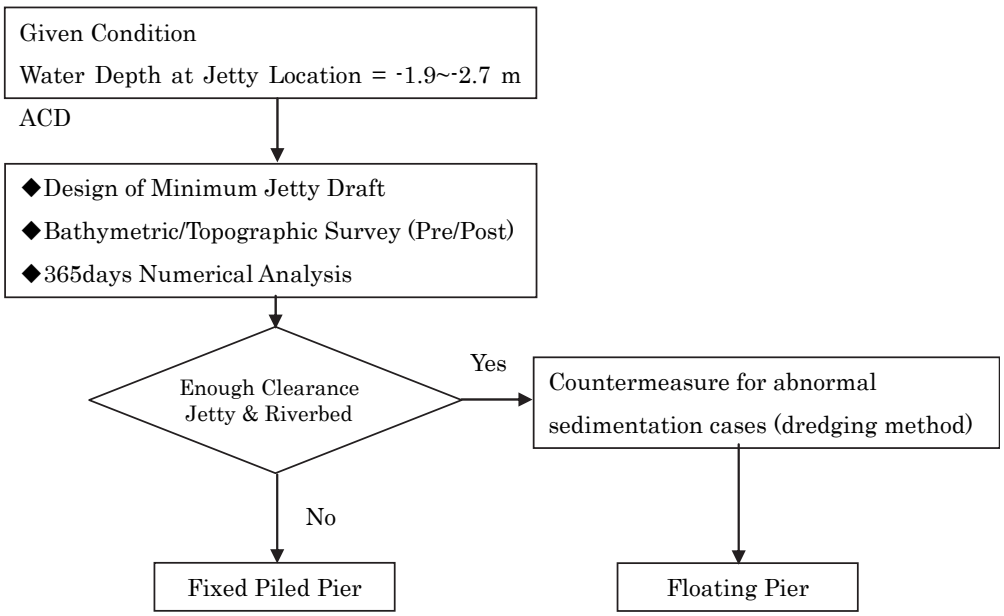
In order to control the quantity of sedimentation, additional analysis was applied assuming that one groyne is constructed to control sedimentation. The analysis shows that the effect of the groyne is limited for 20 days from the beginning of the flood. The sedimentation is foreseen to move over the groyne and accumulate at the jetty location within the 50 days analysis.

However, the analysis covers only one cycle of a flood, while actual water level movement shows many cycles are repeated during the rainy season (Figure 5). The analysis shows that riverbed material has the tendency to move during the flood period and settle during the dry season. The depth and topographic survey was carried out only one time before a flood season where the sedimentation movement for the post-flood season was not monitored enough. Therefore it is recommended to monitor the riverbed movement more precisely and analysis should be applied for 365days in order to make a final decision on the jetty structural type. The following procedure should be performed before making the decision on the type jetty structure to be used.



Source: JICA Study Team

Figure 5 Water Level Movement Data for 50 Days Analysis



Source: JICA Study Team

Figure 6 Flowchart for Final Decision of Jetty Structure Type

3.7.3 Construction Cost of Floating Pier and Fixed Piled Pier

The construction cost of a fixed piled pier was estimated at 10 million US$, while a floating pier costs 22 million US$. The reason for the higher cost of the floating pier is that it was assumed that the floating jetty would be built overseas and brought to Myanmar. However if the building was executed in a domestic factory, the cost of floating pier is assumed to be same as of the cost of fixed piled pier.

Although factories in Myanmar do not possess the technology or facilities to produce a floating jetty, they do have the potential to gain that technology in a short time. It is recommended to monitor the improvement of technology in the country for the next 1~2 years, and the construction cost should be re-estimated for final decision of the structure type.

3.7.4 Project Cost

The following project cost was estimated for both the floating pier and the fixed piled pier. The details of the cost are shown as follows.

Table 3 (1) Project Cost of Mandalay Port Development (Floating Pier)

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	513,060,1110	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	

Table 3 (2) Project Cost of Mandalay Port Development (Fixed Piled Pier)

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: JICA Study Team

3.8 Economic and Financial Analyses

The project of Mandalay Port development is estimated to be feasible from the viewpoint of national economy. The Economic Internal Rate of Return (EIRR) of the project is 14.7% which is over 12%, the level of feasible civil projects in the Asian region. On the other hand, the Financial Internal Rate of Return (FIRR) of the project is estimated at minus 3.4%, which means the revenue of the port operation will not be able to cover the initial investment. The cash flow of the analysis shows that the revenue only covers running expenses and periodical maintenance, therefore the project should be supported by the Grant Aid Assistance for financial sources.

In order to obtain enough FIRR to launch the project by using a soft-loan with the interest of 0.1% p.a., the revenue of the operation shall be 160% assuming the initial investment and the O&M cost remains at the same level, otherwise the rate of the soft loan in the initial investment shall be 65% while the balance shall be invested from the government budget. When these conditions are fulfilled, the project becomes feasible from a financial viewpoint.

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.

3.9 Port Management and Operation

In Myanmar, there are no substantial port facilities in the river port, therefore neither management nor operations have been required. With this study as a turning point, the MOT had basic internal discussions for a port management body, and the following points are confirmed as a conclusion.

1) Mandalay Port construction will be undertaken by DWIR as a project execution body.
2) The owner of the built port facilities will be undertaken by DWIR.
3) IWT will be involved in port operations utilizing private sector's business functions.

By the time the Mandalay Port will be opened for operation, the IWT has to review the own organization, to establish a new division/section to manage port operations, and to bring up the private sector to be capable of cargo handling operations.

3.10 The Contribution by Japan's Official Assistance

As a result of the study, it has been deemed appropriate that the Mandalay Port project development should be supported by Japan's grant assistance. It is a pilot project aimed at introducing mechanical equipment for cargo loading and unloading in all domestic river ports.. The project aims are summarized as follows.

1) To begin equipment cargo handling operation and forward the replacement of manual labor cargo handling with a modern port operation.
2) By utilizing port management functions, to increase operation efficiency and reduce the waterway transport cost.
3) To plot the use of "unitized cargo" by beginning palletization and containerization, and to promote their widespread use to the private sectors.
4) To establish the appropriate river port tariff system and to prompt its wide-use for other river ports.

As the pilot project is an initial attempt to introduce a new management system to encourage the private sector's participation or aiming to privatize a part of government functions, the government should gain experience by supervising the works and ensure that the system works properly.

3.11 Environmental Impact

It is important to execute the project of the Mandalay Port development paying careful attention to the possibility of water pollution and the disposal of waste. During the construction phase, ecological systems shall not be unfairly influenced by building activities.

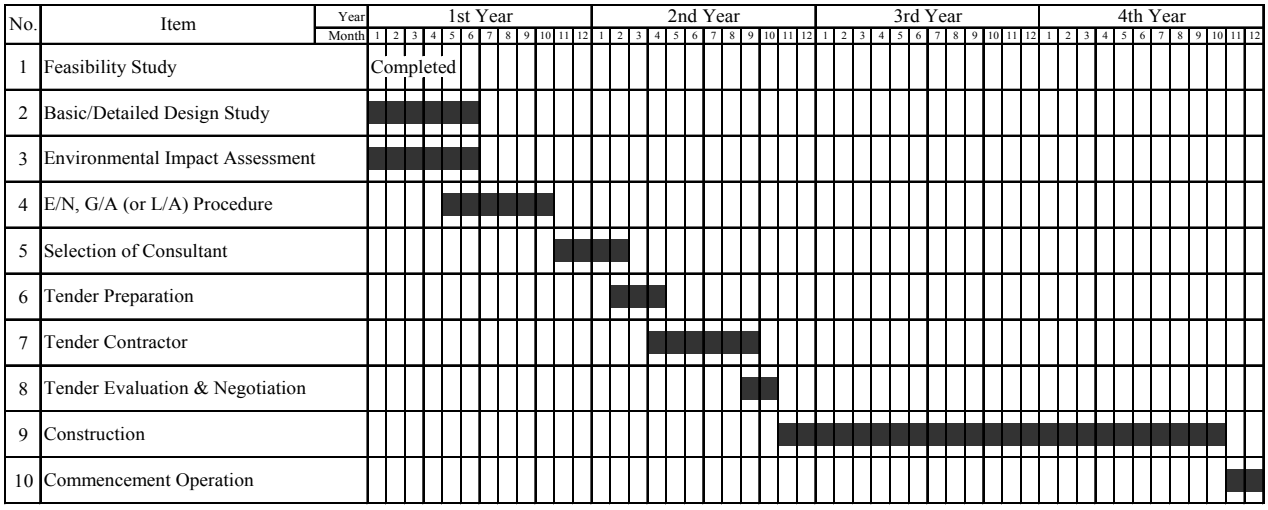
There are no house-holds at the project site, but there are a few farmers who cultivate the riverside land during the dry season. Because the project area is owned by the government, it is understood that these farmers should have no formal right to use the land. However, the Ministry of Transport (MOT) considered the existing status of such land use and farmers, called relevant stakeholders, and held a public hearing meeting in October 2013. In the meeting, the government officials announced that the government will assist the existing farmers life and to hold the suitable budget for them. In the future, the government should continue this practice in order for the project to succeed.

In addition, the river port development has the potential to reduce emission of CO_2 by encouraging the modal shift from road transport to waterway transport. It is estimated that 70% of CO_2 emissions per unit volume of cargo is saved when the cargo shifts from road to water.

3.12 Implementation Schedule

Table 4 shows the implementation schedule assuming the project is implemented by applying Japan's grant aid assistance. For the next step of the project, the study on the jetty structure based on additional survey and more precise riverbed deformation analysis should be carried out following this study, and detailed design works should be conducted. The construction period is assumed to be 24 months. It is preferable that building the revetment for reclamation in the initial construction is executed in the dry season, therefore it is recommended that the construction contract timing should be adjusted to the end of the rainy (flood) season in order to save costs and construction time.

Table 4 Implementation Schedule



Source: JICA Study Team

4. Procurement of Ships for Inland Water Transport

4.1 The Present Condition of Ships

IWT owns 413 ships in which 146 ships are passenger-cum-cargo type ships. More than 50% of them are recognized as over-aged. Generally speaking, IWT owned ships are too large for existing waterways dimensions. On the other hand, private carriers are providing service with smaller sized ships which are more flexible and have more maneuverability.

4.2 Project Concept

Most of the ships owned by the IWT are too old for use. The IWT has requested a loan from Japan's ODA in order to replace these out-dated ships. In this study, the purpose and contents of this request are reviewed, then the appropriate procurement plan is recommended.

Active public passenger ferry routes were selected, keeping in mind their impact on private carriers. The study also considered the intention of the IWT on public transport services.

For cargo barges and tugs, suitable transport routes with high potential demand were selected. The conceptual design of the ships was conducted taking into account the effectiveness of the operation and reducing transportation costs. Conceptual design was also applied paying attention to the existing use of the public service, natural conditions of the waterway and the intention of the IWT on public transport services.

The study was primarily based on the use of an ODA loan, but other options for grant-aid assistance were also considered.

4.3 Demand Forecast for Procurement of Ships

4.3.1 Demand of Passenger Ships

The demand of passenger ships was studied on three routes, Yangon-Pharpone, Yangon-Laputta, and Yangon-Kyonema Ngay. (see 4.4 for the route selection)

Table 5 Demand of Passenger Ships

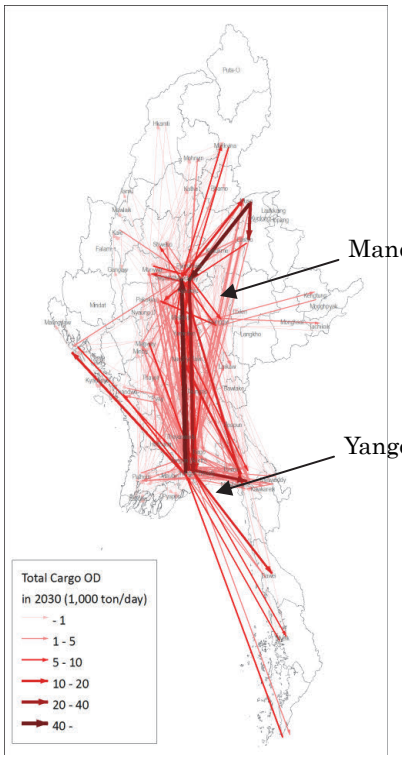
unit: passenger/day

Year	From	Yangon			Kyonema Ngay	Laputta	Pharpone
	To	Kyonema Ngay	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

Source: The Study Team

4.3.2 Demand of Cargo Ship

The route of the cargo ships was assumed to be Yangon-Mandalay. As shown on Figure 7, the same route shows the largest cargo transportation demand among all regional transport routes.



Source: JICA Study Team

Figure 7 Demand of Cargo Transport in 2030 (incl. all trans. modes)

Table 6 shows the demand forecast for water transport of cargo between Mandalay and Yangon. 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 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 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: JICA Study Team

4.4 Study on the Type of Ships

4.4.1 Waterway Routes for New Ships

(1) Passenger Ship

For the study on waterway routes of new ships, the rate of existing demand and the purpose of public transport service were considered. The selected route has no private services with fixed time tables. Only IWT operates by a scheduled time service. It is assumed that the passengers using IWT service on this route are mainly poor people who hesitate to use bus service because of cheaper ticket fees. Three routes were selected, Yangon-Pharpone, Yangon-Laputta, and Yangon-Kyonema Ngay.

(2) Cargo Ship

IWT statistics on passenger-cum-cargo ships shows that Yangon port handles the largest cargo volume, and Mandalay has the second largest volume. It is recommended that the improvement of waterway transport capacity between these two ports is the most important for economic development in Myanmar. The demand forecast also shows the same route has the highest demand.

It is assumed that the main reason that the existing transport mode relies on the road transport between Yangon and Mandalay is that no port facility is available in river ports to handle cargo using lifting equipment. Water transport is fundamentally suitable to carry a large volume or heavy cargo with low cost, but such advantages of water transport has not been utilized at present. When port development is achieved, there is a high possibility that a modal shift from road to water will be promoted and a new water transport demand might be created.

From the viewpoint of a suitable role for public transport, it is recommended that the public sector launches a fixed-time shuttle transport service between Yangon and Mandalay as a pilot project, and cause the private sectors to participate in similar services.

4.4.2 Concept of New Ships

In Myanmar, there are no suitable shipbuilding facilities, nor do they have sufficient technology, therefore the new ships are assumed to be built in Japan then delivered to Myanmar. The operation of the new ships is basically guided by written manual, but it is recommended to offer additional support by dispatching experts by an official technical assistance scheme.

(1) Passenger Ships

Throughout discussions with the Study Team, the IWT has the intention to procure smaller sized passenger ships. The reason of this intention comes from the requirement of reducing fuel consumption and adjusting supply service during low seasons. In designing the engine, a high priority is put on low fuel consumption. Design code of MLIT Maritime Bureau was applied on the acceptance by DMA Myanmar. Ship drafts were examined and a minimum size was proposed taking the size of the ships into account..

(2) Cargo Ships

The procurement of cargo fleets not intended for passenger use was proposed based on a request by the IWT. The combination of cargo barge and pusher tug is recommended for convenient use of the Mandalay Port development and assuming future container transport. The pusher tug is suitable for maneuvering in river channel. Barges with similar dimensions to the

largest barges used by the IWT were selected in order to maintain effective transport services. Ship drafts were examined and a minimum size was proposed taking the size of the ships into account..

4.5 Conceptual Design of Ships

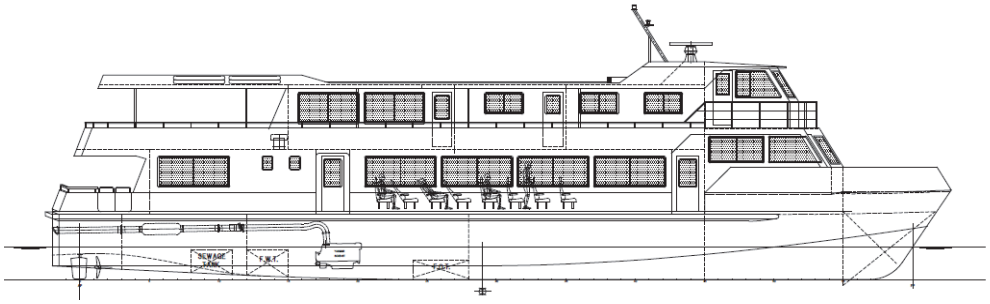
4.5.1 Passenger Ships

(1) Ships Size

L x B x D：32.4 x 7.0 x 2.4m, Draft：1.2m、Gross Tonnage：280GT, Main Engine：500HP (368kW) x 2units

Ships Speed under Full Loaded Condition：10.6knot (75%Load), Capacity：150P

(2) Conceptual Drawing



Source: JICA Study Team

Figure 8 Conceptual Drawing of a Passenger Ship

4.5.2 Cargo Ship

(1) Ship's Size

<u>Pusher Tug</u>

L x B x D：24.8 x 7 x 2.4m, Draft：1.4m, Gross Tonnage：140ton、Main Engine：850HP (625kW) x 2units、

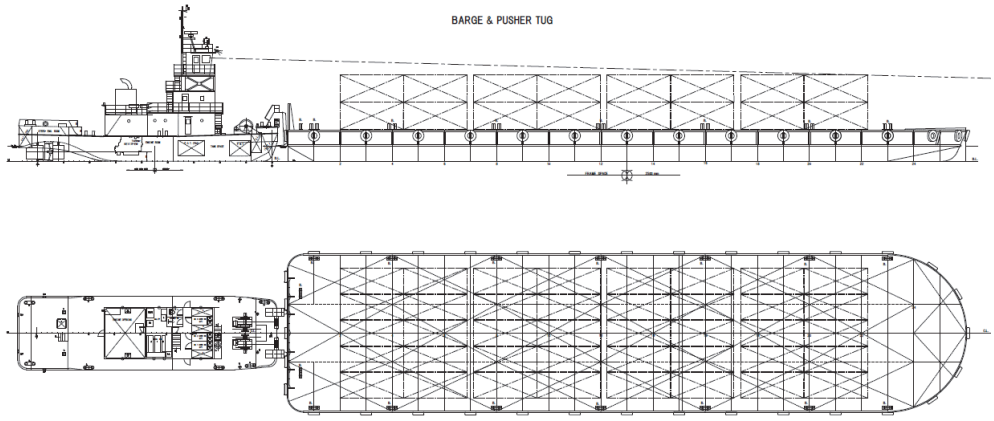
Design Speed：10.6knot (75％Load)

<u>Barge</u>

L x B x D：65 x 15 x 3m, Draft：1.4m、Dead Weigh Tonnage：1000ton

Tug + Barge Speed：Approx. 7knot (75%Load)

(2) Conceptual Drawing



Source: JICA Study Team

Figure 9 Conceptual Drawing of a Barge & Tug

4.6 Shipbuilding Plan

4.6.1 Number of New Ships

Proposed numbers of the ships are, Yangon-Pharpone (3), Yangon-Laputta (3), and Yangon-Kyonema Ngay.(2), 8 ships in total. The number of the cargo fleet is proposed at 2, considering the purpose of the pilot project.

4.6.2 Procurement Schedule

The shipbuilding will take 20 months counted from the order of 12 ships and to the delivery to Myanmar, assuming building in Japan and delivery.

4.7 Cost Estimate

The Table 7 shows the result of the cost estimate.

Table 7 Cost Estimate for Ships Procurement

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: JICA Study Team

4.8 Economic and Financial Analyses

The procurement of ships for Inland Water Transport is not feasible from financial aspect and contribution of national economy. EIRR of the project is 7.6%, which is under 12% of 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 5 years when regular maintenance and inspection is conducted.

The main reason why EIRR for passenger ships appears as a (minus) is that the benefit due to saving travel cost is not enough to cover the cost of fuel which shares large burden of the operational cost. However, looking at the existing passengers using the public services, there is a concrete demand from low income passengers who are obliged to use cheaper transport services, although the recent trend of modal shifting is from waterway to roadway according to the current economic growth and the achievement of road improvement of the country. It is assumed that the role of the public waterway service will continue for 10 ~ 15 years along the transition period of the economic growth of Myanmar.

The transportation fee of the cargo transport is estimated in such a way that the fee is cheaper than road transport (29,000 Kyat/ton) but the profit of approximately 20% is obtained from cash-flow analysis. Although FIRR of the procurement of cargo ships appears minus., the cash flow of each year is (plus) if the initial investment burden is excluded, thus it is concluded that the project is feasible when the initial cost is exempted.

4.9 Operation and Management

The IWT is providing public passenger and cargo transportation service by using inland waterways. The IWT has shipyards, where it operates shipbuilding and repairs. At present, the IWT is undertaking the passenger ferries procurement project for Yangon-Dalla river-crossing transport, supported by Japan's grant-aid assistance.

The proposed ships in this study are also assumed to be owned and operated by IWT. It is important to assure that its organization is capable of annual maintenance of the ships, as the proposed routes are in a delta area in which the ships bodies will suffer corrosion by sea water.

4.10 Environmental Impact

The assumed environmental impact and remedial measures for the operation of the new ships are summarized as follows.

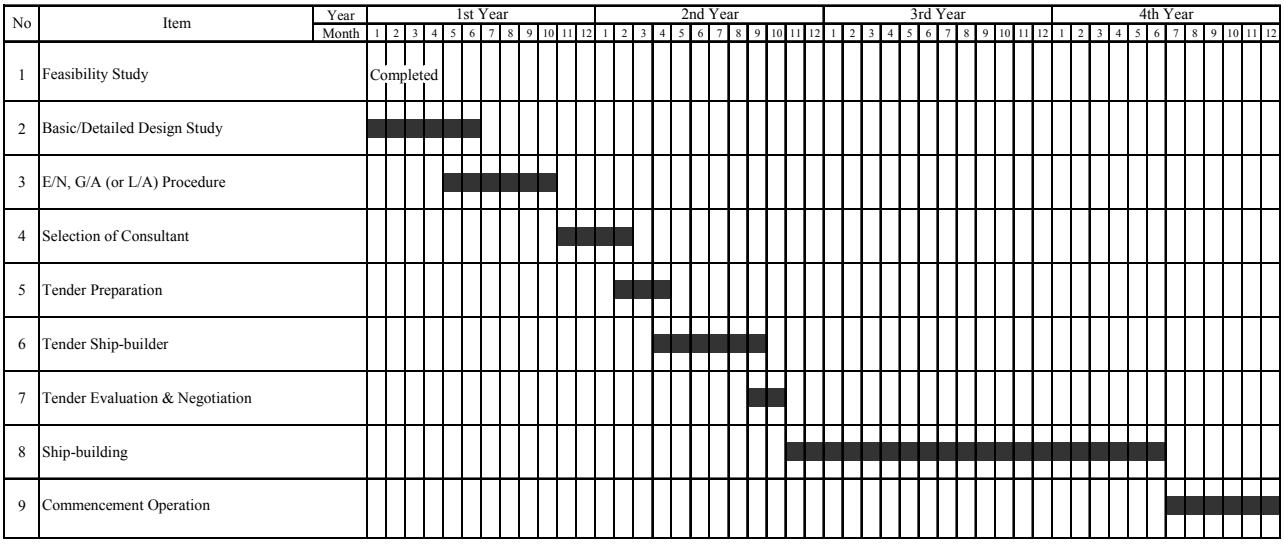
Table 8 Environmental Impact for Ships Operation

Environmental Impact	Description	Remedial Measures
Air Pollution	• Air Pollution due to exhaust gas	• Periodical ships maintenance
Noise	• Noise due to ships engine operation	• Periodical ships maintenance • Prevention of frequent ship whistles
Water Quality	• Water pollution by leakage of ships oil, wastewater from toilets, or turbid water from naked bulk cargo (ex. stone/sand for construction works).	• Installation of toilets, and prevention of direct outflow of waste water. • Sheet covering of bulk cargo at open storage yard. • Installation of partition walls enclosing engine rooms to prevent leakage of waste oil.
Waste Disposal	• Waste water from toilets, garbage disposal, or waste bulk cargo disposal	• Installation of dust-pins. • Education to ship-crew and passengers of rules for waste/garbage disposal.

4.11 Implementation Schedule

Table 9 shows the implementation schedule assuming the project is implemented by applying Japan's grant aid assistance. The required period for ship building of 8 passenger ships and 2 cargo ships fleets is estimated at 20 months.

Table 9 Implementation Schedule



Source: JICA Study Team

5. Conclusion and Recommendation

5.1 Port Development

With respect to the river port development, the project of the Mandalay Port development was proposed and its feasibility study was carried out in this study. The project has the aim of a "national pilot project" which introduces the port management function and modernized machine cargo handling method to the domestic river ports all of which employ manual labor

of cargo at present. The result of the economic analysis shows that the project is highly feasible from the viewpoint of the national economy. The result of the financial analysis shows that the project is preferable to be financed based on the Japan's grant-aid assistance.

The following are the recommendations for the implementation of the project.

5.1.1 Establish & Operate Port Statistics System

Port statistics are extremely important for making the future port development plan by analyzing the past volume of cargo and passenger movements. The government of Myanmar has begun to establish a statistics system. System development can be achieved by taking the following points into consideration:

1) An authority must be established to collect and tabulate both private and public statistics. Taking into account that the volume of private cargo volume is larger than public cargo, it is recommended to assign the port statistics development to DMA for the time being.

2) A common format for recording statistics and to introduce the electric data recording system instead of hand-writen records must be established.

3) The data recording items should be expanded to cover cargo handling time, ship arriving and departing time, ship waiting time, etc. in addition to the existing record items.

5.1.2 Promoting Port Planning Capacity

With the Mandalay Port development as a turning point, it is required to establish an organization or strengthening existing organizations in order to make the future port development plan and maintain the recording of port statistics. At present, the construction of the port will be managed by DWIR and the port operation will be undertaken by IWT. It is necessary for both authorities to cooperate in order to strengthen the port planning capacity of the organizations.

5.1.3 Implementation Agency of Port Development

The construction of the Mandalay Port is scheduled to be managed by the DWIR. It is recommended for the DWIR to establish a new division which undertakes the tasks to manage the detail design of the port and supervision of the construction work,, and to make an effort to learn how to maintain the Mandalay Port development.

5.1.4 Port Management and Privatization

On the port management of the Mandalay Port, the DWIR will hold the responsibility of port owner and the IWT will operate the facilities. Both organizations need to coordinate closely to achieve good port management.

IWT has had little experience in managing and operating modern port facilities, therefore it has no division/section or staff capable of managing and operating one.. Experience needed to strengthen the ability of IWT for future. The following points are important.

1) to amend law or regulation to decide the roles and responsibilities of the IWT
2) budget and auditing systems for port management
3) realization of proper maintenance and management of the port facilities
4) realization of safe and efficient cargo handling operation

5) acquiring knowledge on safety and environmental aspects

6) establishment of cargo and passenger statistics

7) training of a staff to be in charge of port management

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

5.1.5 Establishment of Port Tariff and Management

The rate of a port tariff is a very sensitive matter as it is required to cover enough revenue for the port to operate and maintain facility, but if the rate is set higher than appropriate level, there is the risk to cause business to decline for private port users. Inland water transport has the advantage to reduce transportation cost by carrying a large volume in a trip, though travel time is longer than other transportation modes. In order to achieve and maintain the proper system, it is recommended to assign the task to public sector for the determination of port tariff and its maintenance.

5.1.6 Repairing and Maintenance of the Facility

The task of repairing and maintenance of the facility is important in view of keeping the public and social properties in sound condition. It is recommended to execute a periodical facility inspection, and to make the suitable maintenance plan based on the results of inspections, and carrying out the repairins in a timely manner. It is recommended to make the “inspections and maintenance plan” and “manual for inspections and repairing” together with the facility construction.

5.1.7 Required Detailed Study on Application of Floating Pier Structure

This study concludes the floating type pier is preferable for the initial phase of the modernization of the port cargo handling method because it is suitable on the point that both the manual handling as well as newly introduced equipment handling will be easy. However from the result of riverbed deformation analysis and from the cost estimate, a sufficient reason for its application has not been obtained. For the application, the following additional study is required.

1) To clarify the actual seasonal movement of riverbed, pre andpost surveys of the flood season are required.

2) The calculation model of the riverbed deformation analysis shall be applied using the pre andpost survey data to obtain more accurate forecast.

3) In this study, the duration of the riverbed deformation analysis was set at 50 days to know the general tendency of sedimentation of the riverbed. The further analysis taking 365 days duration is required to forecast a more accurate riverbed deformation.

4) Further study on a manufacturing method and a cost estimate are required assuming that the floating jetty is built in Myanmar, based on its technology development within the next few years.

5) The method to remove sedimentation under the floating pier should be studied for an emergency.

5.2 Ships Procurement

The IWT owns passenger/cargo ships and is carrying out their operation, which has a similar business function as those of private operators. In order to apply official assistance (ODA), it is

required to make the role of the public sector clear to satisfy the public purpose and which does not prevent private sectors from growing soundly.

5.2.1 Passenger Transport

As shipping routes which have to be improved, three routes were selected in this study from the point of view that water way service is still important for the local people who have no other way to move than to use public waterway transport services. The numbers of passenger ships urgently required was estimated at 8 ships.

The result that the financial analysis gives is that it is very difficult to repay a loan with low-level revenue from passenger fees if the Yen-Loan is applied. However taking into account that Myanmar is still LDC which requires the support on the BHN of the people, the procurement of passenger ships should be supported by grant-aid assistance.

5.2.2 Cargo Transport

Because port facility development is insufficient in the inland water transport sector in Myanmar, it is required to change the cargo handling method from existing primitive labor handling to installation of mechanical cargo equipment. The waterway transport is considered to have a potential to grow by modal shifting providing cost-competitive transport services to suitable transport routes, when sufficient facilities are built and cargo handling efficiency is improved.

This study proposes to focus on the waterway route between Yangon and Mandalay which has a large potential demand. The numbers of the barge transport fleet is proposed at 2 barges to begin a pilot project for shuttle transport service on this route.

5.2.3 Japan's Technical Assistance on Ships Procurement

Japan's technical assistance is required on the operation and maintenance of newly procured high-standard ships. In order to implement the pilot project harmlessly, dispatching a port management expert and the training of the operation staff will be important. In addition, a facility for navigation safety will be required when the waterway traffic volume increases. Technical assistance in this field will also be necessary in future.

5.3 Recommendations on General Inland Water Transport Sector

5.3.1 Proposition to Start a Pilot Project of a Shuttle Transport Service

In this study, two topics were selected for the feasibility study to contribute to achieve the modern waterway transport service. Those are 1) the Mandalay Port development project, and 2) procurement of new passenger and cargo ships. In order to achieve more active transport businesses on the inland water transport sector, it is recommended to start a pilot project of a shuttle transport service for cargo by using both the developed port and barge fleets. The route between Yangon and Mandalay is the most suitable for a starter project.

5.3.2 Required Government Authority to Control Whole Inland Waterway Sector

This study recommends to develop the Mandalay Port with mutual coordination between DWIR and IWT as the existing authorities. However, when several river ports are developed similarly and the transport system grows by exchanging cargo and passengers, it is preferable to establish a single authority which governs the whole inland water sector. The following tasks are assumed to be handled by such an authority:

1) Management of statistics covering all waterway transport in Myanmar
2) Planning and execution of nation-wide port development
3) Maintenance and repairing of existing port facilities
4) Research and development for suitable growth of waterway service comparing to other transport modes (road and rail)
5) Development on a port tariff system and its operation
6) Financial management for self-supporting by suitable revenue
7) Promotion and enhancement of privatization of operation of river port and waterway transport service

5.3.3 Modal Shift and its Effect to Reduce Environmental Burden

Waterway transport has the advantage of a low environmental burden compared to other transport modes. In Myanmar, the appropriate modal distribution has not yet been achieved because of the delay in sufficient port facility development. For instance, heavy cargo and mobile cargo are not able to transport by waterway due to a lack of loading and unloading facilities. It is important to lead the suitable modal distribution by the modernization of port facilities and transport ships.

5.3.4 Utilization of Japan's Advanced Technology

In order to utilize Japan's advanced technology, the following suggestions are useful for the inland water transport development projects in Myanmar.

(1) Port Development

- High quality steel material for port construction
- Large-scaled floating jetty
- Strut support systems on long steel piles for piled jetty structures
- Reliable construction management technology

(2) Procurement of Ships

- Technology on low draft ship body (passenger ships and cargo barges)
- High quality engines, devices and their spare parts.

5.4 Future Recommended Projects

5.4.1 Mandalay Port Development

For the implementation of the Mandalay Port development, additional study of the feasibility study is required. The items of the 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 selection of jetty type
- Study on cost the estimate of a jetty (mainly a study on the local manufacturing of a floating jetty)

- Basic design and revised cost estimate of the selected jetty structural type.

5.4.2 Other River Port Projects with High Priority

It is required to develop other river ports to develop the total transport system. The following port development projects are recommended to be implemented following to 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)

5.4.3 River Channel Improvement Project

Along the Ayeyarwady and Chindwin Rivers, no channel survey has been conducted since 1988, when the UNDP last surveyed them. It is urgently required to survey the river channels, and formulate a master plan for river channel improvement.

5.4.4 Navigation Safety Facilities

At present, passenger services are operated during the day and night, but there are no safety navigation facilities provided. 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.

5.4.5 Replacement of Aged Public Service Ships

It is important to replace the aged public service ships owned by IWT with new ones.

5.4.6 Technical Assistance for Inland Water Transport Sector

The following Technical Assistances by Japan's ODA scheme should be required to improve public waterway transport services_:

- Technical assistance for establishing port statistics and port planning
- Technical assistance for port construction management and for the practice of port operations
- Technical transfer for ship building technology and its repairs