Republic of the Union of Myanmar
Myanma Port Authority

The Data Collection Survey for the Development of Yangon Port in Republic of the Union of Myanmar

Final Report

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Japan International Cooperation Agency

The Overseas Coastal Area Development Institute of Japan

NIPPON KOEI CO., LTD

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ABBREVIATIONS

A	ADB	Asian Development Bank
	AIPT	Ahlone International Port Terminal
	ASEAN	Association of South-East Asian Nations
	AWPT	Asia World Port Terminal
B	BOT	Built, Operate and Transfer
	BL	Bill of Lading
C	CDC	City Development Committees
	CDL	Chart Datum Level
	CFS	Container Freight Station
	CG	Computer Graphics
	CIF	Cost, Insurance and Freight
D	DCCA	Department of Commercial and Consumer Affairs
	DD	Detailed Design
	DOH	Department of Highway
	DWT	Deadweight Tonnage
E	EBIT	Earnings before Interest and Taxes
	ECC	Environmental Compliance Certificate
	EDI	Electronic Data Interchange
	EIA	Environmental Impact Assessment
	EIRR	Economic Internal Rate of Return
	EMP	Environmental Management Plan
	EMoP	Environmental Monitoring Plan
F	FAL	Facilitation of International Maritime Traffic
	FAO	Food and Agricultural Organization
	FCL	Full Container Load
	FDA	Food and Drug Administration
	FDI	Foreign Direct Investment
	FIRR	Financial Internal Rate of Return
	FOB	Free on Board
G	GDP	Gross Domestic Product
	GS	Ground Slot
	GMS	Greater Mekong Sub-region
H	HHWL	Highest High Water Level
	HWL	High Water Level
I	ICD	Inland Container Depot
	IEE	Initial Environmental Examination
	ISPS	International Ship and Port Facility Security

J	JV	Joint Venture
K	KPI	Key Performance Indicator
	KVA	Kilo Volt Ampere
L	LCL	Less than Container Cargo
	Lo/Lo	Lift-on/Lift-off
	LOA	Length Overall
	LWL	Low Water Level
M	MACCS	Myanmar Automated Cargo Clearance System
	MCIS	Myanmar Customs Intelligent Database System
	MEP	Ministry of Electrical Power
	METI	Ministry of Economy, Trade and Industry (Japan)
	MIC	Myanmar Investment Commission
	MICS	Myanmar Intelligent Customs System
	MIP	Myanmar Industrial Port Terminal
	MIPL	Myanmar Integral Port Ltd.
	MITT	Myanmar International Terminals Thilawa
	MJTD	Myanmar Japan Thilawa Development Ltd,
	MMU	Myanmar Maritime University
	MOAI	Ministry of Agriculture and Irrigation
	MOBA	Ministry of Border Affairs
	MOC	Ministry of Commerce
	MOLI&P	Ministry of Labor, Immigration and Population
	MONREC	Ministry of Natural Resources and Environmental Conservation
	MOTC	Ministry of Transport and Communications
	MPE	Myanma Petrochemical Enterprise
	MT	Empty
	MWL	Mean Water Level
N	NACCS	Nippon Automated Cargo Clearance System
	NCDP	National Comprehensive Development Plan
	NSDP	National Spatial Development Plan
O	ODA	Official Development Assistance
P	PCM	Public Consultation Meeting
	PD	Public Disclosure
	PPP	Public Private Partnership
	PVD	Plastic Vertical Drain
Q	QGC	Quay Gantry Crane
R	RTG	Rubber Tired Gantry Crane
S	SAD	Shipping Agency Department
	SCF	Standard Conversion Factor
	SEZ	Special Economic Zone

	SDR	Social Discount Rate
T	TCD	Terminal Container Depot
	TDCs	Township Development Committees
	TEU	Twenty-foot Equivalent Unit
	TGL	Thilawa Global Logistics
	TLC	Thilawa Logistic Center
	TMIT	Thilawa Multi-Purpose International Terminal
	TOS	Terminal Operation System
U	UMEH	Union of Myanmar Economic Holding Ltd.
V	VICT	Viet-Nam International Container Terminal

Exchange Rate

August, 2018

	USA (US$)	Japan (JPY)	Myanmar (Kyat)
US$	1	110	1,410
JPY	0.0091	1	0.078

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SUMMARY

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1.1 Demand Forecast

(1) Cargo handling volume of Myanmar ports

Table S-1.1.1 shows the total cargo handling volume of containerized cargo and non-containerized cargo for international trade at ports in Myanmar.

Table S-1.1.1 Myanmar ports' total cargo handling volume of containerized cargo and non-containerized cargo for international trade

unit: 000 ton

	2011	2012	2013	2014	2015	2016	2017
Import							
Containerized Cargo	2,830	3,356	4,229	5,657	6,456	8,609	7,843
Non Containerized Cargo	11,301	14,846	14,278	13,578	19,728	15,719	21,171
Total	14,131	18,202	18,507	19,236	26,184	24,328	29,014
Export							
Containerized Cargo	2,498	2,734	2,762	3,246	3,129	3,477	3,220
Non Containerized Cargo	7,333	6,369	7,373	7,723	5,558	6,537	5,142
Total	9,831	9,103	10,135	10,970	8,688	10,014	8,362
Grand Total	23,962	27,305	28,642	30,205	34,871	34,343	37,376

Source : MPA

(2) Cargo handling volume of Yangon Port

1) Import Cargo Volume of Yangon Port

Table S-1.1.2 shows the import cargo volume of Yangon port.

Table S-1.1.2 Import Cargo Volume of Yangon Port

unit: 000 ton

	2013	2014	2015	2016	2017
Container Cargo	4,229	5,657	6,456	8,609	7,843
Non Container Cargo					
Fuel	2,402	2,716	3,885	4,786	5,774
Aircraft fuel	86	106	123	125	152
Gasoline and other fuel	2,315	2,604	3,762	4,658	5,620
LPG	1	6	0	4	2
Others	9,872	10,939	14,113	10,130	6,702
Cement	234	580	1,588	1,041	279
Edible Oil	458	478	577	556	649
Iron & Steel Products	686	1,098	1,279	793	1,258
Vehicles	289	311	288	229	230
Concrete Products	9	24	28	21	31
Fertilizer	22	12	43	47	49
Sugar	0	15	9	328	166
General Cargo and Others	8,174	8,420	10,301	7,115	4,042
Total	16,503	19,312	24,454	23,525	20,319

Source: Study Team based on MPA data

2) Export Cargo Volume of Yangon Port

Table S-1.1.3 shows the export cargo volume of Yangon port.

Table S-1.1.3 Export Cargo Volume of Yangon Port

unit: 000ton

	2013	2014	2015	2016	2017
Container Cargo	2,762	3,246	3,129	3,447	3,220
Non Container Cargo	3,734	2,587	2,509	3,899	4,798
Timber	501	325			
Rice	391	471	242	687	1,956
General Cargo and Others	2,842	1,791	2,267	3,212	2,842
Total	6,496	5,833	5,638	7,346	8,018

Source: Study Team based on MPA data

3) Container Cargo Handling Volume of Yangon Port

Table S-1.1.4 shows the container cargo handling volume of Yangon Port.

Table S-1.1.4 Container Cargo Handling Volume of Yangon Port

Unit: TEU

		2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Import	Laden	224,751	296,156	365,548	443,916	507,335	491,062
	Empty	14,596	13,608	12,029	15,121	12,395	23,872
	Total	239,347	309,764	377,577	459,037	519,730	514,934
Export	Laden	120,516	132,493	136,383	137,998	175,069	206,922
	Empty	118,477	171,311	230,749	296,166	363,091	312,363
	Total	238,993	303,804	367,132	434,164	538,160	519,285
Total	Laden	345,267	428,649	501,931	581,914	682,404	697,984
	Empty	133,073	184,919	242,778	311,287	375,486	336,235
	Total	478,340	613,568	744,709	893,201	1,057,890	1,034,219

Note: There are two statistical periods: from Jan. to Dec. and from Apr. to next Mar.

Source: MPA

(3) Cargo Volume Demand Forecast

1) Container Cargo Volume Forecast

i) Target Years of Forecast

Target years for the forecast are 2025 as short term, 2030 as middle term and 2035 as long term.

ii) Economic Scale and Population in each target year

Table S-1.1.5 shows estimated economic scale and population in target years.

Table S-1.1.5 Socio-economic Frame Work in Target Years

Target Year			2010	2025	2030	2035
Scale of Economy	High Case	7.4%	1.00	2.86	4.09	5.85
	Low Case	5.7%	1.00	2.48	3.27	4.32
Population		0.89%		57,313,000	59,909,000	62,623,000

Source: Study Team

iii) Container Cargo Volume Forecast of Yangon Port

The forecast method adopted by the Study team utilizes the correlation between GDP per capita and TEU per capita in ASEAN countries.

Correlation between GDP per capita and TEU per capita in ASEAN countries is shown by the following formula.

TEU/capita = 0.000027 X + 0.000331 (R2 = 0.952)

X : GDP per capita

Table S-1.1.6 shows container cargo volume forecast result of Myanmar.

Table S-1.1.6 Container Cargo Volume Forecast Result in each Target Year

Unit: 000 TEU

	2025	2030	2035
High Case	3,126	4,664	6,964
Low Case	2,713	3,734	5,149

Source: Study Team

As the trade value ratio except for bulk cargo of sea trade and border trade of Myanmar is almost 8:2, the study team assumes that 80% of container cargo is transported by sea. The results of estimate are shown in Table S-1.1.7.

Table S-1.1.7 Container Cargo Forecast Volume of Sea Port of Myanmar

unit: 000 TEU

	2025	2030	2035
High Case	2,504	3,733	5,568
Low Case	2,171	2,989	4,116

Source: Study Team

(4) Forecast of total cargo handling volume of Myanmar ports

Cargo handling volumes of Yangon port are forecast for the years 2025, 2030 and 2035.

1) Forecast of Total Cargo Handling Volume of Myanmar ports

The study team forecasts cargo volume in target years based on the expected economic scale. Forecast of total cargo handling volume of Myanmar ports is shown in Table S-1.1.8. Total cargo volume of ports in

Myanmar in 2010 is 21,455 thousand tons.

Table S-1.1.8 Forecast of Total Cargo Handling Volume of Myanmar ports

unit: 000 tons

	2025	2030	2035
High Case	61,362	87,539	125,515
Low Case	53,210	70,160	92,688

Source: Study Team

Yangon port handled 85.5% of Myanmar's total cargo handling volume from 2012 to 2016. Study team assumes that this proportion will not change in target years. Assuming that the Yangon port cargo share will maintain in 2025, 2030 and 2035, Forecast of total cargo handling volume of Myanmar ports is given in Table S-1.1.9

Table S-1.1.9 Forecast of Total Cargo Handling Volume of Yangon port

unit: 000 tons

	2025	2030	2035
High Case	52,465	74,845	107,315
Low Case	45,494	59,987	79,248

Source: Study Team

Yangon port international trade cargo handling volume occupies 96.1 % of total cargo handling volume from 2012 to 2016. Study team assumes that this proportion will not change in target years. Table S-1.1.10 shows the forecast of international cargo handling volume of Yangon Port.

Table S-1.1.10 Forecast of International Cargo Handling Volume of Yangon Port

unit: 000 tons

	2025	2030	2035
High Case	50,419	71,927	104,130
Low Case	43,720	57,647	76,158

Source: Study Team

Import cargo volume at Yangon port accounts for approximately 75% of the total international trade volume from 2012 to 2016. Study team assumes that this proportion will not change in target years. Table S-1.1.11 shows the forecast of export and import cargo handling volume of Yangon Port.

Table S-1.1.11 Forecast of Export and Import Cargo Handling Volume of Yangon Port

unit: 000 tons

		2025	2030	2035
Import Cargo	High Case	37,814	53,945	78,098
	Low Case	32,790	43,235	57,118
Export Cargo	High Case	12,605	17,982	26,033
	Low Case	10,930	14,412	19,039

Source: Study Team

2) Forecast by Main Commodities (Micro Estimation)

Main import commodities in Yangon port are containerized cargo, liquid fuel (gasoline, diesel and jet fuel), cement, cooking oil, iron material (billet) and steel products, car and general cargo. On the other hand, main export commodities are containerized cargo and rice.

Border trade with neighboring countries is active, especially with Yunnan province in China and Thailand. It is said border trade accounts for 20% of Myanmar's total international trade on a money basis.

i) Main Import Commodities

Forecast Results of Main Import Commodities of Yangon Port

Tables S-1.1.12, 13 and.14 show the forecast results of main import commodities of Yangon port in target years.

Table S-1.1.12 Forecast Results of Main Import Commodities of Yangon Port（Year 2025）

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	21,371	19,957	18,543
Non Container Cargo			
Fuel	10,220	9,614	9,008
Others	6,223	5,731	5,239
Cement & Clinker	500	500	500
Edible Oil	639	639	639
Iron & Steel Products	940	894	848
Vehicles	270	242	213
Wheat	573	573	573
General Cargo and Others	3,301	2,884	2,466
Total	37,814	35,302	32,790

Source: Study Team

Table S-1.1.13 Forecast Results of Main Import Commodities of Yangon Port (Year 2030)

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	31,881	28,703	25,524
Non Container Cargo			
Fuel	14,609	13,252	11,895
Others	7,455	6,636	5,816
Cement & Clinker	715	658	600
Edible Oil	669	669	669
Iron & Steel Products	1,294	1,192	1,090
Vehicles	382	321	259
Wheat	749	749	749
General Cargo and Others	3,646	3,048	2,449
Total	53,945	48,590	43,235

Source: Study Team

Table S-1.1.14 Forecast Results of Main Import Commodities of Yangon Port (Year 2035)

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	47,613	41,405	35,197
Non Container Cargo			
Fuel	20,903	18,276	15,648
Others	9,582	7,928	6,273
Cement & Clinker	1,025	945	865
Edible Oil	699	699	699
Iron & Steel Products	1,816	1,621	1,425
Vehicles	584	474	363
Wheat	939	939	939
General Cargo and Others	4,519	3,251	1,982
Total	78,098	67,608	57,118

Source: Study Team

ii) Main Export Commodities

Tables S-1.1.15, 16 and 17 show the forecast results of main export commodities of Yangon port in each target years.

Table S-1.1.15 Forecast Results of Main Export Commodities of Yangon Port (Year 2025)

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	8,253	7,707	7,161
Non Container Cargo	4,352	4,061	3,769
Rice	1,200	1,200	1,200
General Cargo and Others	3,152	2,861	2,569
Total	12,605	11,768	10,930

Source: Study Team

Table S-1.1.16 Forecast Results of Main Export Commodities of Yangon Port（Year 2030）

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	12,312	11,085	9,857
Non Container Cargo	5,670	5,113	4,555
Rice	1,200	1,200	1,200
General Cargo and Others	4,470	3,913	3,355
Total	17,982	16,197	14,412

Source: Study Team

Table S-1.1.17 Forecast Results of Main Export Commodities of Yangon Port（Year 2035）

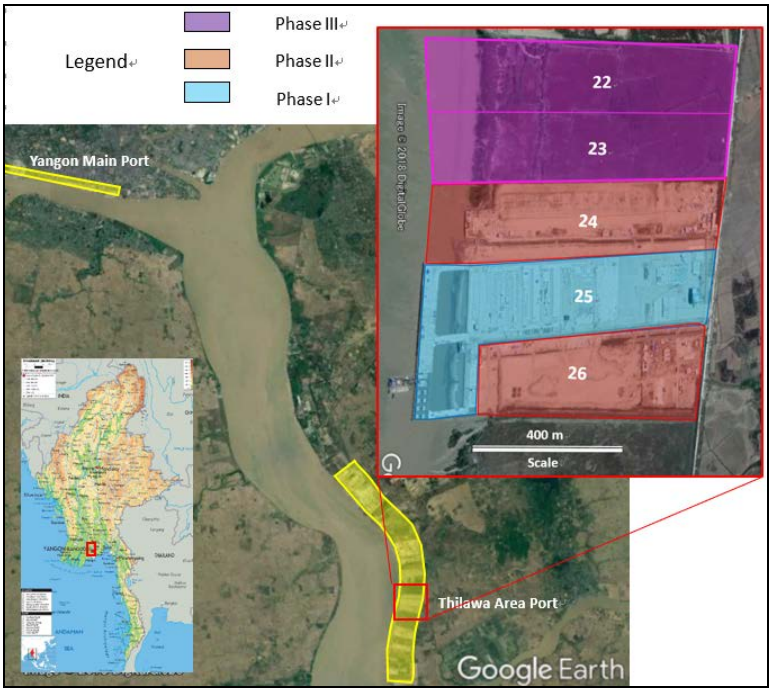
unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	18,388	15,991	13,593
Non Container Cargo	7,645	6,546	5,446
Rice	1,200	1,200	1,200
General Cargo and Others	6,445	5,346	4,246
Total	26,033	22,536	19,039

Source: Study Team

1.2 Port Development Plan

The study area includes Yangon Main Port and Thilawa Area Port (Plots 22 to26) shown in Figure S-1.2.1.



Source; Study Team (Google Earth)

Figure S-1.2.1 Location of Yangon Main Port and Thilawa Area Port

1.2.1 Yangon Main Port

(1) Basic Development Policy

The basic development policy is set as below;

① No additional large terminal development at Yangon Main Port should be conducted but the existing and planned port facilities for international trade cargo should be utilized as extensively as possible.
② Increase cargo handling productivity.
③ Enhance navigation security including the maintenance of channel depth.
④ The remaining water front areas should be used for facilities which directly benefit the lives of citizens such as passenger terminals, domestic transport terminals, promenades, shopping centers and office buildings.
⑤ Thilawa Area Port should be well utilized for port facilities which will handle future increasing international trade cargo.
⑥ Promotion of a new road network development connecting Thilawa area and the city and other areas should be contemplated in order to improve the existing poor road network.
⑦ The development of a deep water port near Yangon and the relocation of container terminals in Yangon Main Port shall be considered by Myanmar Government as a long term issue.

(2) Container Terminals

In line with the above mentioned basic development policy, it is realistic to handle the international cargo such as the containerized cargo at the four container terminals in Yangon Port and MITT and MPA (ODA) terminal under construction before concentrating the container handling operation at a new deep water port in Yangon.

(3) Domestic Terminals

The coastal and inland water transport of cargo and passengers are handled at such areas as Lamadaw, Pansodan and Botathaung. Pansodan and Botathaung where passenger transport is the major operation are situated very close to the city area. MPA has a plan to convert these areas into urban development areas including shopping centers, office buildings and passenger terminals by making use of the amenity-rich waterfront nature of these areas.

Lanmadaw area (total length of about 1,500 m as shown in Figure S-1.2.2) where the cargo handling area is quiet narrow (maximum width is 150 m and minimum width is 20 m) handles almost all domestic cargo. In order to improve the cargo handling productivity, it is necessary to redevelop this area. Since this area is adjacent to the city area, it is recommended to use this area as an amenity-rich waterfront urban development space including shopping centers and office buildings. In addition to Lamadaw area, the port area at Kyeemyindang (see Figure S-1.2.3) which exclusively handles bananas is recommended to be redeveloped similar to Lamadaw area redevelopment.

Source: Study Team (Google Earth)

Figure S-1.2.2 Layout Plan of Lamadaw Area Redevelopment

Source: Study Team (Google Earth)

Figure S-1.2.3 Layout Plan of Kyeemyindang Area Redevelopment

1.2.2 Thilawa Area Port

(1) Basic Development Policy

37 Plots in Thilawa Area Port are operated or will be operated by private companies under the BOT contracts with MPA. The major cargoes to be handled at terminals are grain and liquid cargo as shown in Table 4.1.3.

According to the Middle Case container demand forecast, it is necessary to start the operation of Phase II terminal (Plots 24 and 26) which is expected to be developed by JICA's ODA loan in 2025 and Phase III terminal (Plots 22 and 23) in 2029. Assuming that the project preparation (including a study, financing, detailed design and procurement) will take 4 years and construction works 5 years, the project formulation of Phase III should be started in 2020.

Thilawa Area Port will not be able to handle the entire container demand in 2030 even after the completion of Phase III terminal. Therefore it is necessary to develop a port in a brand-new area. In the vicinity of Thilawa Area Port, the norther part is occupied by the navy base and the southern part faces very shallow

water area, so that it is not possible to develop a new port at this area. Therefore, it is necessary to develop a new deep-sea port at a brand-new area including off the Yangon river mouth.

It is necessary to investigate natural condition surveys such as bathymetry, wave and sedimentation in advance of the formulation of a new port development plan. The study (including natural condition survey) for the formulation of a new port development plan need to be started by 2020.

(2) Container Terminals

The capacity of port facilities required in future is estimated based on the current container handling capacity in Yangon Port and the demand forecast. The Middle Case scenario in the demand forecast is applied as the planning case.

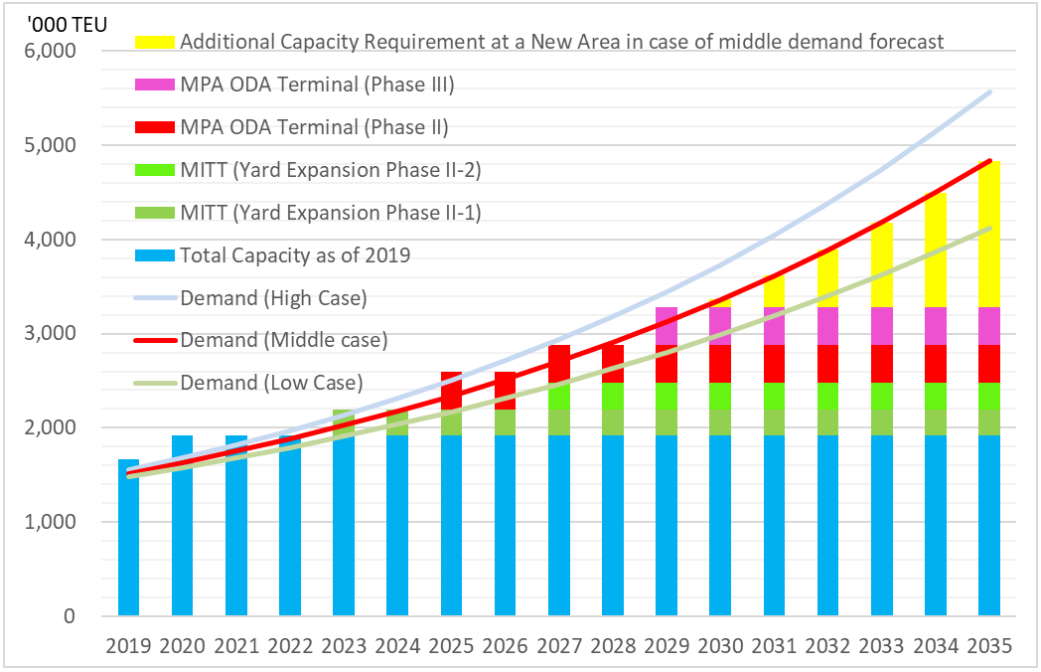
Present and future container handling capacity of terminals and development schedule is shown in Table S-1.2.1 and development schedule of terminals is shown in Figure S-1.2.4.

Table S-1.2.1 Present and Future Container Handling Capacity of Terminals and Development Schedule (Demand Forecast: Middle Case)

unit:thousand TEUs

Terminals \ Carendar Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hteedan Terminal	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Hteedan Terminal (Yard Expansion)		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Ahlone Terminal	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295
Ahlone International Port Terminal (AIPT)	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188
Myanmar Industrial Port Terminal (MIP)	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556
Bo Aung Kyaw Terminal	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Myanmar International Terminals Thilawa (MITT)	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
MITT (Yard Expansion Phase I)		225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225
MPA ODA Terminal (Phase I)	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202
Total Capacity as of 2019	1,665	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915
MITT (Yard Expansion Phase II-1)					280	280	280	280	280	280	280	280	280	280	280	280	280
MITT (Yard Expansion Phase II-2)									282	282	282	282	282	282	282	282	282
Total Expected Expansion by MIP &MITT	0	0	0	0	280	280	280	280	562	562	562	562	562	562	562	562	562
MPA ODA Terminal (Phase II)							404	404	404	404	404	404	404	404	404	404	404
MPA ODA Terminal (Phase III)											404	404	404	404	404	404	404
Total Capacity	1,665	1,915	1,915	1,915	2,195	2,195	2,599	2,599	2,881	2,881	3,285	3,285	3,285	3,285	3,285	3,285	3,285
Demand (High Case)	1,552	1,680	1,820	1,971	2,134	2,311	2,504	2,712	2,937	3,181	3,446	3,733	4,043	4,380	4,745	5,140	5,568
Demand (Middle Case)	1,518	1,631	1,753	1,885	2,026	2,178	2,342	2,517	2,706	2,910	3,128	3,363	3,616	3,888	4,180	4,495	4,833
Demand (Low Case)	1,480	1,577	1,681	1,792	1,910	2,036	2,171	2,314	2,467	2,630	2,803	2,989	3,186	3,397	3,621	3,861	4,116
Additional Capacity Requirement at a New Area in case of middle demand forecast												78	331	603	895	1,210	1,548

Source: Study Team



Source: Study Team

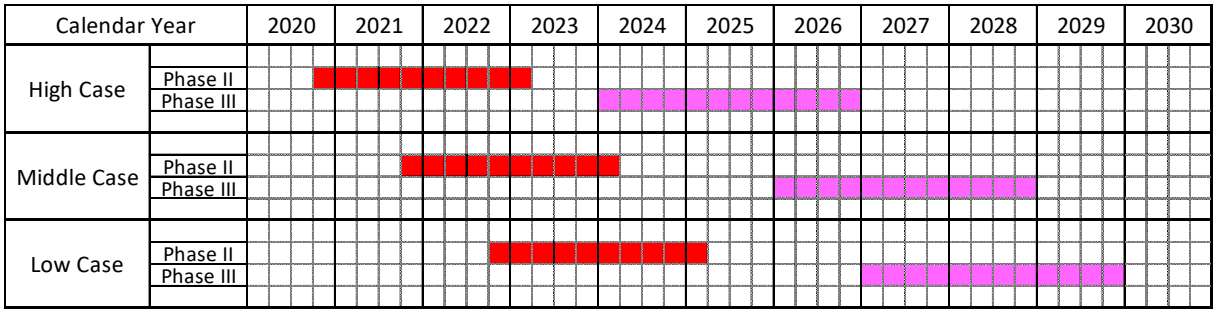
Figure S-1.2.4　Development Schedule of Terminals（Demand Forecast: Middle Case）

Although a capacity shortage is expected in 2023, MPA ODA Terminal Phase II will not be operational in time to cover the expected shortage due to the period needed for the implementation process and construction. However, capacity can be increased at MITT through container yard development and the installation of an additional gantry crane as MITT has a 1,000 m quaywall and a sufficiently wide yard area. It should be noted, however, that the capacity shortage can be covered by MITT Phase II-1 only until 2024. The operation of a new terminal will be needed in 2025. The MPA ODA Terminal II (404 thousand TEUs /year) will come into operation at that time to meet the demand.

A capacity shortage will surface again in 2029 even with the addition of the MITT Yard Expansion Phase II-2 (282 thousand TUEs/year). The commencement of terminal operation of MPA ODA Terminal Phase III (404 thousand TEUs /year) will be needed in 2097 in order to cover the shortage.

Even after the completion of all container terminal development projects in Yangon and Thilawa areas, a capacity shortage will be expected in 2030. In order to cover this shortage, it will be necessary to develop new terminals at a brand new location. The new location would ideally be in the vicinity of Yangon which represents the biggest market. The new location will be selected by carefully examining water depth requirements, channel sedimentation and other natural environmental conditions.

The construction schedule of MPA ODA Terminal Phase II (Plots 24 and 26) and MPA ODA Terminal Phase III (Plots 22 and 23) can be set based on the current and expected cargo handling capacity of existing terminals and expected expansion plans and future cargo demand. Yearly construction schedule of Phase II and Phase III terminals based on the demand forecast for three scenarios (High Case, Middle Case and Low Case) is summarized as shown in Figure S-1.2.5.



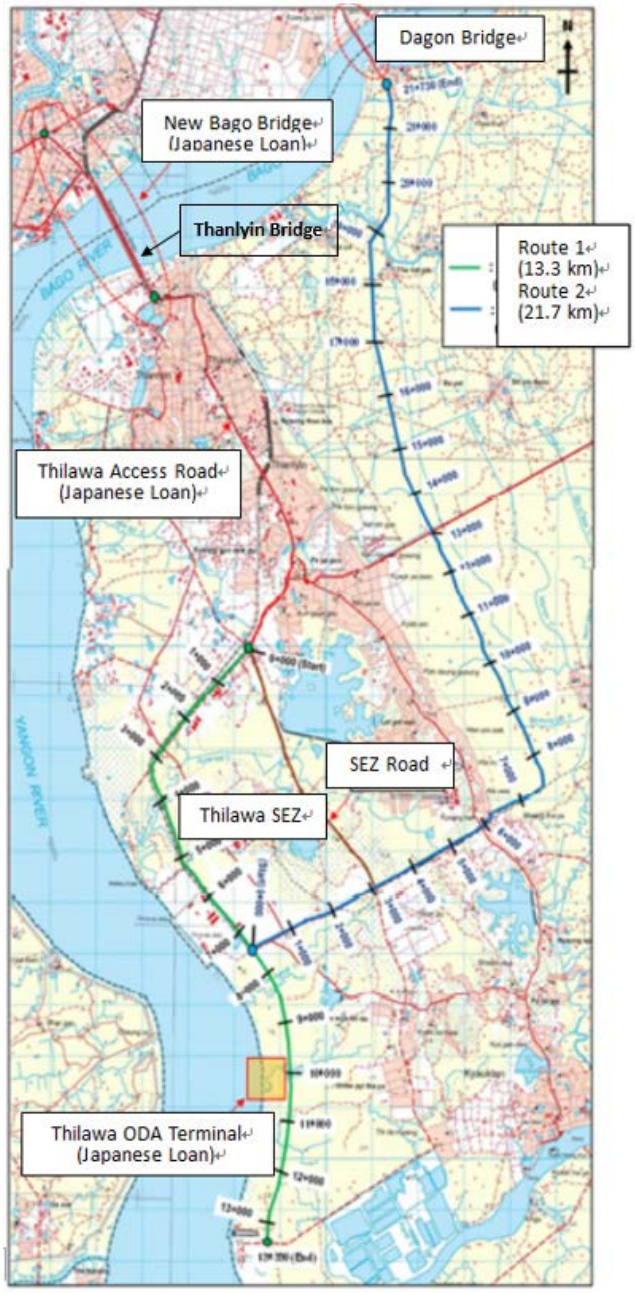
Source: Study Team

Figure S-1.2.5 Yearly Construction Schedule of Phase II and Phase III Terminals based on Three Different Demand Forecast Scenarios

(3) Access

i) Road

There are two road routes from Yangon to Thilawa area, namely Route 1 via Thanlyin bridge and Route 2 via Dagon bridge (see Figure S-1.2.6). Currently, construction of the new Bago bridge (1,224 m in length and four lanes) downstream of Thanlyin bridge is being carried out as a Japanese Yen loan project. In addition, a Japanese Yen loan road improvement project (8.7 km in length and four lanes) from this bridge to Thilawa area has been underway.



Source: Infrastructure Development Plan Study around Thilawa SEZ in Myanmar (METI, 2018.3)

Figure S-1.2.6 Proposed Road Improvement Routes

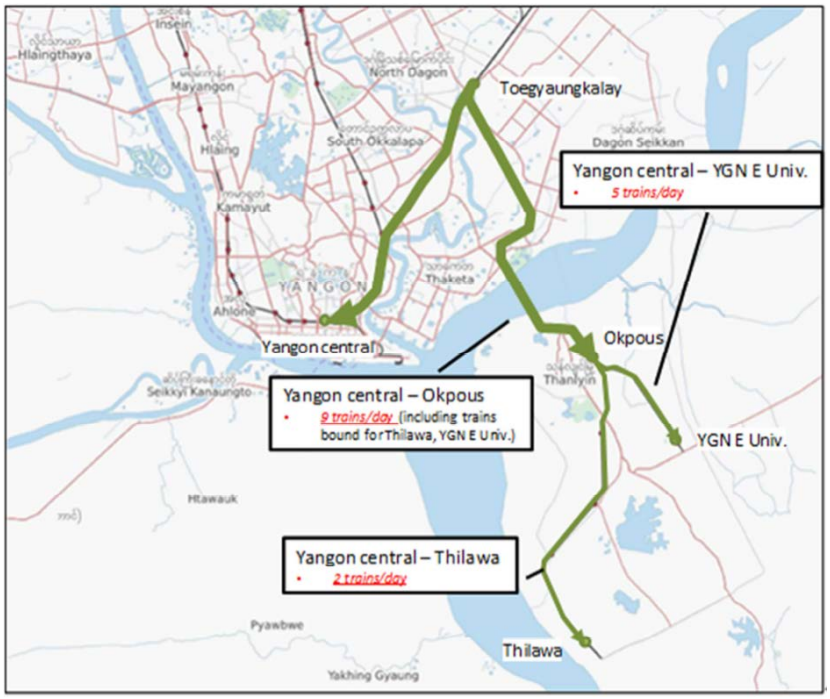
In the report entitled “Infrastructure Development Plan Study around Thilawa SEZ in Myanmar (METI, 2018.3)” (hereinafter called “Infrastructure Development Plan Study around Thilawa SEZ”), two access routes from Thanlyin bridge to Thilawa Area Port are proposed as shown in Figure S-1.2.6, namely Route 1, 13.3 km in length and 6 lanes (4 lanes in some sections) and Route 2, 21.7 km in length and 6 lanes, (also 4 lanes in some sections).

In order to operate Thilawa Area Port and SEZ efficiently, it is necessary to develop a road network by completing both current road projects and other road development projects which will be undertaken in the

near future.

ii) Railway

The railway access to Thilawa Area through Thanlyin railway bridge is extended to both MMU direction and MITT direction as shown in Figure S-1.2.7.



Source: Infrastructure Development Plan Study around Thilawa SEZ in Myanmar (METI, 2018.3)

Figure S-1.2.7 Railway Access to Thilawa Area

All seaborne containers for Myanmar are handled in Yangon Port. According to the report entitled "Infrastructure Development Plan Study around Thilawa SEZ", it is assumed that the origin/destination of containers in Yangon area accounts for 60% of all containers, while Mandalay accounts for 30% and other areas account for 10%.

Generally, railway transport has an advantage over road transport when the hauling distance exceeds 500 km. Since the distance between Yangon and Mandalay is about 620 km, railway transport is a suitable transport mode in this section.

The major origin/destination of container cargo in Yangon is Mingaladon Industrial Area. The possibility of utilizing railway transport in the Yangon area as an alternative transport means is expected to increase because the daytime truck traffic in the city area is restricted.

Considering the expected increase in railway container transport in the future, the possibility of the realization of the railway network extension project for Thilawa SEZ and Thilawa Area Port needs to be examined. A separate feasibility study covering the items shown in Table S-1.2.2 will be required.

There will be several alternative plans for the railway extension project. Among them, Plan A (railway

container transfer terminal is to be located in Phase III ODA terminal area) and Plan B (to be located in Thilawa SEZ area) are shown in Figures S-1.2.8 and S-1.2.9 respectively. The detailed layout plan for Plan A is shown in section 3.3 for reference.

Source: Study Team (Google Earth)

Figure S-1.2.8 Railway Development Plan A
(located in Phase III area, exclusive use for ODA terminal)

Source: Study Team (Google Earth)

Figure S-1.2.9 Railway Development Plan B
(located in SEZ area, common use with other cargo from SEZ and other terminals)

Table S-1.2.2 Concept and Examination Items of Railway Development Plan

	Plan A (to be developed in Phase III ODA terminal)	**Plan B (to be developed in Thilawa SEZ area)**
Concept	① Exclusive use for ODA terminal ② To be located in Phase III area (plot 23)	① To be used for ODA terminal cargo, SEZ cargo and other Thilawa terminal cargo including container break bulk and bulk cargo ② To be located in SEZ area
Items to be examined	① Demand forecast and transport capacity of railway ② Possible conflict between railway site and future road expansion site ③ Loading capacity of Thanlyin railway bridge ④ Project implementation entity and fund raising ⑤ Impact to the capacity of Phase III terminal	① Demand forecast and transport capacity of railway ② Possible conflict between railway site and future road expansion site ③ Loading capacity of Thanlyin railway bridge ④ Project implementation entity and fund raising ⑤ Possibility of interference between railway traffic and road traffic and crossing method between railway and road.

Source: Study Team

2 Facility Development Plan

2.1 Natural Conditions

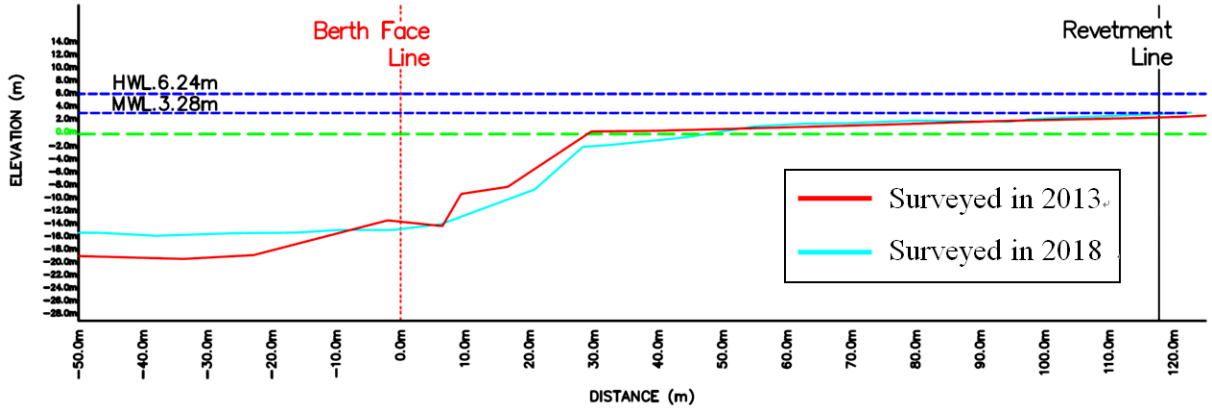
2.1.1 Soil Condition

From the soil investigation conducted separately by MPA, following points are confirmed on the soil condition of the surveyed area.

- From the upper layer to around CDL-20m, clay with N-value of 1 to 5 and silty clay with N-value of 10 are evenly accumulated.
- Most of the land side from around CDL-20m~-30m to the bottom are accumulated by sand which could be a bearing stratum.
- The N-value of the sand layer is varied from 20 to 50, and it tends to be higher when the location is deeper.
- The river side of Plot 24 South is the single point where silty sand with N-value of 10 to 20 is accumulated down to CDL-37m. The bearing stratum is around CDL-40m.
- At the river side, accumulated condition varies at the locations. Alternate layering of silt and sand is also confirmed. The bearing stratum is around CDL-30m~-40m or deeper.
- There is little difference between the results in 2013 and 2018 excluding the N-value of the surface layer. Therefore, the construction work of Phase I project is hardly influenced on the soil condition.
- At Plot 22 to 26, the soil condition of the yard area is not so different. But, the soil condition at riverside is different from place to place. Therefore, additional survey at riverside is necessary at the stage of detailed design.

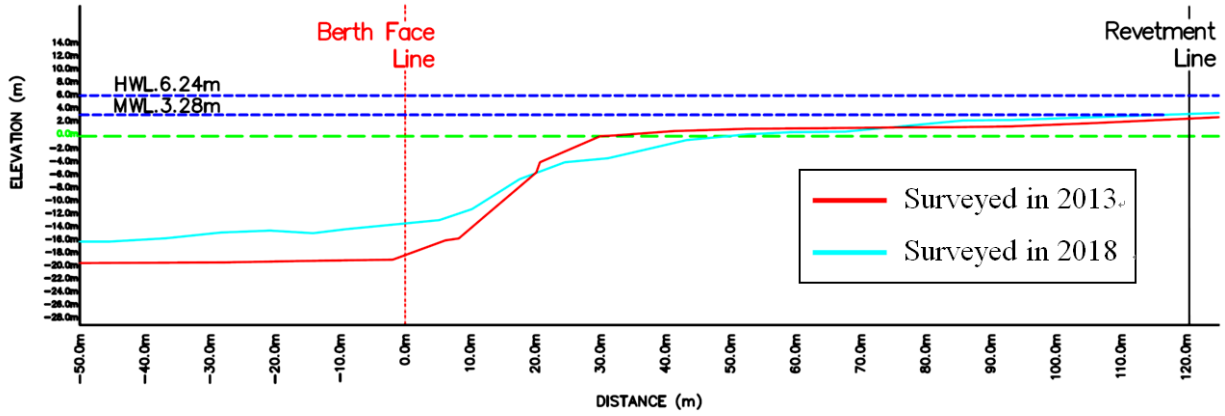
2.1.2 Bathymetric Survey / Channel Sedimentation

River bed profile in front of Plot 24 is as shown in Figures S-2.1.1 and S-2.1.2.



Source: Study Team

Figure S-2.1.1 Line 1 Cross Section View



Source: Study Team

Figure S-2.1.2 Line 2 Cross Section View

From the cross section views above, following points are confirmed on the condition of water depth and channel sedimentation of the Yangon River.

- Water depth is suddenly changed in the 30 m range between the Berth Face Line and the inner area. The other areas are almost flat.
- At the area where water depth is suddenly changed, there is a deference of almost 2 m by comparing the survey result in 2013 and 2018. So, the design condition at the jetty become strict by the erosion.
- Water depth at the outer area from the Berth Face Line is shallower in 2017 than in 2013. It was -19 m in 2013 but decreased to -15 m in 2018.
- According to the surveys, the massive change of water depth in Yangon river is found. As the period will be taken up to the start of detail design, it is necessary to implement bathymetric survey again at the time of detailed design.

2.1.3 Topographic Survey

According to the topographic survey, the elevation of Plot 22 to Plot 26 is about 6, 7 m. Then, it is so flat. However, the topographic survey in 2013 was carried out before the construction stage of Phase I Project. Therefore, the influence of the construction work is not considered. As the area of Plot 24 and Plot 26 is the temporary yard of Phase I Project, it is necessary to implement topographic survey again. At Plot 22 and Plot 23, it is considered that there is no change excluding to the area near river side.

2.2 Facility Layout

2.2.1 Terminal Facility Plan

(1) Preconditions for the Facility Plan

1) Container Handling Capacity

Targeted Terminal Capacity of Plot 24, 25 and 26 is 600,000 TEUs per annum in total.

2) Container Handling Volume and its Breakdown

In the last several years, increase in the container volume at Yangon Port has been driven by import cargo, whereas export cargo has remained stagnant or has only slightly increased. Eventually, the proportion of empty containers for export will become ridiculously high due to this imbalance. The long-term and short-term proportions of container volume by type are shown in Table S-2.2.1

Table S-2.2.1 Proportions of Container Volume by Type

Type of Container		Long-term Proportions		Short-term Proportions		Current Proportions
		Proportion (%)	Container Volume (TEU/Year)	Proportion (%)	Container Volume (TEU/Year)	Proportion (%)
Import	Full Container	90%	270,000	90%	270,000	95%
	Empty Container	10%	30,000	10%	30,000	5%
Export	Full Container	80%	240,000	60%	180,000	55%
	Empty Container	20%	60,000	40%	120,000	45%
Total	Full Container	85.0%	510,000	75.0%	450,000	75.0%
	Empty Container	15.0%	90,000	25.0%	150,000	25.0%
Grand Total		100.0%	600,000	100.0%	600,000	100.0%

Source: Study Team

3) Material Flow related to the Terminal

i) Import Containers

Full containers unloaded from a vessel and delivered from the yard are de-vanned at the consignee's warehouse or factory. The empty containers are usually deposited to the inland container depots (ICD) or returned to the container depots in the terminal (TCD). These empty containers are washed or maintained and stored at the ICD or TCD.

ii) Export Containers

When shippers need empty containers for stuffing their export cargoes, there are two possibilities depending on their sites. Shippers in the SEZ will pick them up from the empty container yard/depot near the Thilawa port container terminals or in the SEZ (this is expected to become an option in future). After they stuff their export cargoes, they will use Thilawa port for loading onto ships. On the other hand, shippers in the industrial zone northwest of Yangon City will likely pick up empty containers for stuffing from the ICDs near their site, i.e., the ICDs behind or surrounding the Yangon city terminals.

In the Phase II project, an empty container storage facility is planned behind the terminal yard (container depot as free area). Because the containers once extracted from the terminal are deemed as domestic containers (except bonded transportation), the storage facility will be segregated from the empty container yard (bonded area) in the terminal.

4) Berthing Side of the Calling Vessels

As almost all container vessels calling this port have a deep draft, they come into the port on the flood tide. Accordingly, they come alongside the pier of Thilawa Terminal on starboard-side in response to the change in the direction of the current. If the current is still flowing in the same direction, they turn round and berth at the pier along the port-side of vessels. Therefore, calling vessels will berth both at starboard-side as well as port-side.

In terms of land transportation, vehicles are obliged to run on the right side of the road while trailers from the hinterland mainly come from the north of the terminal; therefore, the safest and most efficient traffic flow (less intersecting in the terminal traffic road) is for trailers to 1) come into the terminal from the north side, 2) go through the traffic road in the terminal anti-clockwise, 3) enter into the stacking yard from the north side of stacking blocks, and 4) exit from the south side of the terminal. In other words, trailers for vessel operation go round between the quayside and stacking yard in a clock-wise direction.

Considering the situation above, land transportation rules and traffic safety in the terminal are given priority over water side requirements, and calling vessels will berth at the starboard side.

5) Cargo handling System in the Terminal

i) Cargo handling system at quay-side

The quay-side cargo handling system in the Phase II project applies QGC (Quay Gantry Crane) the same system as in the Phase I project.

ii) Cargo handling system in the yard

In the Phase II project, RTG (Rubber Tired Gantry Crane) system is applied for container handling in the yard (full container stacking yard), the same system as applied in the Phase I project, where the same maximum stacking height is one over five (1 over 5).

The new Thilawa terminal has a high possibility of being operated as a multi-purpose terminal for handling general cargoes (imported vehicles, steel products, construction materials, machinery and equipment, etc.) rather than a container-dedicated terminal in the early stage of its operation or even for a long period depending on the situation. Therefore, the whole terminal should be planned flexibly so that it can serve as a multipurpose terminal. Considering this requirement, the pavement structure of half the RTG yard is designed to accommodate general cargoes using reach stackers or forklifts.

2.2.2 Yard Capacity and Required Yard Blocks

(1) Preconditions for Planning

1) Annual container handling volume; 600,000 TEUs

2) Container dwelling time in the yard:

Targeted dwelling time as a precondition for the Phase II yard facility planning is assumed as shown in

Table S-2.2.2.

Table S-2.2.2 Container Dwelling Time

Type of Container		Average Dwelling Time	
		Targeted Dwelling Time	Present Dwelling Time
Import	Full Container	8	8～10
	Empty Container	14	14～15
Export	Full Container	7	7～9
	Empty Container	14	14～15
Reefer Container		4	4～7

Source: Study Team

3) Yard efficiency:

The yard efficiency as a precondition for the Phase II yard facility plan is 65% (for full containers) and 70% (for empty containers).

(2) Required Ground Slots for Empty Containers

Physical stacking capacity of 1,244 TEU in ground slots for empty containers in Plot 24/25/26 is sufficient to accommodate total capacity of 600,000 TEUs for long-term and short-term container volume proportions in the Phase II project.

2.2.3 Customs Inspection Facilities and CFS

(1) Preconditions for Planning

① Container Volume and daily container flow: 600,000 TEU/Year
② Customs operation days per year: 287 days/year
③ Customs operation hours per day: Normal days:7.5 hours/day (9:00-16:30), Peak days:10 hour/day (9:00-19:00)
④ Inspection Rate by each category：Refer to Table S-2.2.3
⑤ X-ray inspection efficiency (per hour): 12 Boxes/hour
⑥ X-ray inspection efficiency (per day): 90 Boxes/day（120 Boxes/day at peak days）

Table S-2.2.3 Inspection Rate by Category

Inspection Category	Import Container	Export Container
(1) Green ：Document Check	70%	0%
(2) Yellow : X-Ray Inspection	20%	90%
(3) Red : Physical Examination	10%	10%

Source: Study Team

(2) Required Physical Examination Facilities

① Operating hours of physical examination: Normal days:7.5hours/day, Peak days: 10 hours /day）
② Average Examination hour: 1 hour/ Box/ (Examination group)

③ Capacity of physical examination per day: Average:7.5 Boxes/ day/(Examination group)（Peak days: 10 Boxes/ day/(Examination group)

④ Required number of examination groups: 12 Groups (import: 8 group + export 4 group)

⑤ Bay occupation hours in physical examination: 4 hours/Box（1.9 cycles/bay/day）

In the facility plan for import containers, two kinds of platforms are required; the platforms for physical inspection (30 to 33 bays as shown above) and customs seal setting platforms for SEZ containers (which is assumed to be approximately 5 bays). In total, 35 to 38 bays are required. Hence, a CFS for import containers with a platform capacity of 40 bays (as a round figure) is to be constructed in the Phase II project.

For the physical inspection of export containers, a CFS facility planned in the Phase I project will secure the required capacity (18 to 20 bays) in the Phase II project.

(3) Required CFS Capacity

In the Phase II project, CFS is planned to be the same type as designed in the Phase I project. Size of the CFS is planned at 50 m in depth including the platform for customs inspection.

1) Preconditions of the Plan

① LCL cargo volume: 12,150 TEUs per year (5% of import container cargoes excluding Thilawa SEZ related cargo)

② Block size of the cargo storage area: 30 m (L) x 2.5 m (D) x 6 m (H) (96 pallet racks)

③ Length of the CFS Area : 6 m x (number of blocks) + 3 m

2) Required Length of CFS

Total length of CFS is planned at 168 m in the Phase-II project, which comprises the CFS area (used for import LCL cargo storage area: 99 m), LCL customs bonded area (53 m) and Office area (16 m).

2.2.4 Administration Building

Total number of inhabitants in the tentative plan of Phase II is assumed at approximately 122 persons which is 1.7 times more than the number of inhabitants planned in the Phase I project (73 persons). Hence, the administration building planned in the Phase I project may not be able to comfortably accommodate the inhabitants of the Phase II Project.

However, the total floor space of the building can accommodate some more inhabitants if some changes to the interior are made and the workers' space is shifted to the CFS office in Plot 26. Therefore, the original administration building will continue to be used for the Phase II project since expansion works would be too costly.

2.2.5 Cargo Handling Equipment Deployment Plan

The cargo handling equipment deployment plan in Phase II is shown in Table S-2.2.4.

Table S-2.2.4 Required Capacity and Main Features of Equipment

No.	Equipment	Required number of Equipment (Plot 24/25/26)			Main Use	Capacity and Main Features
		ODA Loan	Private Invest.	Total		
1	QGC	6		6	Containers	・Earthquake resistance gantry crane with seismic isolation system ・Capacity: 40.6 Ton, ・Rail span: 16 m ・Outreach: 14 rows on deck (Phase-2)
2	RTG	18		18	Containers	・Capacity: 40.6 Ton, ・Gantry Span: 23.5m ・Stacking height: 1-ober-5, ・Span:23.5m
3	Reach Stacker	3		3	Containers General Cargoes	・Capacity: 40.6 Ton, ・Stacking height: 5 tier
4	MT Container Lifter	3	3	6	Containers	・Capacity: 10 Ton (for Empty Container Handling) ・Stacking height: 5 tier
5	Tractor Head	30	6	36	Containers	・20 feet x2, 40 feet x1
6	Trailer Chassis					
7	Engine Fork Lift	1		1	General Cargoes (Heavy Duty)	・Capacity: 24 Ton
8	Engine Fork Lift	1	1	2	General Cargoes	・Capacity: 10 Ton-12 Ton
9	Engine Fork Lift	4		4	General Cargoes	・3 Ton-4 Ton
10	CFS Battery Fork Lift	6	6	12	General Cargoes	・3 Ton (General Cargo handling in CFS)
11	CFS Battery Lifter	6	6	12	General Cargoes	・3 Ton (General Cargo handling in CFS)
12	Fuel Supplying Vehicle		1	1	Fuel Supply	・Fuel Supply for Yard Equipment (RTG, Reach Stacker, MT Container Lifter, Fork Lift, etc.)
13	Pick-up Car		2	2	General Use	
14	Company Vehicle		4	4	General Use	
15	Commuting Bus		6	6	Commuting Workers	(29-Passanger)

Source: Study Team

2.3 Facility Layout Plan

2.3.1 Basic Policy for Layout Planning for Phase II

(1) Terminal Unit

Plots 24‐26 (quay length 600m) are deemed as one business unit from the viewpoint of efficient terminal operation. The reason is described in detail in Section 3.8.1 “Basic Policy for Layout Planning”.

(2) Targeted Terminal Capacity

Targeted terminal capacity is 600,000 TEUs per annum

(3) Unified Layout

Phase II terminal layout is planned under a unified concept with Phase I layout to enable effective operation among three yard Plots (24/25/26). For example, a QGC system is adopted as the cargo handling system at the quay side while an RTG System is adopted at the yard side as in the Phase I System. In addition, stacking blocks in the yard are arranged in a straight line alongside to the quay line.

The new Thilawa terminal has a high possibility of being operated as a multi-purpose terminal for handling general cargoes (imported vehicles, steel products, construction materials, machinery and equipment, etc.) rather than a container-dedicated terminal in the early stage of its operation or even for a long period depending on the situation. Therefore, the whole terminal should be planned flexibly so that it can serve as a multipurpose terminal. Considering this requirement, the pavement structure of half the RTG yard is designed to accommodate general cargoes using reach stackers or forklifts.

2.3.2 Quantity and Dimensions of each Component

(1) Yard Blocks

Table S-2.3.1 Quantity and Dimensions of Stacking Blocks

	Plot 24	Plot 25	Plot 26	Total
	Block Size			
	(Bays (TEUs) x Rows x Blocks)			
Dry	26 TEUs x 6 x 8	22 TEUs x 6 x 8	24 TEUs x 6 x 8	72 TEUs x 6 x 8
Empty	20 TEUs x (6/10) x 2	(18/22) TEUs x (6/10) x 2	(21/23) TEUs x (6/10) x 4	(18/23) TEUs x (6/10) x (2/4)
Reefer	20 TEUs x 6 x 1	17 TEUs x 6 x 1	17 TEUs x 6 x 1	54 TEUs x 6 x 1
	Number of Ground Slots			
	(TEUs)			
Dry	1,232	1,056	1,152	**3,440**
Empty	320	312	612	**1,244**
Reefer	120	102	102	**324**
	Stacking Height			
	(Tiers)			
Dry	1 over 5	1 over 5	1 over 5	1 over 5
Empty	5	5	5	5
Reefer	3	3	3	3
	Stacking Capacity			
	(TEUs)			
Dry	6,160	5,280	5,760	**17,200**
Empty	1,600	1,560	3,060	**6,200**
Reefer	360	306	306	**900**
Total	8,120	7,146	9,126	**24,300**

Source: Study Team

(2) Customs Inspection Facilities & CFS

Container cargoes related to the Thilawa SEZ are assumed to be inspected and cleared at the SEZ Customs, and are to be transported between Thilawa Port and the SEZ in bond.

Table S-2.3.2 Quantity and Dimensions of Customs Inspection Facilities

Facility	Quantity of Facilities		Building Size	Physical Inspection Platform	CFS Truck Lane
X-Ray Inspection Facilities	Import Cargo Inspection	2 sets	35m (L) x 13m (W)	-	-
	Export Cargo Inspection	2 sets		-	-
Physical Inspection Facilities & CFS	Import Cargo Inspection	1 building	104m (L) x 50m (W)	40 Bays	40 Bays
	Export Cargo Inspection	1 building	170m (L) x 50m (W)	36 Bays	12 Bays

Source: Study Team

(3) Equipment Maintenance & Repair Facilities

Quantity of facilities (S1 & S2) is estimated based on the types & quantities of the equipment. Maintenance & repair facilities are concentrated in the same area.

Table S-2.3.3 Quantity and Dimensions of Equipment Maintenance & Repair Shops

Maintenance Facility	Building Size	Quantity		Remarks
		Phase-2 *1	Phase-1 *2	
Maintenance Shop (S1)	18 m x 32 m	2 buildings	1 building	Cargo Handling Equipment Maintenance
Maintenance Shop (S2)	18 m x 32 m	2 buildings	1 building	
Container Repair Shop	15 m x 42 m	1 building	1 building	Container Repairing
RTG Maintenance Depot	-	3 depots	2 depots	RTG Maintenance
Note: *1 Corresponding to three Plots (Plot 24, 25 and 26) *2 Corresponding to Plot 25				

Source: Study Team

(4) Administration Building & Marine Workers' Lounge

In the Phase II project, the layout of the administration building is planned based on the assumption that the building under construction (for Phase I) will be used by shifting some of the functions to the CFS office to be constructed in Plot 26.

Marine workers' lounge building for the Phase II project is to be built due to the increase of workers. In the layout planning of this study, size of the additional building is tentatively drawn as the same size as the Phase I project. The final size will be designed based on the number of workers in the DD Stage. The buildings for Phase I and Phase II will be located in the same area.

Table S-2.3.4 Quantity and Dimensions of Administration Building & Marine Workers' Lounge

Building	Building Size	Quantity	
		Phase-2 *1	Phase-1 *2
Administration Building	40m x 21 m (5 stories, Total Floor Space 3,400 ㎡)	1 Building	
Marine Workers' Lounge	18 m x 12 m *3 (2 stories, Total Floor Space 684 ㎡)	2 buildings	1 building
Note: *1 Corresponding to three Plots (Plot 24 to 26) *2 Corresponding to Plot 25 *3 Size of the Building for Phase-2 is tentative in the Feasibility Study.			

Source: Study Team

(5) Electrical Power Supply Facility Building

Electrical power is supplied to the terminal facility and equipment through three types of Substations; electric facility substations (Main Stations), jetty substations and reefer container substations. Dimensions and quantity of the substation buildings are shown in Table S-2.3.5.

Table S-2.3.5 Quantity and Dimensions of Power Supply Facilities

Substations	Building Size	Quantity	
		Phase-2 *1	Phase-1 *2
EF Substation (Main Station)	23 m x 33 m (760 ㎡)	2 buildings	1 building
Jetty Substation	8.8 m x 7.4 m (65 ㎡)	2 buildings	1 building
Reefer Container Substation	4.1 m x 7.9 m (12 ㎡)	3 buildings	1 building
Note: *1 Corresponding to three Plots (Plot 24 to 26) *2 Corresponding to Plot 25 *3 Size of the Building for Phase-2 is tentative in the Feasibility Study.			

Source: Study Team

(6) Water Supply Facilities

Phase I Water Supply Facilities were designed to have a capacity of 480 ㎥/day including 1) building water supply of 68 ㎥/day, 2) ship water supply of 400 ㎥/day, 3) and water supply for container washing of 3 ㎥/day. Considering that the need for ship water supplying service has lessened since MPA started the service by water boat, water supply needs for Phase II terminals can be covered by the Phase I facilities. Hence, an additional water supply facility is not planned.

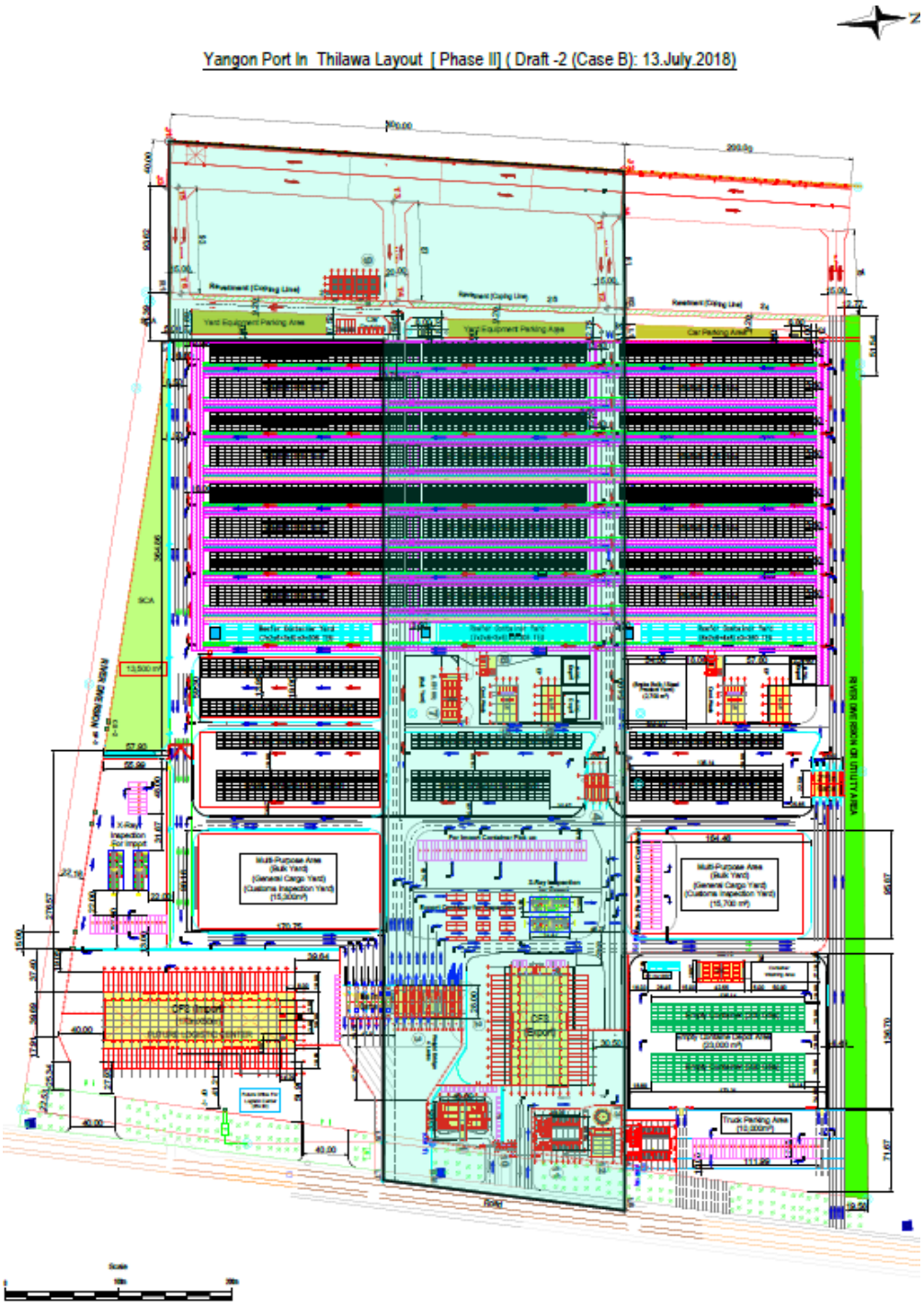
Table S-2.3.6 Quantity and Dimensions of Water Supply Facilities

Substations	Building Size	Quantity	
		Phase-2 *1	Phase-1 *2
Water Supply Facility	23 m x 33 m (760 ㎥)	1 building	
Water Supple Tower	35 m high, Tank Capacity:40㎥	1 tower	
Note: *1 Corresponding to three Plots (Plot 24 to 26) *2 Corresponding to Plot 25			

Source: Study Team

2.3.3 Layout Drawing of Phase II Project (Plot 24 & Plot 26)

A Layout Drawing corresponding to the basic policy of the planning and quantity and dimensions of each component described above is attached in Figure S-2.3.1.



Source: Study Team

Figure S-2.3.1 Layout Drawing of Phase I (shadowed) and Phase II

2.3.4 Basic Policy for Layout Planning (Phase III)

(1) Targeted Terminal Capacity

Targeted terminal capacity is 400,000 TEUs per annum (Plot 22/23).

(2) Terminal Business Units

① As described in the Phase II layout planning, quay-lines of Plot 22/23 (400m length) and Plot 24/25/26 (600m length) are not in a straight line (inflective at 8-degrees). Therefore, a calling vessel cannot be berthed at the area where the jetties are joined; accordingly, each jetty has no choice but to be operated independently.

② As Plot 22/23 has two berths (total length of 400 m), two vessels can be accommodated at the same time. Therefore, Plot 22/23 can be operated as an independent terminal.

③ A Japanese terminal operator, who was awarded the Plot 25/26 concession, is interested in operating Plot 24/25/26 as a business unit in the Phase-II Project. However, the operator does not show any interest in the project at Plot 22/23 at the present stage because the Phase I (Plot 25/26) terminal is still under construction.

Due to the above, when considering the facility plan in the Phase III project, it is too risky to make the layout plan based on the assumption that Plot 22-26 will have a quay length of 1,000m and be operated as one integrated business unit. Therefore, in this survey, Plots 22/23 will be planned to be operated as an independent business unit.

(3) Quantity and Dimensions of each Component (Phase III)

Quantity and approximate dimensions of each component that form the basis of the facility layout plan (Phase III) are summarized in Table S-2.3.7. The dimensions are estimated based on 3.2.10 "Required capacity of each facility (Phase III)" in the previous section.

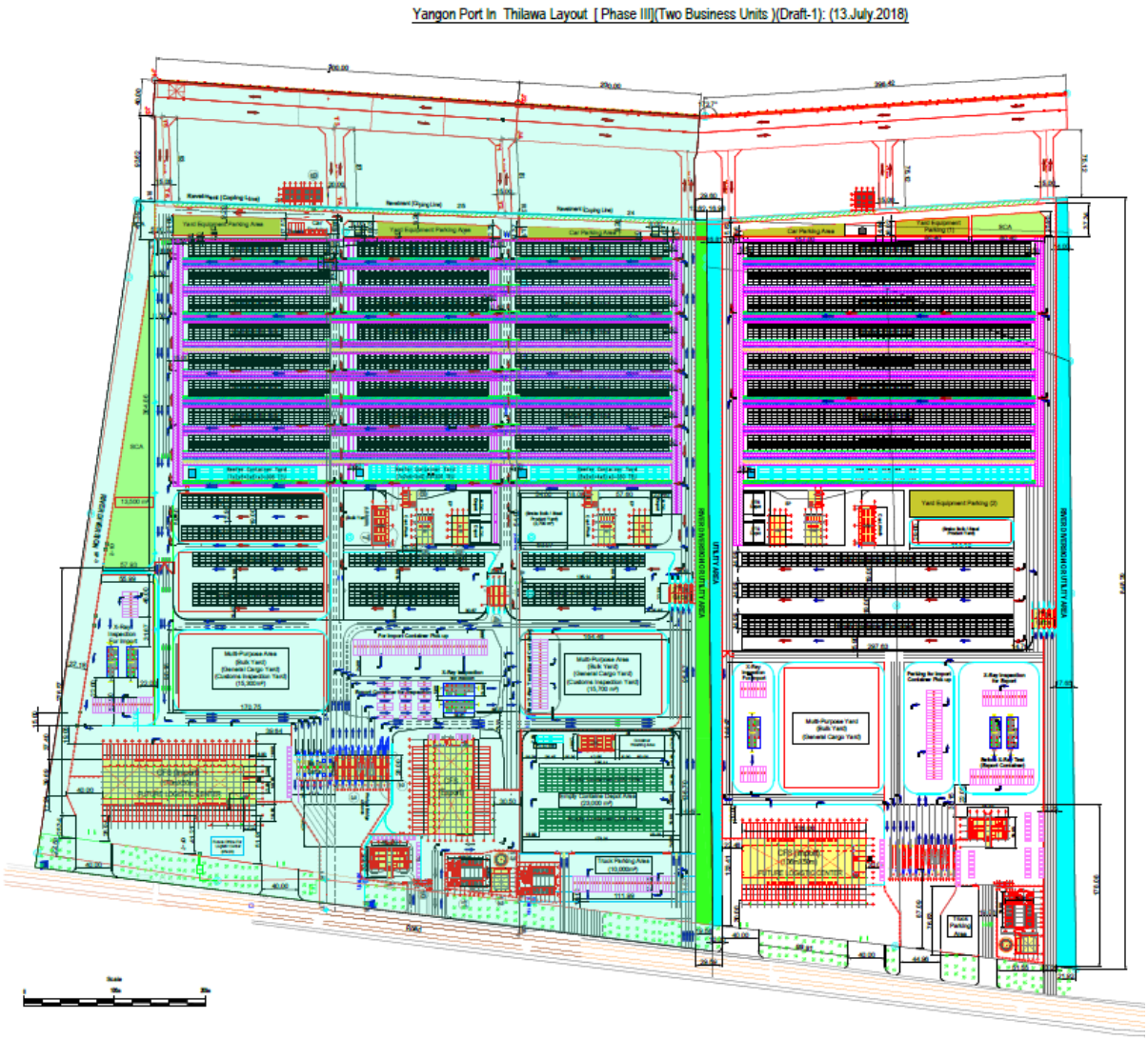
Table S-2.3.7 Quantity and Dimensions of Terminal Facilities (Plot 22/23)

Facility		Required Capacity	Approximate Size of the Facility/ Building*1	Remarks
Stacking Yard	Dry Container Yard (Full)	8 blocks x 48 bays in TEUs	Block size: 342 m (L) x 26m	Stacking area : 48 TEUs x 6.5 m = 312 m RTG traverse lane: 14m (N) + 16 m (S)
	Empty Container Yard	1,244 ground slots in TEUs	Block size: 286 m (L) x 15 m, 286 m x 25 m	Block length : 44 TEUs x 6.5 m = 286 m
	Reefer Container Yard	1 block x 39 bays in (TEUs)	Block size: 300 m (L) x 26m	Excluding RTD traverse lane
Terminal Gates	Main Gate	10 lanes	28m(L) x73m(W)	with 3～4 weighing bridges
	2nd Gate	3~4 lanes	23m(L) x 27m(W)	
Customs Inspection Facilities	X-Ray Inspection Facilities	3 sets	35m (L) x 13m (W) per machine	
	Physical Inspection Facilities & CFS	34 Inspection platforms	136m(L) x 50m(W)	Size of CFS will be reexamined.
Maintenance Shops	Maintenance Shop (S1)	1 building	18 m (W) x 40 m (L)	Size of S1 shop will be reexamined.
	Maintenance Shop (S2)	1 building	18 m (W) x 32 m (L)	Same size as Phase-I repair shop
	Container Repair Shop	1 building	15 m (W) x 42 m (L)	Same size as Phase-I repair shop
	RTG Maintenance Depot	2 depots	-	Same size as Phase-I RTG depots
Administration Building		1 building	44m x 33 m	Same size as Phase-I admi. building
Marine Workers' Lounge		1 building	28(L) x 15m(W)	Examined based on the Phase-III workforce plan
Power Supply Facilities	EF Substation	1 set	23 m x 33 m (760 ㎡)	200% of Phase-I capacity
	Jetty Substation	1 set	8.8 m x 7.4 m (65 ㎡)	200% of Phase-I capacity (4 QGCs)
	Ref Container Substation	1 set	-	200% of Phase-I capacity
Water Supply Facilities	Water Supply Facility	1 building	23 m x 33 m (760 ㎥)	Same capacity as Phase-I Facility
	Water Supply Tower	1 Tower	35 m high, Tank Capacity:40 ㎥	Same capacity as Phase-I Facility
Note: *1 Approximate Size of the Building is tentative for Pre-feasibility Study, and to be examined in the Feasibility Study.				

Source: Study Team

(4) Draft of Facility Layout Plan of Phase III Project (Plot 22/23)

The original draft of the facility layout plan (Plot 22/23) formulated based on the above preconditions is illustrated in Figure S-2.3.8. As described above, this layout plan is drawn assuming that plot 22/23 is operated by an entity independent of the Phase II terminal. However, even when Plot 22/23 is integrally operated with Plot 24/25/26, the layout will be almost the same since 1) the required facilities are estimated based on the handling capacity of 400,000 TEUs, and as a result 2) the quantity and size of each component will be the same as in the independent case.



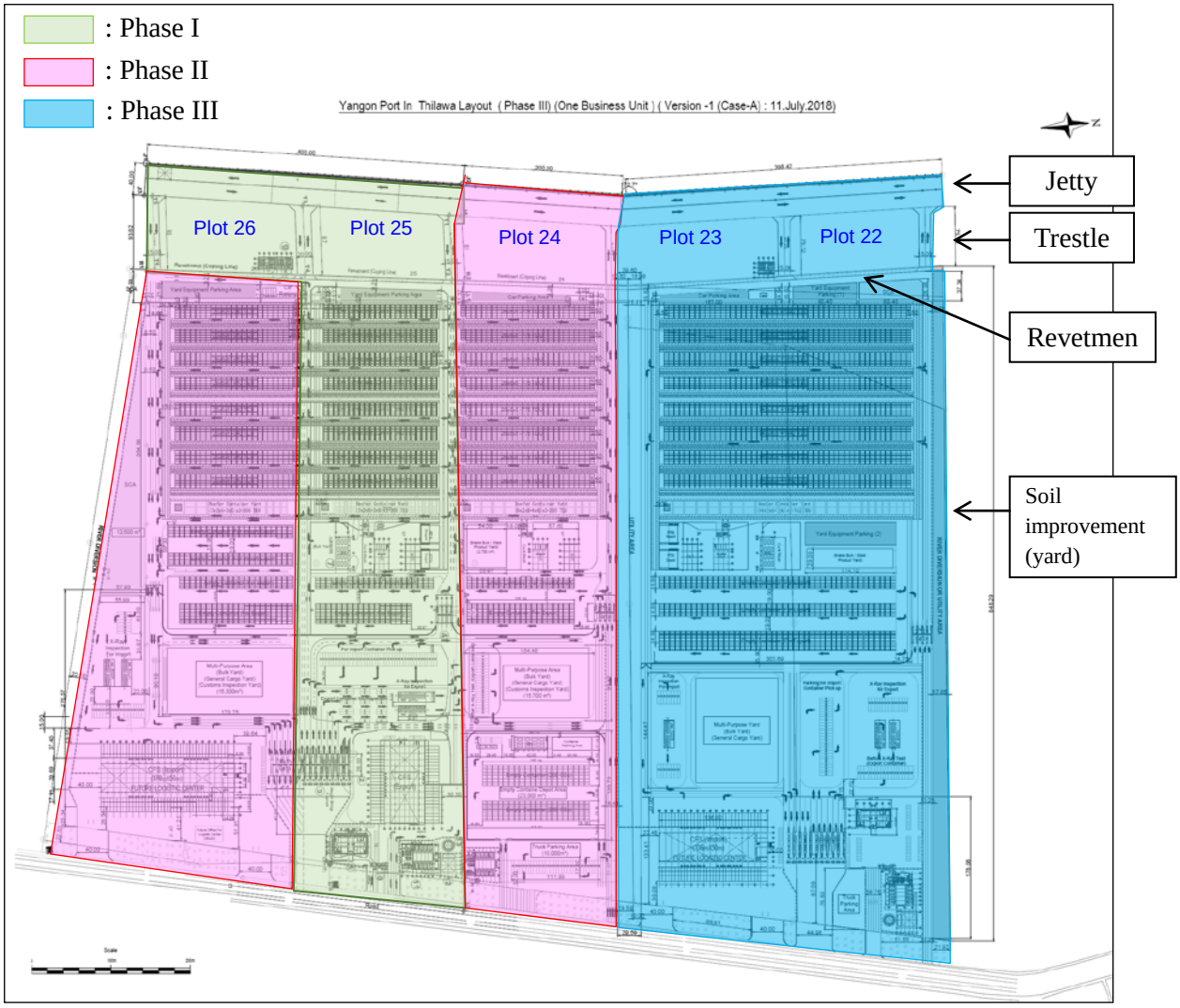
Source: Study Team

Figure S-2.3.8 Layout Drawing of Phase I/ Phase II (shadowed) and Phase III (Case-A)

2.4 Preliminary Design of Major Facilities

2.4.1 Civil Facility

The phase-wise layout plan of Plots in Thilawa area of Yangon Port is summarized in Figure S-2.4.1. Preliminary design was conducted for civil facilities of the port, which are 1) jetty, 2) trestle, 3) revetment and 4) soil improvement of Plots 24, 23 and 22 in Phase II and III. Overview of the layouts is summarized in Table S-2.4.1 and structural drawings are shown in Figures S-2.4.2 to S-2.4.5.



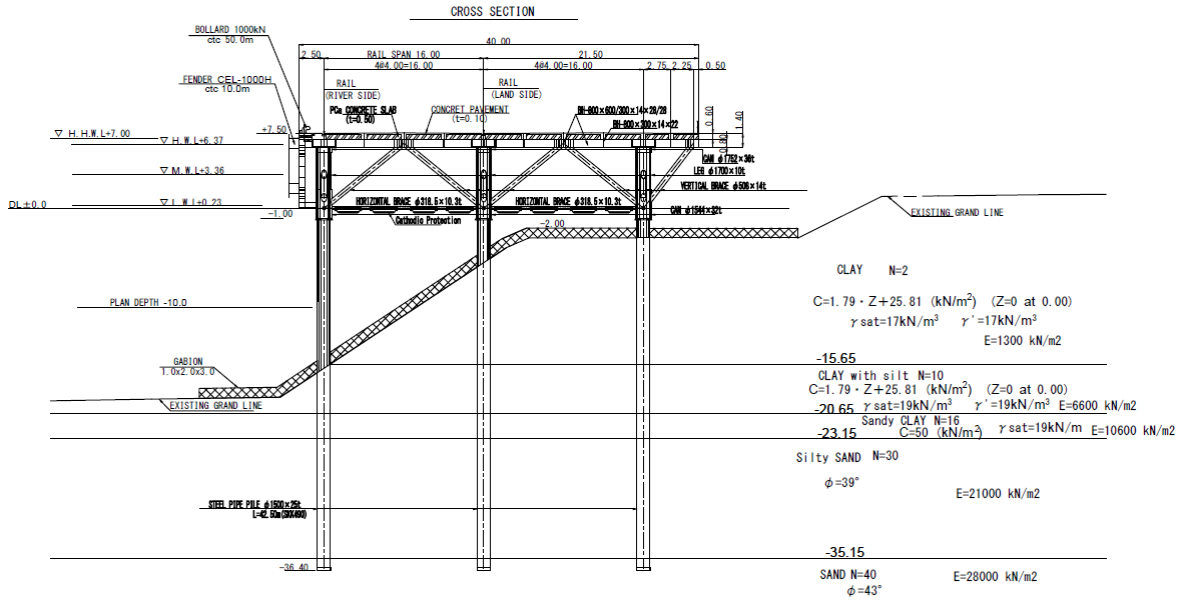
Source: Study Team

Figure S-2.4.1 Phase-wise Layout Plan for Plots

Table S-2.4.1 Recommended Structures/ Methods

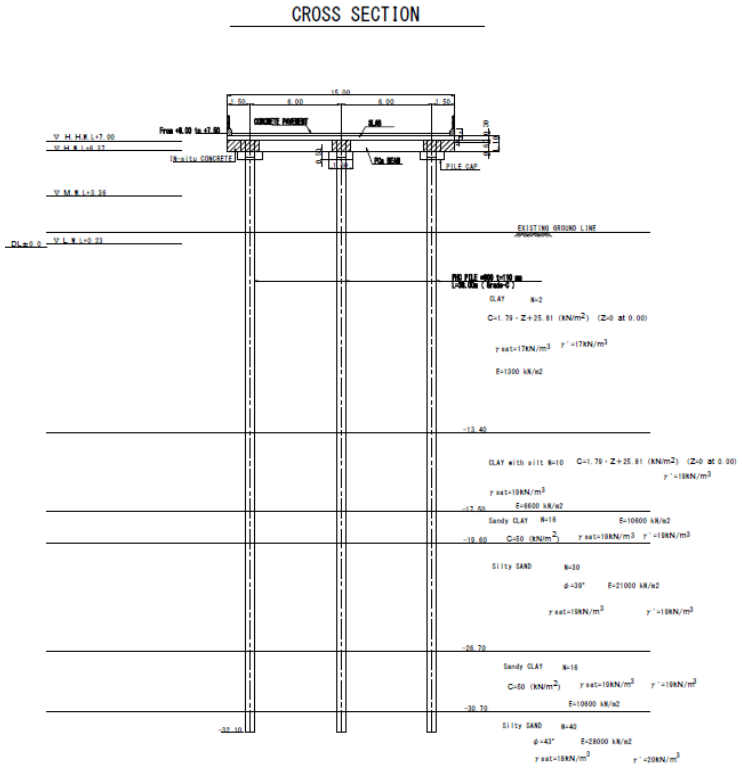
Facility	Recommended structures/ methods	Note
Jetty	Jacket type (SPP)	To be applied for Plots 24,23 and 22
Trestle	Vertical pile type (PHC)	(Ditto)
Revetment	Concrete sheet pile	(Ditto)
Soil improvement	PVD and surcharge	(Ditto)

Source: Study Team



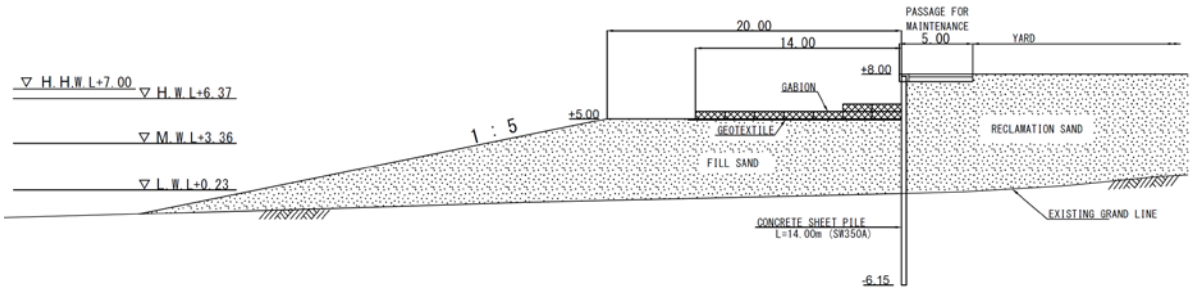
Source: Study Team

Figure S-2.4.2 Typical Cross Section of Jacket Type Jetty



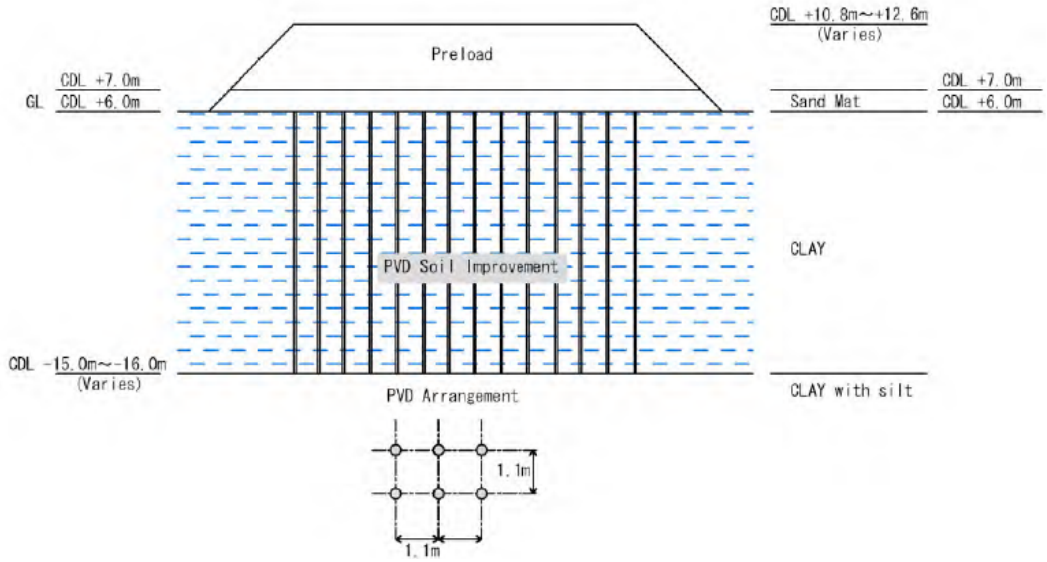
Source: Study Team

Figure S-2.4.3 Typical Cross Section of Trestle



Source: Study Team

Figure S-2.4.4 Typical Cross Section of Revetment



Source: Study Team

Figure S-2.4.5 Schematic Figure of Soil Improvement by PVD and Surcharge

2.4.2 Buildings and Utilities

The summary of main buildings and utilities for Phase II and Phase III project is shown in Table S-2.4.2

Table S-2.4.2 List of Buildings and Utilities for Phase II and Phase III Project

No	Buildings	Quantity (Story)		Remarks
		Phase II	Phase III	
1	Administration Building (ADM)	-	3,400 m^2 (5)	-
2	Container Freight Station (CFS)	8,500 m^2 (1+M)	6,800 m^2 (1+M)	For import use (it will be used for logistic center in the future)
3	Terminal Gate	6 lane (1)	11 lane (1)	-
4	2nd Gate	4 lane (1)	5 lane (1)	Entrance of bonded area
5	Maintenance Shop (1)	580 m^2 (1+M)	580 m^2 (1+M)	With the wall
	Maintenance Shop (2)	580 m^2 (1)	580 m^2 (1)	Without the wall
6	Container Repair Shop	770 m^2 (1)	770 m^2 (1)	-

7	Fuel Station	160 m^2 (1)	160 m^2 (1)	-
8	Marine Workers' Lounge	670 m^2 (2)	670 m^2 (2)	-
9	Security Post	-	70 m^2	Beside a terminal gate
10	Power Supply Facility	6,600 kVA (1)	8,800 kVA (1)	2,200 kVA per one (1) Gantry Crane
11	Water Supply facility	-	500 m^2 (1)	Phase III: including water supply tower (H=35 m)
12	Reefer Sub-station	1 set (-)	1 set (-)	Beside a reefer container
13	Jetty Sub-station	1 set (-)	1 set (-)	For Gantry Crane
*	X-ray Inspection Facility	2 unit (1)	3 unit (1)	-

(Note) M : Mezzanine,
Source : Study Team

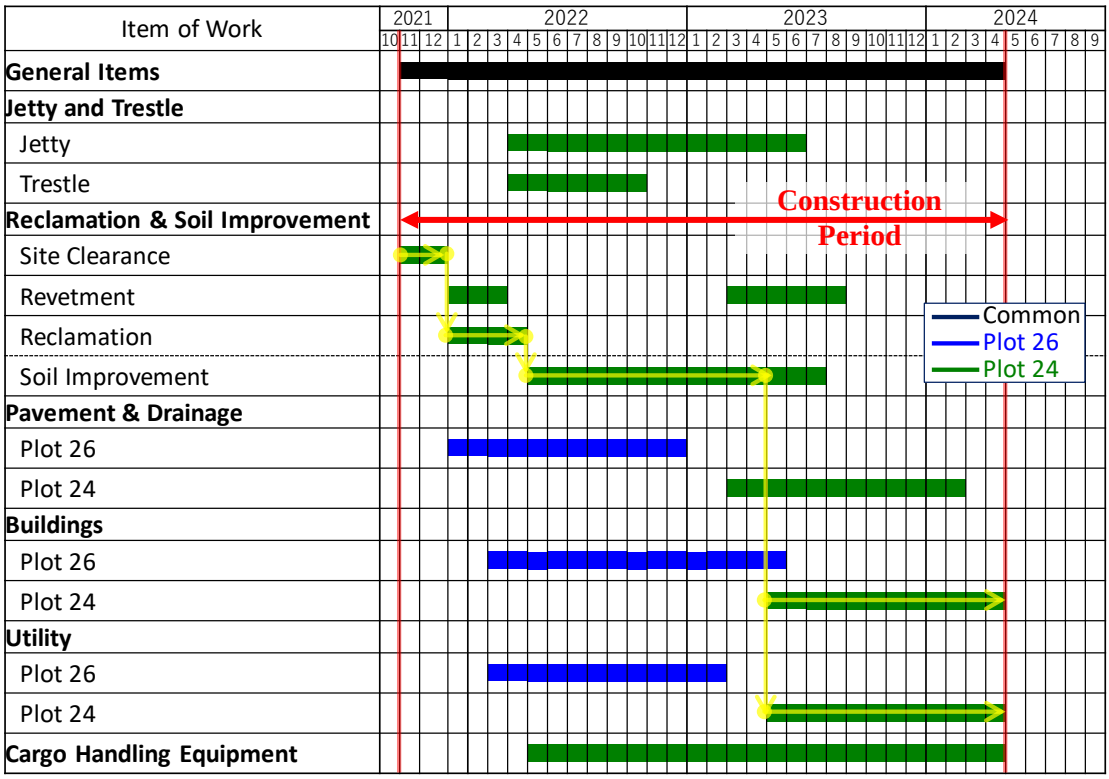
2.5 Project Implementation Schedule

2.5.1 Construction Schedule

The construction schedule for Phase II are presented in Table S-2.5.1, which includes the procurement period of equipment including fabrication, delivery, installation and commissioning at the site, in addition to the preparatory works for the construction of civil works and buildings.

The critical path (buildings and utility works after the reclamation and soil improvement work) is highlighted by yellow line in these table.

Table S-2.5.1 Construction Schedule for Phase II Project



Source: Study Team

2.5.2 Project Implementation Schedule

Since Myanmar side expects to employ a soft loan for the project, the implementation schedule including the period for loan procedure, detailed design and tender assistance, etc. is as shown in Table S-2.5.2.

Table S-2.5.2 Project Implementation Schedule for Phase II Project

	Months	2018	2019	2020	2021	2022	2023	2024	2025
Selection of consulting service	12								
Detailed Design	11								
Tender Assistance	12								
Construction (Civil, Buildings, Utilities)	30								
Procurement (Cargo Handling Equipment)	24								
Defect Liability Period	12								

Source: Study Team

3 Port Management and Operation

3.1 Present Situation of Port Management in Myanmar

(1) Organization, Function and Responsibility of MPA

MPA consists of nine departments, two divisions, and four regional offices. The full quota of MPA is 11,577 including officers and staff. Present number of officers and staff is 2,852 as of March 2018, which is only 25% of the full quota. Considerable manpower has been allocated to the Traffic Department, Marine Dpt., Civil Engineering Dpt., and Mechanical Engineering Dpt., however, there have been significant decreases in the staff sizes of these four departments. Ratios of present number of staff among the quotas of each department are 22% in the Traffic Dpt., 14% in the Civil Engineering Dpt., 19% in the Mechanical Engineering Dpt., and 44% in the Marine Dpt.

The Yangon Port Act was promulgated in 1879 after which the Commissioner of the Port of Yangon began to develop the port. The new Yangon Port Act (No. 4/1905) was promulgated in 1905, which empowered the commissioner's function and encouraged the development of the Yangon Port. In April 2015, new Myanmar Port Authority Act (No. 21/2015) was promulgated and the Yangon Port Act of 1905 and the Out-ports Act (No. 2/1914) were repealed. The new Myanmar Port Authority Act of 2015 was established as the basic law on ports including a clause on port tariff, which was previously regulated by the Port Act of 1908.

(2) Terminal Operators in Main Port and Thilawa Area in Yangon

Six terminals in the inner harbour of Yangon Port are operated by private terminal operators. Only berths nos. 5 to 7 of Sule Terminal remain as a general cargo terminal directly operated by MPA.

Among the 37 plots in the Thilawa area of Yangon Port, Plots nos. 22-26 are allotted to MPA and the others are for private investors. As of now, 13 plots are already in operation and 24 plots are under construction or under planning for development by concessionaires.

(3) Lessons Learnt from New Port Development and Challenges

When a new port is developed far from an old port, as in the case of Thilawa area, shippers and consignees may not be willing to move from the old port to the new port. Development of port facilities alone is not enough to attract shippers and consignees. Users demand an access road and railway connection as well as offices for shipping agents, forwarders, customs brokers, and shipping companies. Moreover, government services such as customs, immigration, quarantine and animal/plant inspections are also required. Incentives and regulations for the use of new/old port are also important to encourage the use of the new port.

Taking into consideration lessons learnt from new port development, following measures will be effective

for successful development of container and multi-purpose terminals in Thilawa area.

- To urgently develop a highway between Thilawa area and outskirts of Yangon City;
- To extend the railway in Thilawa area to Plot 26 or nearby;
- To encourage barge transportation from Thilawa to the upstream, and develop jetties for barge transportation;
- To set a limit of cargo handling in the inner harbour up to a certain level in view of traffic congestion and redevelopment of water front in Yangon City;
- To allow private operators to decide cargo handling charges by negotiation with shipping companies and consignees/shippers within the ceiling of MPA's tariff;
- To encourage operators to increase their productivity, variable concession fee shall be calculated based on the volume of cargo, not based on the possible revenue, and the rate of variable fee shall be reduced if cargo handling exceeds a certain level;
- To encourage the development of ICD between Thilawa and the outskirt of Yangon City.

(4) Port EDI and MACCA

The Project for National Single Window and Customs Modernization by Introducing Automated Cargo Clearance System (MACCS) has been implemented by the technical cooperation and grant aid of Japan since 2014, and the system entered into operation in November 2016. The Project for Port EDI for Port Modernization has also been implemented since 2015 and the system was officially opened in May 2018. Port EDI (Electronic Data Interchange) is designed for port entry declaration, port clearance for departure, and other documentation related to cargo handling and storage in a port.

(5) Financial Situation of MPA

It is reported that MPA's total revenue is 90.0 billion Kyat, total expenditure 19.7 billion kyat, net revenue 70.3 billion kyat, corporate tax 17.6 billion kyat (25% of net revenue), contribution to the government 14.1 billion kyat (20% of net revenue), and net surplus after taxes 38.6 billion kyat in fiscal year of 2016/2017.

Earnings before Interest and Taxes (EBIT), which shows earning power of a company (a satisfactory level is said to be 30% or over), was calculated at 78% in 2016/2017, which indicates that MPA has satisfactory earning power. This may stem from the fact that terminal operations are commissioned to private operators, main expenditure is personnel cost, staff number has been reduced in the recent several years, port tariff is high compared with regional ports, and income is about USD70 per container. Fiscal year of Myanmar is from April to March until 2017/2018 and the term will change from October to September after 2018/2019.

(6) Port Tariff and Fee Collection

Port dues for a 30,000 DWT container ship is estimated at USD 18,600 at Yangon Port, USD 15,000 at Chittagong Port, USD 27,000 at Sihanoukville Port, USD 15,000 at Bangkok Port, USD 17,900 at VICT, Ho Chi Minh Port inclusive of VAT. Berth charges of Yangon Port are lower than other cases and light dues are not charged in other cases. Consequently, terminal operators receive less from berthing charges and

MPA receives more from light dues. .

MPA's container handling charges include Lo/Lo charge and wharfage which are 1.5 to 2.3 times higher than other cases. In particular, container handing charges are levied on a TEU basis, so that charges on 40 footers are considerably higher than the other cases. Handling charges on 40 footers should not be twice that 20 footers in consideration of actual handling cost.

Total cost is estimated at USD 291,700 at Yangon Port, USD 144,900 at Chittagong Port, USD 214,400 at Sihanoukville Port, USD 176,600 at Bangkok Port, and USD 133,400 at VICT, Ho Chi Minh Port inclusive of VAT. Total cost of Yangon Port for a model ship entry and cargo handling is 1.4 to 2.2 times of other ports. Taking into account that private terminal operators refund cargo handling charges to ship operators, port tariff should be revised, or allow private terminal operators to modify their tariff within the ceiling of MPA's tariff.

3.2 Port Management System and PPP

(1) Port Management Reform

MPA is proceeding to a landlord type port authority by privatizing terminal operations and reducing its own services. However, MPA controls ship entry, berth allocation and regulates port tariff, which means that private operators cannot operate their terminals completely at their own discretion.

As a landlord port authority, it is important for MPA to tackle the following tasks and issues.

- **Preparation of National Port Policy and Master Plan**

Ports of Myanmar faces high port tariff compared with regional ports, and difficulty in accommodating mother vessels due to shallow water. It is urgently necessary to establish a national port policy and master plan to cope with these problems.

- **Terminal Operator's Discretion in setting Cargo Handling Charges**

Terminal operators cannot decide their own cargo handling charges and fees due to the compulsory tariff of MPA. Service provider shall be able to decide charges and fees of their services. It will be appropriate that MPA will allow the entry of private shipping agents in the business of SAD.

- **Maintenance of Navigation Channel**

Siltation and sedimentation in the approach channel severely limits the draft of calling vessels, thereby hampering ship entry and departure. It is imperative to regularly survey the water depth and dredge the approach channel in a timely manner.

- **Development of Access Road and Railway**

To reduce traffic congestion in Yangon City, it is indispensable to develop a highway between Thilawa and the outskirt of Yangon City and extend the railway to Thilawa terminals.

(2) PPP for Port Development and Management

In case of port development projects, the public sector is usually responsible for the development of marine facilities and breakwaters while the private sector participates in operational aspects. Development of waterfront facilities and procurement of cargo handling equipment are shared by the public and private sectors. In case of a project that needs a large initial investment and anticipates low profitability at the initial stage, the public sector will develop all facilities and install cargo handling equipment. Conversely, if a project is profitable and has low risks, the private sector will develop all facilities and procure cargo handling equipment.

Taking into account that terminal development in Thilawa area faces difficulty in terms of land transportation and would not be attractive for investors at the initial stage, the public sector is expected to develop all infrastructure and superstructures and the private sector participates in operations. As the cargo volume increases, the private sector will procure additional cargo handling equipment and expand the cargo handling capacity.

4 Technical Cooperation Scheme

4.1 Port Development Plan

4.1.1 Yangon Main Port

(1) Container terminals

Container terminals in Yangon Main Port are located in a narrow area between the city area and the Yangon River and thus the terminals interfere with city functions and generate traffic congestion which also hampers port functions. Therefore, after the BOT contracts expire, it is necessary to relocate the terminals gradually to a brand-new area in order to separate the terminals from city function area.

Thilawa Area Port is supposed to be a candidate site for relocating container terminals in Yangon Main Port, however, all 37 Plots except for Plots 22 to 26 (owned by MPA) are allocated to private operations based on BOT contracts with MPA. Therefore, there is no room in Thilawa Area Port for the relocation of container terminals from Yangon Main Port.

Therefore, it is necessary to develop a brand-new port to handle the container cargo expected in the future at Yangon Port.

(2) Domestic Terminals

The coastal and inland water transport of cargo and passengers are handled at such areas as Lamadaw, Pansodan and Botathaung. Lanmadaw area, where almost all domestic cargo is handled, is quiet narrow. In order to improve the cargo handling productivity, it is necessary to redevelop this area. In addition to Lamadaw area, the port area at Kyeemyindang is recommended to be redeveloped similar to Lamadaw area redevelopment.

The concrete redevelopment plan shall be formulated in the close consultations with the port users because the redevelopment should be conducted without disturbing the daily port operations.

4.1.2 Thilawa Area Port

According to the Middle Case container demand forecast, it is necessary to start the operation of Phase II terminal (Plots 24 and 26) in 2025 and Phase III terminal (Plots 22 and 23) in 2029. Assuming that the project preparation (including a feasibility study, project appraisal, loan negotiation, consultant selection, detailed design, bidding etc.) will take 4 years and construction works 5 years, the project formulation of Phase III should be started in 2020.

Thilawa Area Port will not be able to handle the entire container demand in 2030 even after the completion of Phase III terminal. Therefore it is necessary to develop a port in a brand-new area. In the vicinity of Thilawa Area Port, the norther part is occupied by the navy base and the southern part faces very shallow

water area, so that it is not possible to develop a new port at this area. Therefore, it is necessary to develop a new deep-sea port at a brand-new area including off the Yangon river mouth.

It is necessary to investigate natural condition surveys such as bathymetry, wave and sedimentation in advance of the formulation of a new port development plan. The study (including natural condition survey) for the formulation of a new port development plan need to be started by 2020.

4.2 Project Implementation Scheme

(1) Development of Plot 24 and Plat 26

Phase II of the Thilawa Multi-Purpose International Terminal (TMIT) project is to develop the yard in Plot 26 and the berth facilities and yard in Plat 24. TMIT is designed to have three berths with a total length of 600 meters in the area of Plots 24, 25, and 26. If Plot 24 becomes an independent terminal, the Plot 25/26 terminal and the Plot 24 terminal would have difficulties in yard operation, berth allocation, QGC assignment, and their productivities will stay at low level. It is rational to include Plot 24 in the concession contract of the Plots 25/26

(2) Development of Plot 22 and Plot 23

When the cargo handling at the terminal of Plots 24/25/26 reaches its capacity, a new terminal will be opened in the area of Plots 22/23. As the access road and highway will be completed and related facilities/services will be established in Thilawa by then, Plots 22/23 can be developed by the private initiative type PPP or the intermediate type PPP.

Integrated operation of Plots 24/25/26 and the Plots 22/23 would be more productive than separate operation in view of economies of scale, so that it is advisable to operate Plots 22-26 as one integrated terminal.

MAIN PART

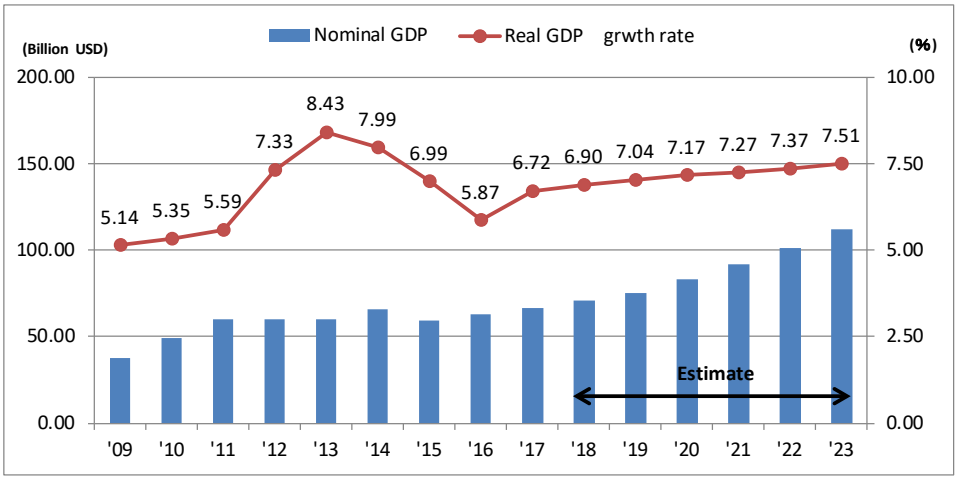
1 Background of Port Development

1.1 Present Situation of Transport in Myanmar

1.1.1 Social and Economic Situation of Myanmar

(1) Economic Trends

As shown in Figure 1.1.1, Myanmar had maintained economic growth exceeding 7% since the civilian government took power in 2011, however the real GDP growth rate in 2016 dropped slightly to 5.9%. The economic slowdown can be attributed to a decline in agricultural production due to the floods in 2015 and sluggish foreign investment due to the absence of a clear economic policy. In addition, although the consumer price inflation rate declined from 10.0% in 2015 to 7.0% in 2016, the International Monetary Fund (IMF) has pointed to the rise in food prices and other factors negatively affecting domestic consumer markets as reasons for the slower economic growth. However, IMF forecasts that Myanmar's GDP growth rate will exceed 7.0% from 2019.

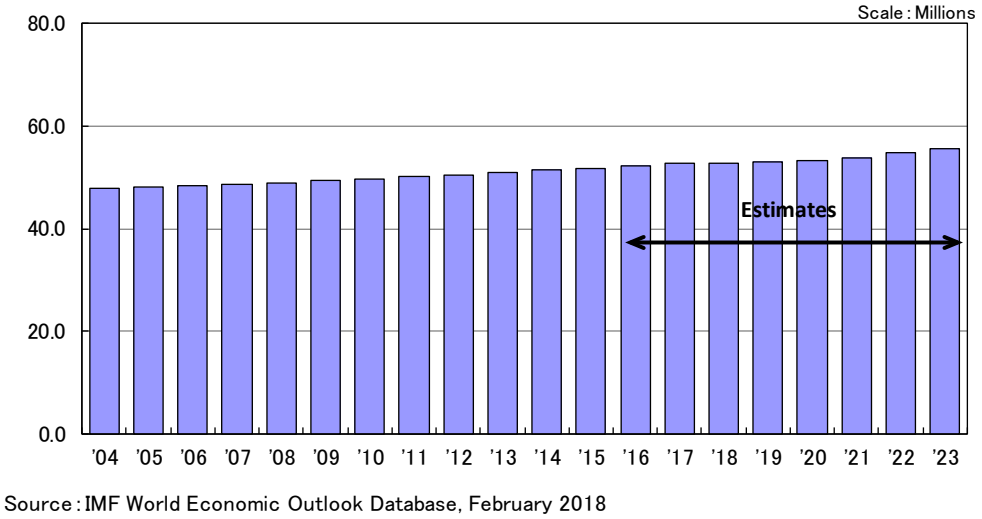


Source : IMF World Economic Outlook Database, February 2018 2018～ : IMF estimate

Figure 1.1.1 Nominal GDP and Real GDP growth rate

(2) Population

The most recent census was conducted in 2014 after a long interval. According to the IMF, the population of Myanmar in 2015 is 51,846,000 while the future population growth rate is estimated at 0.7%. Changes in population are shown in Figure 1.1.2.



Source : IMF World Economic Outlook Database, February 2018

Figure 1.1.2 Changes in population

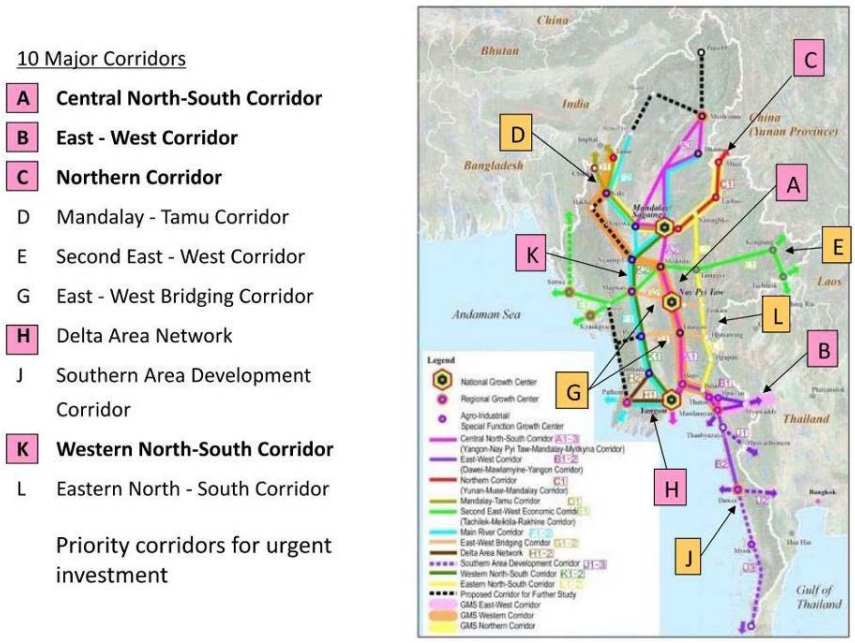
1.1.2 Fundamental National Transport Plans

In Myanmar, the current system comparable to socioeconomic plans of other countries consists of the National Spatial Development Plan (NSDP) and the Short-term five-year plan. The 20-year National Comprehensive Development Plan (NCDP) from 2011 to 20131 serves as the framework for future projects.

"Myanmar National Transport Development Master Plan" prepared with the assistance of JICA aims to develop transport infrastructure with target growth of 7.2% per year in all sectors from 2014 to 2030.

In total, 1.166 trillion yen is planned to be invested for infrastructure development in the fields of aviation, roads, railroads, ports and inland water transport, the majority of which will used for key transport infrastructure projects from 2014 to 2020 (this amounts to 87% of the total investment in all transport sectors during the same period). An additional 1.625 trillion yen is planned to be invested from 2020 to 2030 in core transportation infrastructure in rural areas in order to achieve balanced development.

In consideration of the natural conditions of the Myanmar including natural disasters and to maintain a balance between the urban and rural areas, 10 major corridors which form the development axis of national land are proposed. Five of them are designated as preferred corridors. Figure 1.1.3 shows the 10 major corridors.

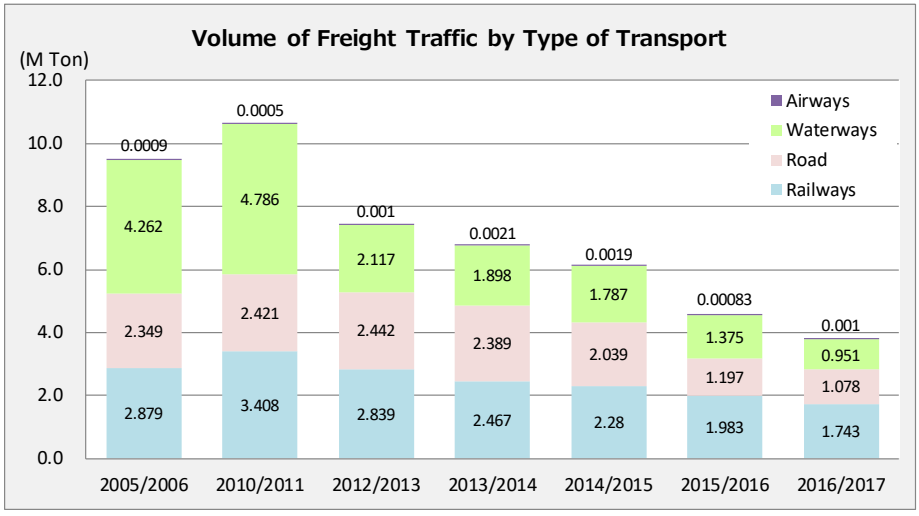


Source: Myanmar National Transport Development Master Plan

Figure 1.1.3 10 Major Corridors

1.1.3 Current Situation of Logistics

The domestic volume of freight traffic in Myanmar has been decreasing year by year; after peaking at 10.62 million tons in 2010/2011, a volume of 3.77 million tons was recorded 2016/2017, which is about one-third of the peak level. The volume of freight traffic by type of transport is shown in Figure 1.1.4.

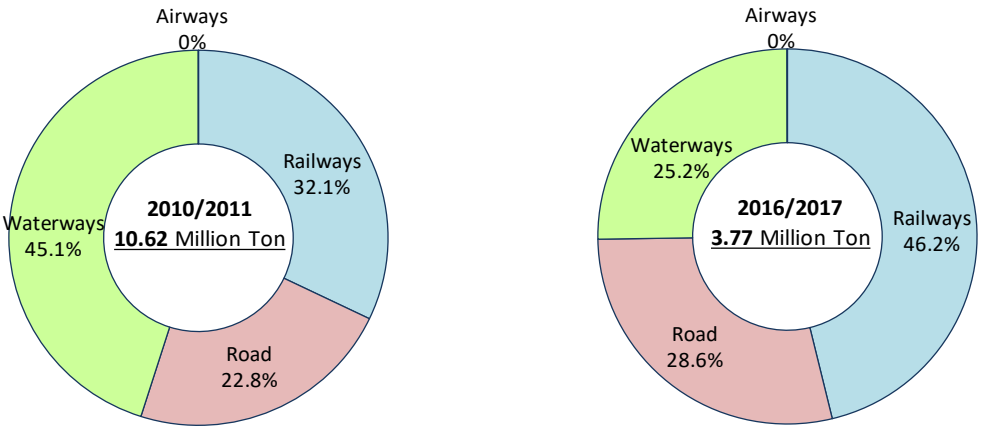


source：Myanmar Statistical Yearbook 2017

Figure 1.1.4 Volume of Freight Traffic by Type of Transport

Most domestic freight is transported by roads, railways and waterways. In 2010/2011, 45.1 % of cargo was transported by waterways but in 2016/2017 railways became the predominant mode of transport, accounting for 46.2% of the total cargo volume. Changes in the ratio for each transport mode are shown in

Figure 1.1.5.



source：Myanmar Statistical Yearbook 2017

Figure 1.1.5　Share of Transport Modes

(1)　Road

The Myanmar road network is connected to ASEAN countries and South Asian countries by Asian Highway, GMS Corridors, Tripartite Highway as shown in Figure 1.1.6. Figure 1.1.7 shows the road network in Myanmar.

Source: Myanmar Transport Sector Policy Note (ADB 2016)

Figure 1.1.7　International Road Corridors

Source: Myanmar Transport Sector Policy Note (ADB 2016)

Figure 1.1.6　Road Network

The road network in Myanmar consists of expressways, national highways, state roads, local roads, urban roads, spanning 157,000 kilometers (km) in total length. The main road stretches about 40,000 km and is managed by the Department of Highways (DOH) on behalf of the Ministry of Construction (MOC), state and local governments. Rural roads and roads along border areas make up 97,000 km of the road network and are managed by MOALI (Ministry of Agriculture, Livestock and Irrigation), MOBA (Ministry of Border Affairs) and TDCs (Township Development Committees). Of the remainder, roads with a total length of 9,000 km are managed by CDC (City Development Committees) of Yangon, Mandalay, Nay Pyi Taw, while MEP (Ministry of Electrical Power) and the Army Corps of Engineers oversee roads stretching 11,000 km. Table 1.1.1 shows the administrative departments of the roads and summary tables by status, respectively.

Table 1.1.1 Road Lengths by Road Type and Responsible Agency, 2013

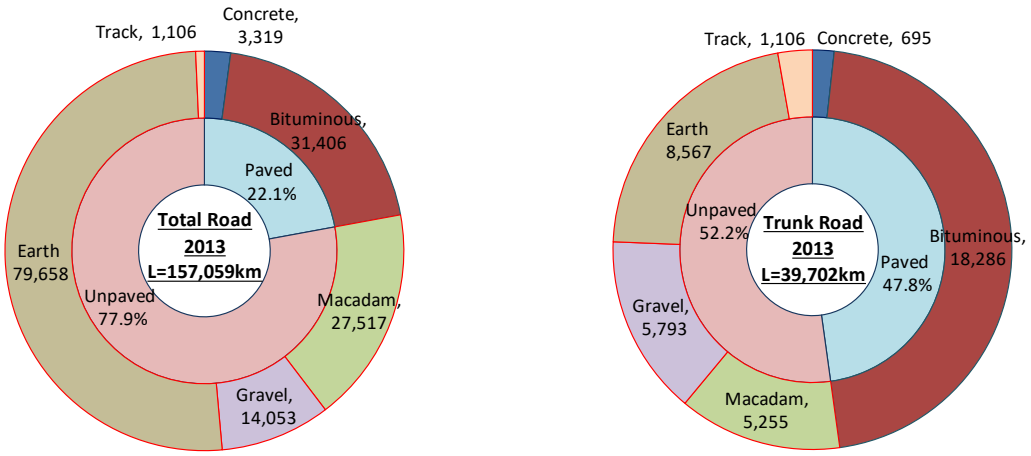
Responsible Agency	Concrete	Bituminous	Macadam	Gravel	Earth	Track	Total
DOH for MOC + state/regions	695	18,286	5,255	5,793	8,567	1,106	**39,702**
MOALI + MOBA + TDCs	193	9,294	20,807	5,638	60,848	0	**96,780**
Yangon CDC	1,108	1,766	0	551	1,032	0	**4,457**
Mandalay CDC	55	1,034	172	0	491	0	**1,752**
Naypyitaw CDC	795	276	67	1,652	476	0	**3,266**
Army Corps of Engineers	393	685	1,035	171	8,142	0	**10,426**
MEP	79	64	181	250	103	0	**676**
Total	**3,319**	**31,406**	**27,517**	**14,053**	**79,658**	**1,106**	**157,059**

CDC = City Development Committee; DOH = Department of Highways; km = kilometer; MEP = Ministry of Electrical Power; MOALI = Ministry of Agriculture, Livestock and Irrigation; MOBA = Ministry of Border Affairs; MOC = Ministry of Construction; TDC = Township Development Committee.

Source: ADB estimates based on Ministry of Construction data.

Source: Myanmar Transport Sector Policy Note (ADB 2016)

Approximately 35,000 km of the total road length, or 22.1 % of the total, is paved. In addition, 47.8 % of the trunk road, or 19,000 km, is also paved. Figure 1.1.8 shows the percentage of roads paved by type of road.



Source: Myanmar Transport Sector Policy Note (ADB 2016)

Figure 1.1.8 Percentage of Roads Paved by Road Type

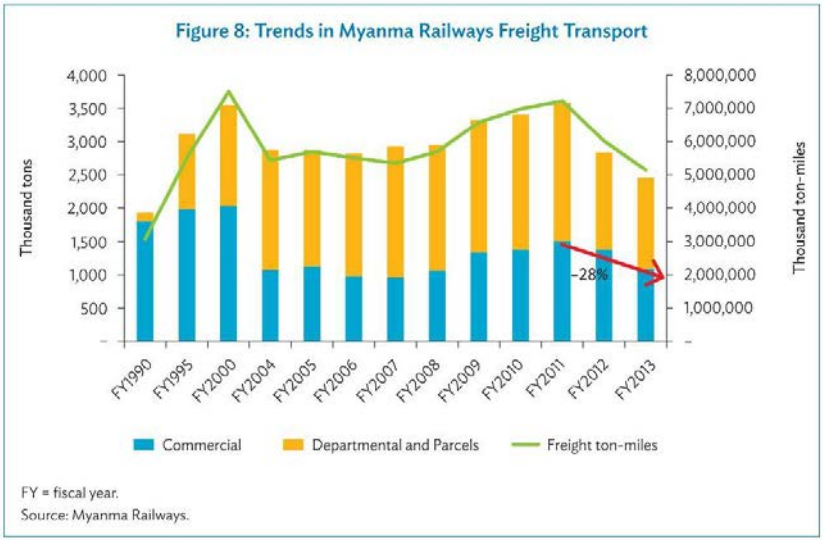
(2) Railways

The Myanmar Railway (MR) had a total length of 6,106 km as of 2014, and the 705 km section between Yangon-Mandalay is double-tracked. Approximately 50% of the route was laid from 1988 to 2010 while 186 km has been newly established since 2011. The Myanmar railway network is shown in Figure 1.1.9.

Approximately 2.5 million tons of cargo was handled by MR in 2013, of which about 60% are due to government accounts; the handling volume of commercial cargo is less than 1 million tons per year. Commercial freight traffic volume has decreased by 28% since FY2011. The transition of commercial cargo transportation of MR is shown in Figure 1.1.10.

Source: Myanmar Transport Sector Policy Note (ADB 2016)

Figure 1.1.9 Railway Network



Source: Myanmar Transport Sector Policy Note (ADB 2016)

Figure 1.1.10 Trends in Myanma Railways Freight Transport

Currently, MR is working on establishing a container train service between Yangon and Mandalay, and seeking the possibility of "Establishing an inland port near the center of both cities" and "Management of container train service".

(3) Waterways

As shown in Table 1.1.2 and Figure 1.1.11, the inland water transport network in Myanmar has a total length of 6,650 km including a navigable canal in Ayeyarwaddy River, Chindwin River, Thanlwin River, Ayeyarwaddy Delta and Rakhine State.

Along the Ayeyarwaddy River, Chindwin River, Ayeyarwaddy Delta, there are more than 50 designated ports; this area represents the center of domestic logistics.

Table 1.1.2 Extent of Navigable River

Navigable Waterways	Length (km)
Ayeyarwaddy River	1,534
Chindwin River	730
Thanlwin River and rivers in Mon State	380
Rivers in Ayeyarwaddy Delta	2,404
Rivers in Rakhine State	1,602
Total	**6,650**

km = kilometer.
Source: Directorate of Water Resources and Improvement of River Systems.

Source: Myanmar Transport Sector Policy Note (ADB 2016)

Source : Myanmar Transport Sector Policy Note (ADB 2016)

Figure 1.1.11 Navigable Waterway Network

One of the problems of inland water transport is that the depth of water becomes shallow in the dry season; the minimum depth is about 1.2 m in the vicinity of Mandalay in the Ayeyarwaddy River, about 0.8 m in the uppermost stream and about 0.8 m in the Chindwin River. Table 1.1.3 shows draft restrictions of the Ayeyarwaddy River and Chindwin River.

Table 1.1.3 Draft Restrictions by River Stretch

River Sections	Depth (m)	Distance (km)
Ayeyarwaddy		
Myitkyina–Sinbo	0.8	90
Bhamo–Katha	1.1	130
Katha–Mandalay	1.2	290
Mandalay–Pyay	1.5	522
Pyay–Hinthada	1.7	172
Delta	1.9	n/a
Chindwin		
Hkamti–Homalin	0.8	62
Homalin–Kalewa	0.9	64
Kalewa–Monywa	1.0	234
Monywa–Confluence	0.9	85

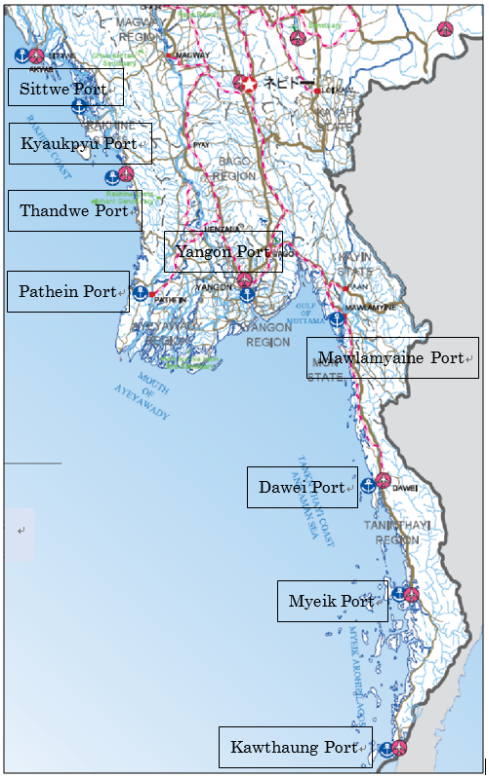
km = kilometer, m = meter, n/a = not applicable.
Source: Directorate of Water Resources and Improvement of River Systems.

Source: Myanmar Transport Sector Policy Note (ADB 2016)

1.2 Current Situation of Ports in Myanmar

1.2.1 Current Situation and Trend of Port Developments in Myanmar

There are 9 major ports in Myanmar: Sittwe, Kyaukpyu, Thandwe, Pathein, Yangon, Mawlamyaine, Dawei, Myeik and Kawthaung. Sittwe Port is located along the border with Bangladesh while Kawtaung Port is located along the border with Thailand. The location of the 9 major ports is shown in Figure 1.2.1.



Source: Study Team

Figure 1.2.1 Location of Myanmar's 9 Major Ports

(1) Sittwe Port

Sittwe Port is located adjacent to borders with Bangladesh and India and is about 1,000 km from Yangon by road.

There are 2 large jetties at Sittwe Port: the Phaung Taw Gyi Jetty near the city area and the Mingan Jetty located at the estuary of the Mingan creek. However, the jetty currently being constructed with Indian funds as part of the Kaladan river project will become the largest jetty in Sittwe Port once completed.

Facilities at each jetty in Sittwe Port are outlined in Table 1.2.1.

Table 1.2.1 Sittwe Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Phaung Taw Gyi Jetty (concrete jetty)	73	14.6	5.0	General cargo
2	MPA No.2 Jetty (wooden jetty)	25	3.7	1.5	General cargo, Passenger
3	Mingan Jetty (concrete jetty)	80	11	5.0	General cargo
4	Indain aided Jetty (concrete jetty)	270	15.2	8.0	General cargo

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

Since Sittwe Port is located near the borders of Bangladesh and India, this port is utilized as a part of a waterborne detour route of road transport at the eastern part of those countries where road development is weak. This port plays an important role as a distribution base to villages facing the coastal areas of Myanmar and the Kaladan River where roads are not well developed due to the existence of many tributaries. Therefore, Sittwe Port will be developed as a transit port of general cargo and container cargo in future.

(2) Kyaukpyu Port

Kyaukpyu Port is a domestic port which mainly functions as a fishery port; it is located about 640 km by road from Yangon. The port has the following jetties which are mainly used for general cargo handling; one pontoon jetty (-5m) owned by MPA, one pontoon jetty (-3m) owned by the city and one reinforced concrete jetty owned by the state. In addition, a privately-owned reinforced concrete jetty (-7 m) used for off shore natural gas exploitation, a reinforced concrete jetty adjacent to the former for public use and other jetties for fishing boats are also found. Cement from Thailand which arrives via Kawthaung Port is the major cargo handled here while daily necessities for the people of Kyaukpyu are also handled here to some extent.

There are several islands at the inner part of the bay of Kyaukpyu where deep-sea is available. At Made Island, oil handling facilities which can accommodate 300,000 DWT tankers and a tank yard have been developed by a Chinese company by making use of its deep-sea area.

Facilities at each jetty in Kyaukpyu Port are outlined in Table 1.2.2.

Table 1.2.2 Kyaukpyu Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Daewoo (Concrete jetty)	77	20	10	Oil, General cargo
2	MPA Jetty (Concrete jetty)	17	7.8	10	General cargo
3	Nga La Pwaye Jetty (Pontoon)	30	4	4.3	General cargo, Cement, Fishery, Dairy use
4	Nga La Pwet Jetty (Pontoon)	30	4	4.3	general cargo, Cement, Fishery,

					Dairy use
5	MPA Jetty	30	5	10	Fishery, Dairy use

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

This port will be developed as an integral part of the coastal shipping network in order to transport necessities and other cargo to surrounding areas. There is no rationale for developing the port as a deep sea port which handles cargo for the hinterland such as Nay Pyi Taw due to the long distance (about 500km) from the port. However, there is potential to develop a deep sea port for petrochemical or gas related industrial development by utilizing the available water depth which exceeds 20m.

(3) Thandwe Port

Thandwe Port is located about 500 km away from Yangon by road. A pontoon jetty (water depth of 6 m) owned by MPA is located at Thanbyugyaing about 30 km south from the downtown area of Thandwe in the bay of Andrew. Tankers carry fuel oil to this jetty from Yangon once a month. Then fuel oil is stored at tanks on land and supplied to fishing boats working in the nearby sea. Fuel oil is also transported to the downtown area by oil tank lorries. Fishes taken and packed with ice on fishing boats are unloaded at this pontoon jetty and transported to the downtown by trucks three times a month. In addition, at a privately-own reinforced concrete piled pier about 100 m away from the pontoon jetty (water depth of 3.5 m), fuel oil and water are supplied to fishing boats. However, general cargo is not handled through those port facilities.

A small scale reinforced concrete jetty (water depth of 2 m) is located at Gyeiktaw about 16 km north of the downtown area and the north part of the bay. Fishing boats and passenger boats are using this jetty. But no general cargo ship handles cargo at this jetty.

Facilities at each jetty in Thandwe Port are outlined in Table 1.2.3..

Table 1.2.3 Thandwe Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Tha Pyu Chaing Jetty (Pontoon)	120	20	6.0	Fishery, Oil
2	Tha Pyu Chaing Jetty (Pontoon)	120	20	3.5	Oil
3	Lone Thar Jetty (Rock)	80	3	2.0	Passenger, Fishery

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

Currently, there is no port facility for handling general cargo including the daily necessities required by the population (about 140 thousand) of Thandwe. Consequently, the general cargo transport depends on truck transportation. In order to enhance transportation efficiency, it is recommended to develop this port as a domestic port which handles general cargo.

(4) Pathein Port

Pathein Port, which is a river port facing the Pathein River (one of the tributaries of the Ayeyarwady River)

approximately 190 km west of Yangon, is a strategic point in the inland water transport network (see Table 1.2.4). Daily inland water transport service is provided over the navigation distance of 172 miles between Yangon and Pathein.

Small-scale port facilities such as pontoons (MPA owns nine pontoons which range in depth from 18 ft to 45 ft) and a reinforced concrete jetty with a depth of 6 m for coastal shipping vessels are scattered along a 3 km stretch on the left river bank of the Pathein River The cargo handling area in the port is very narrow because a city road is situated close behind the jetties. Maintenance work for port facilities such as pontoons is conducted only once every four years due to budgetary constraints and consequently aging of facilities is significant. The reinforced concrete jetty used for handling cement transported from Thailand via Kawthaung Port should be extended since ships are forced to wait for berthing during the dry season.

Facilities at each jetty in Pathein Port are outlined in Table 1.2.4.

Table 1.2.4 Pathein Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	No.1 Jetty (Pontoon)	36.5	6.5	7.4	Passenger
2	No.2 Jetty (Pontoon)	20.0	8.5	6.6	Passenger
3	U LU Jetty (Pontoon)	19.0	5.0	2.9	Fishery, Passenger
4	Mitta Oo Jetty (Pontoon)	37.0	7.0	14.4	Market
5	Port Jetty (Pontoon)	40.0	7.0	13.6	Passenger
6	Zay Chaung Jetty (Pontoon)	37.0	6.0	8.7	Passenger
7	Myay Nu Jetty (Pontoon)	37.0	6.0	5.6	Under repair
8	Ohmar Danti Jetty (Pontoon)	37.0	7.0	7.2	Passenger
9	Polan 1 Jetty (Pontoon)	4.8	19.0	10.3	Passenger
10	Wae Daung Jetty (Concrete jetty)	110.0	11.5	8.7	General cargo

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

Due to the rapid development of the road transport network from Yangon, a significant increase in waterborne transport between the hinterland and the port is not expected. In order to cope with the demand for long haul transport of large cargo volumes, the maintenance and improvement of the port function for the coastal and inland water shipping is required.

(5) Yangon Port

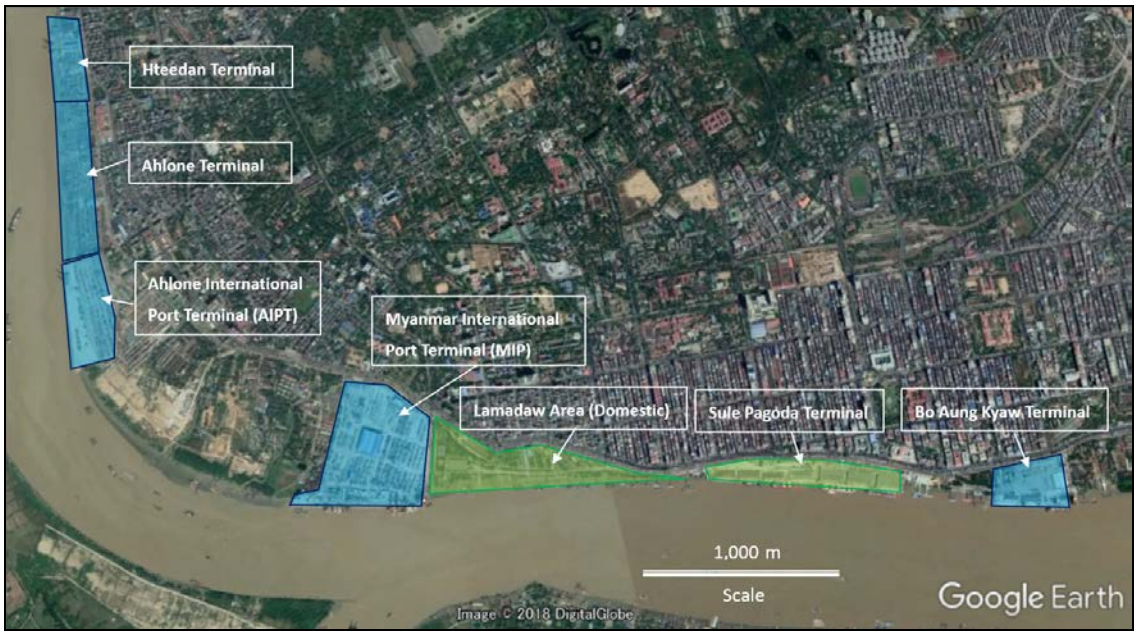
The major port facilities of Yangon Port are separately located in Yangon Main Port and Thilawa Area Port. Yangon Main Port is located about 32 km from the mouth of the Yangon River and extends about 9 km on the left bank of the river. Thilawa Area Port is located about 16 km downstream and extends on the left bank of Yangon River. The size of ships entering Yangon Port is limited. Ships entering Yangon Main Port must have an overall length of less than 167 m and a draft of 9 m and ships entering Thilawa Area Port must have an overall length of less than 200m and a draft of 9 m respectively.

The port land area is very narrow at Yangon Main Port because the city area is close to the port area. Road

traffic generated from five container terminals (Asia Terminal, Hteedan Terminal, Ahlone International Port Terminal, MIP Terminal and Bo Aung Kyaw Terminal) and inland container depots which are spread over the narrow port area results in heavy congestion.

Container terminals, grain terminals and petroleum terminals coexist in Thilawa Area Port on 37 Plots (one plot is 200 m in length and 750 m in depth).

The location of major terminals in Yangon Main Port and Thilawa Area Port is shown in Figure 1.2.2 and Figure 1.2.3. The dimensions of the terminals are given in Table 1.2.5.



Source: Study Team (Google Earth)

Figure 1.2.2 Major Terminals in Yangon Main Port

Source: Study Team (Google Earth)

Figure 1.2.3 Container Terminals in Thilawa Area Port

Table 1.2.5 Dimension of Major Terminals in Yangon Main Port and Thilawa Area Port

No.	Name of terminal	Area (ha)	Storage Capacity (Slots)	Length of Berth (m)	Depth of Berth (m)	Number of Berths
1	Hteedan Terminal	9.3	1,781	360	9.0	2
2	Ahlone Terminal	9.5	2,629	614	9.5	3
3	Ahlone International Port Terminal (AIPT)	19.0	1,674	600	9.0	3
4	Myanmar Industrial Port Terminal (MIP)	43.0	5,000	750	10.0	3
5	Bo Aung Kyaw Terminal	9.6	1,000	457	9.0	2
6	Sule Pagoda Terminal	General Cargo	0	1,026	9.0	5
7	Myanmar International Terminals Thilawa (MITT)	75.0	1,000	1,000	10.0	5
8	MPA ODA Terminal (Phase I, Plot 25)	15.0	1,800	200	10.0	1
	Total			5,007		24

Source: Study Team

Small jetties (mainly pontoon) for inland water transport and coastal shipping shown in Table 1.2.6 are scattered in Yangon Main Port.

Table 1.2.6 Small Jetties in Yangon Main Port

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Chaungwa Jetty	200	40	8.0	Coastal
2	Kyeemyindine No. 3 Jetty	120	20	6.0	Delta
3	Kyeemyindine No. 5 Jetty	80	20	6.0	Delta
4	Kyeemyindine Bazar Jetty	120	20	6.0	Delta
5	Bagaya No. 1 Jetty	120	20	6.0	Coastal
6	Bagaya No. 2 Jetty	120	20	6.0	Coastal
7	Bagaya No.3 Jetty	120	20	6.0	Coastal
8	Concrete short Jetty	177	23	8.0	Public/Delta
9	Wardan No. 4 Jetty	240	40	8.0	Coastal/Delta
10	Wardan Ro/Ro Jetty	275	18	NA	Public
11	Wardan No. 6 Jetty	120	20	6.0	Coastal
12	Between Wardan No. 6 & Kaingdan No. 1 Concrete short Jetty	105	62	NA	Public
13	Kaingdan No. 1 Jetty	120	20	6.0	Coastal/Passenger
14	Between Kaingdan No. 1 & No. 2 short Jetty	90	11	6.0	Public
15	Kaingdan No. 2 Jetty	120	20	6.0	Delta
16	Between Kaingdan No. 2 & Lan Thit	101	11	6.0	Public

	Street Pier				
17	Lan Thit Street Jetty	120	20	6.0	IWT/Delta/Passenger
18	Hledan No. 1 Jetty	120	20	6.0	IWT/Delta/Passenger
19	Between Hledan No. 1 & No. 2 short Jetty	83	12	6.0	Public
20	Hledan No. 2 Jetty	120	20	6.0	Public/Delta
21	Between Hledan No. 2 & Phoegyilan Street No. 1 short Jetty	115	41	6.0	Public
22	Phoegyilan Street No. 1 Jetty	120	20	6.0	Delta
23	Between Phoegyilan Street No. 1 & No. 2 short Jetty	88	31	6.0	Public
24	Phonegyi Street No. 2 Jetty	120	20	6.0	IWT/Delta
25	Shwee Taung Dan No. 1 Jetty	120	20	6.0	IWT/Delta
26	Shwee Taung Dan No. 2Jetty	120	20	6.0	IWT/Delta/Passenger
27	Lanmadaw No. 1 Jetty	120	20	6.0	Delta
28	Lanmadaw No. 2 Jetty	120	20	6.0	Delta
29	Sin Oh Dan No. 1 Jetty	120	20	6.0	Delta
30	Sin Oh Dan No. 2 Jetty	154	40	8.0	Delta
31	New Port Health Jetty	294	40	NA	Coastal
32	Pansodan Jetty	120	20	6.0	IWT/Passenger
33	Nam Thi Da Jetty	480	40	NA	MPA/Official
34	Ship yard Jetty	120	20	6.0	MPA
35	Botatoung No. 3 Jetty (upper)	200	40	8.0	MPA/Public
36	Botatoung No. 3 Jetty (lower)				
37	Botatoung No. 4 Jetty (upper)	200	40	8.0	Public
38	Botatoung No. 4 Jetty (lower)				
39	Botatoung No. 5 Jetty (upper)	200	40	8.0	IWT/Public
40	Botatoung No. 5 Jetty (lower)				
41	Botatoung No. 6 Jetty (upper)	240	40	8.0	Floating Hotel
42	Botatoung No. 6 Jetty (lower)				

Source: Study Team

It is necessary to redevelop Lamadaw and Kyeemyigang area at the present location to provide space for urban development with waterfront amenity while maintaining port functions.

When cargo handling demand increases beyond current estimates, it will be necessary to find a suitable water and land area for port facility expansion other area than the left bank of the Yangon river; the right bank of the river is a possible candidate site.

(6) Mawlamyaine Port

Mawlamyaine Port is located about 300 km from Yangon and is the origin-destination point on the west side for East-West Corridor which crosses the Malay Peninsula. Mawlamyaine Port has geographical

advantages, the old days, shipping of overseas shipping route also put in the harbor where activity was given as the third city of Myanmar.

Mawlamyaine Port is a river port located at the confluence of the Thanlwin River and the Jyain River. The water depth is only 4.5 m. Even when utilizing the spring tide (4.2 m) or the neap tide (2.4 m), the maximum draft of ships which can enter the port is only 4.5 m.

There are eight pontoon type jetties and two reinforced concrete piers at the port. Because the port is adjacent to the downtown area, roads are located just behind the port area and consequently the space for cargo handling is very narrow. Cargo is manually handled without using any handling equipment.

Facilities at each jetty in Mawlamyaine Port are outlined in Table 1.2.7.

Table 1.2.7 Mawlamyaine Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Zaygyi Jetty (Pontoon)	36.5	6.0	3.1	Passenger, General cargo
2	Myeik Jetty (Pontoon)	36.5	6.0	3.1	Passenger, General cargo
3	Shwe Myine Jetty (Pontoon))	36.5	6.0	6.1	Passenger, General cargo
4	Myo Ma Jetty (Pontoon)	36.5	6.0	3.1	－
5	Seik Kan Thar Jetty (Pontoon)	36.5	6.0	6.1	Passenger, General cargo
6	Dawei Jetty (Pontoon)	73.0	12.0	7.0	Passenger, General cargo
7	Yamanya Jetty (Pontoon)	36.5	6.0	5.8	
8	Than Lwin Jetty (Concrete jetty)	36.5	6.0	5.8	Fishery
9	Kyauk-me-thwe(Coal) Berth (concrete jetty)	38	5.5	－	Coal

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

The increasing demand will be handled at new jetties to be constructed on the island of Bilu located opposite of Mawlamyaine; a connecting bridge is being constructed. Other daily use general cargo shall be handled at the existing jetties (after some improvement works) which are located near the cargo demand area of the city. It is necessary to maintain the channel depth in the Thanlwin River.

The construction of a new deepwater port at Kyaikami near Mawlamyaine is recommened to handle export cargo when the government begins promoting exports such as grain from Mawlamyaine area in future.

(7) Dawei Port

Dawei Port is situated about 270 km south of Mawlamyaine and is expected as a terminal on the western edge of the South Coastal Corridor. However, the road between the Thailand border and Dawei (about 150km) has not been paved.

At the existing river port in Dawei City, jetties of concrete types, steel types and pontoon types are owned by MPA/private firms; water depth ranges from 3.0 to 4.0 m. There is a pontoon type jetty in Sym Phu

Binh about 27 km southward with a water depth of 3.5 to 6.0 m. A high-speed craft is operational between Sym Phu Binh and Kawthaung via Myaik. Cargo is transported along the following route: Yangon–Dawei– Kawthung- Yangon and Dawei- Myeik/Kawthung- Ranong (Thailand). Although there is no official restriction regarding night time calls or departures, cargo ships choose day time operation using a pilot because it is dangerous to navigate the river at night.

Facilities at each jetty in Dawei Port are outlined in Table 1.2.8.

Table 1.2.8 Dawei Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Seik Kan Thar Jetty	33.3	6.1	3.3	Passenger, General cargo
2	Kyet Sar Pyin Jettty 1	33.3	6.1	4.0	General cargo
3	Kyet Sar Pyin Jettty 2	33.3	6.1	4.0	General cargo
4	Sin Phyu Pyin Jetty (Pontoon)	66.7	6.1	3.2	Passenger
5	Mawlamyine Jetty	9.2	3.1	3.0	Passenger, General cargo

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

This port will continue to handle the daily necessities, construction materials and fuel oil transport for the Dawei area population. It is necessary to maintain the channel depth.

(8) Myeik Port

Myeik Port is located about 750 km away from Yangon by road. Since this area is surrounded by many islands, the water area near Myeik Port is calm even during the monsoon season. There are four MPA jetties as well as many jetties owned by private companies and a national petroleum company found at the port. In addition to commuting passengers, the jetties are used for the handling of fish, fish paste, frozen fish, rubber, lumber, cement, oil and the supply of ice to fishing boats. Although the water depth at the MPA jetties is 4 m (it is 6 m at privately-owned jetties), calling ships have to wait for high tide (tidal range is about 5 m) due to the shallowness of the channel entrance (2 m). Despite its multipurpose usage, Myeik Port actually seems to be a fishing port judging from the many fishing boats (approx. 700) which generally station here for operations etc.

Most of the import cargo is diesel oil and edible oil from Malaysia and Thailand. Some general cargo is transported by container ships of about 1,500 GRT (LOA of 70 m and draft of 5 m) which are capable of carrying about 40 TEUs twice or three times per month. Imported container cargoes are consumed in this area though some are transferred to Yangon, Dawei and Kawthaung by coastal shipping vessels of about 500 GRT. On the other hand, most export cargoes are fish paste and frozen fish bound for Japan via Penang, Malaysia.

Facilities at each jetty in Myeik Port are outlined in Table 1.2.9.

Table 1.2.9 Myeik Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Seik Nge Jetty (Pontoon)	73	6	3～4	Passenger, Pearl
2	Nauk Le No.1 Jetty (Pontoon)	12	6	2～5	Fishery
3	Nauk Le No.2 Jetty (Pontoon)	29	11	2～5	Fishery
4	Yaw Gyi Wa Jetty (Pontoon)	73	6	6.4	Passenger, General cargo
5	Fish Market Jetty (Concrete jetty)	325	15	2	Fishery

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

Myeik Port is a domestic port which is indispensable for handling fish and fish products as well as for the commuting of peoples of surrounding islands. In addition, this port plays an important role for the international trade between Myanmar and Thailand. Since this situation is likely to continue in future and additional private jetties are expected to be constructed, it will not be necessary to develop new large scale port facilities. Therefore, the most important issue for this port is to secure deep channels so that ships can access the port anytime without waiting for high tide.

(9) Kawthaung Port

Kawthaung city is adjacent to Thailand which is located only about 4 km away over the Pachain River and it is a base of international trade with Thailand. Since there are no roads which connect to the Thai side near Kawthaung city, waterborne transport is vital for trade. Although there is a road to Dawei which is located about 630 km north of Kawthaung, bridges on this road are in poor condition. Cargo volume of daily necessities for Kawthaung city is not large as the population is only about 60,000. Approximately 80 % of the international cargo transported from Thailand is cement while the remainder consists of general cargo and fuel oil.

There are 3 jetties managed by MPA and other many private own jetties.

Facilities at each jetty in Kawthaung Port are shown in Table 1.2.10.

Table 1.2.10 Kawthaung Port Facilities

No.	Name of Jetty (Structure Type)	Dimensions (m)			Major Commodity
		Length	Width	Depth	
1	Taw Win Jetty (Concrete jetty)	110	9.2	5	General cargo
2	Bayint Naung Jetty (Pontoon)	37	10	5	Passenger
3	Myo Ma Jetty (Pontoon)	37	10	5	Passenger
4	Golden Bear Company Jetty	85	30	3	Petroleum, Fishery
5	Private Jetty (Wooden jetty)	30	5.0	2.5	General cargo, Daily necessities

Source : Report of The Project for the National Logistics Master Plant Study, Myanmar (JICA, 2016)

It is necessary to maintain and enhance the functions of Kawthaung Port as a transit port for international

trade between Myanmar and Thailand.

1.2.2 Cargo Demand

The international cargo volume and domestic cargo volume of each port are given in Table 1.2.11. The container handling volume of Yangon Port, the only container handling port in Myanmar, is given in Table 1.2.12.

Table 1.2.11 International and Domestic Cargo Volume at each Port

unit; thousand tons

Port		2012			2013			2014			2015			2016			2017		
		Im.	Ex.	Total	Im.	Ex.	Total	Im.	Ex.	Total	Im.	Ex.	Total	Im.	Ex.	Total	Im.	Ex.	Total
Yangon	Inter.	16,709	6,148	22,857	16,503	6,496	22,999	19,312	5,833	25,145	24,454	5,638	30,092	23,525	7,346	30,871	20,319	8,018	28,337
	Coast.	831	479	1,310	420	630	1,050	314	618	932	395	570	965	316	738	1,054	236	812	1,048
	Total	17,540	6,627	24,167	16,923	7,126	24,049	19,626	6,451	26,077	24,849	6,208	31,057	23,841	8,084	31,925	20,555	8,830	29,385
Sittwe	Inter.	12	14	26	13	20	33	8	14	22	8	11	19	5	10	15	2	26	28
	Coast.	152	28	180	214	52	266	278	40	318	298	19	317	302	18	320	347	37	384
	Total	164	42	206	227	72	299	286	54	340	306	30	336	307	28	335	349	63	412
Kyaukpyu	Inter.	152	5	157	3	14	17	144	0	144	3	0	3	0	0	0	7,867	0	7,867
	Coast.	246	23	269	114	36	150	100	40	140	112	28	140	65	19	84	82	16	98
	Total	398	28	426	117	50	167	244	40	284	115	28	143	65	19	84	7,949	16	7,965
Thandwe	Inter.	0	3	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Coast.	9	13	22	12	12	24	11	9	20	12	9	21	9	8	17	11	8	19
	Total	9	16	25	12	13	25	11	9	20	12	9	21	9	8	17	11	8	19
Pathein	Inter.	0	2	2	0	42	42	0	6	6	0	0	0	0	55	55	0	0	0
	Coast.	16	24	40	78	71	149	89	67	156	138	67	205	142	57	199	119	66	185
	Total	16	26	42	78	113	191	89	73	162	138	67	205	142	112	254	119	66	185
Mawlamyaine	Inter.	5	0	5	4	112	116	4	1,676	1,680	11	715	726	0	76	76	1	0	1
	Coast.	22	209	231	23	127	150	77	380	457	166	442	608	244	962	1,206	310	1,703	2,013
	Total	27	209	236	27	239	266	81	2,056	2,137	177	1,157	1,334	244	1,038	1,282	311	1,703	2,014
Dawei	Inter.	286	403	689	105	891	996	37	760	797	74	152	226	6	448	454	88	217	305
	Coast.	76	264	340	106	213	319	128	140	268	140	91	231	165	98	263	170	73	243
	Total	362	667	1,029	211	1,104	1,315	165	900	1,065	214	243	457	171	546	717	258	290	548
Myeik	Inter.	59	861	920	88	2,053	2,141	80	98	178	116	103	219	203	124	327	259	99	358
	Coast.	77	123	200	78	107	185	100	106	206	108	146	254	116	169	285	116	208	324
	Total	136	984	1,120	166	2,160	2,326	180	204	384	224	249	473	319	293	612	375	307	682
Kawthaung	Inter.	137	304	441	307	0	307	443	300	743	547	0	547	532	0	532	478	2	480
	Coast.	41	183	224	50	331	381	59	467	526	46	590	636	40	571	611	41	525	566
	Total	178	487	665	357	331	688	502	767	1,269	593	590	1,183	572	571	1,143	519	527	1,046
All Ports	Inter.	17,360	7,740	25,100	17,023	9,629	26,652	20,028	8,687	28,715	25,213	6,619	31,832	24,271	8,059	32,330	29,014	8,362	37,376
	Coast.	1,470	1,346	2,816	1,095	1,579	2,674	1,156	1,867	3,023	1,415	1,962	3,377	1,399	2,640	4,039	1,432	3,448	4,880
	Total	18,830	9,086	27,916	18,118	11,208	29,326	21,184	10,554	31,738	26,628	8,581	35,209	25,670	10,699	36,369	30,446	11,810	42,256

* Legend; Inter. : International, Coast. : Coastal, Im. : Import, Ex. : Export

Source: MPA

Table 1.2.12 Container Handling Volume in Yangon Port including Thilawa Area Port

unit:TEU

Name of Terminal		2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
Asia World Port Terminal (AWPT)	Import	144,520	107,308	110,562	93,144	98,166	110,214
	Export	134,421	101,619	102,940	84,846	84,007	106,240
	Total	278,941	208,927	213,502	177,990	182,173	216,454
Hteedan Terminal (HPT)	Import	0	51,069	88,650	127,576	117,218	108,961
	Export	0	49,471	80,501	127,750	104,712	105,850
	Total	0	100,540	169,151	255,326	221,930	214,811
Ahlone International Port Terminal (AIPT)	Import	—	—	—	—	3,465	23,008
	Export	—	—	—	—	2,437	29,781
	Total	—	—	—	—	5,902	52,789
Myanmar Industrial Port Terminal (MIP)	Import	46,731	70,500	97,027	131,654	205,550	176,456
	Export	49,373	75,037	98,613	132,977	199,450	193,538
	Total	96,104	145,537	195,640	264,631	405,000	369,994
Bo Aung Kyaw Terminal (BSW)	Import	14,854	2,850	8,958	14,893	7,684	15,220
	Export	15,669	3,244	11,497	13,589	8,395	17,769
	Total	30,523	6,094	20,455	28,482	16,079	32,989
Myanmar International Terminals Thilawa (MITT)	Import	1,435	7,110	5,625	9,815	22,048	84,907
	Export	1,040	9,755	7,796	8,649	28,980	84,907
	Total	2,475	16,865	13,421	18,464	51,028	169,814
Total	Import	207,540	238,837	310,822	377,082	454,131	518,766
	Export	200,503	239,126	301,347	367,811	427,981	538,085
	Total	408,043	477,963	612,169	744,893	882,112	1,056,851

Source: MPA

1.2.3 Role of Yangon Port

The port facilities of Yangon Port are located at the Yangon area and Thilawa area which is 16 km downstream of the Yangon river from the Yangon area.

The hinterland population of Yangon Port is 12.198 million including Yangon's population (7.355 million) and Bago state's population and thus it constitutes a large market. In 2017, about 96% of the total international cargo handled in Myanmar (29.48 million tons excluding petroleum handled at Kyaukpyu Port) was handled at Yangon Port which is the only international trading port in Myanmar. Although the development of rural areas will likely be a priority of the new government, the role of Yangon area in the national logistics network will remain large.

The access channel of Yangon Port is very shallow (draft limitation is 9 m) and narrow compared to most international ports. If a maritime accident were to occur in Yangon Port, the port would be forced to close for a long time which in turn would have an extremely adverse impact on the national economy. In order to prevent such a situation, it is necessary for Myanmar to develop several deep-sea international ports which are capable of substituting for Yangon Port.

Myanmar is situated at a strategic location as the west gate of ASEAN and GMS. Namely, Myanmar will serve as the gateway to India, the Middle-east and Africa. Currently, international waterborne transport cargo from GMS except Myanmar to the west is transported via Singapore and the Malacca Straits. By

transporting such cargo through Myanmar, transport time and cost could be reduced. Thus, it is expected that ports in Myanmar including Yangon Port will play important role in GMS.

1.3 Current Situation of Investment in Port Development

1.3.1 Cooperation and Investment by International Organizations and the Private Sector

Operation of MPA's ports had been conducted by MPA itself prior to 1988. Since 1988, however, private companies mainly carry out port operations under a BOT contract while MPA acts as the landlord. Currently, Asia World Terminal, Hteedan Terminal, Ahlone International Port Terminal, Myanmar Industrial Port Terminal (MIP) and Bo Aung Gyaw Terminal are operated by private companies under BOT contracts in Yangon Main Port. Almost all terminals such as Myanmar International Terminals Thilawa (MITT) in Thilawa Area Port are operated by private companies under BOT contracts.

Financing of port development projects in Myanmar in the past was provided once only by the Asian Development Bank (ADB). In recent years, donor agencies such as ADB and the world Bank have not financed port development projects

1.3.2 Application of Japanese Technology and Participation in Port Development Projects by Japanese Firms

The Thilawa SEZ is under development as a SEZ connected directly with the port. In the area constructed by a Japanese contractor under JICA loan, 78 companies (39 Japanese companies: automobile related, electronic parts, sewing, shoes, logistics, etc.) have acquired land. Factories have been built by 53 companies and among them 20 companies are already in operation as of November 2016.

Regarding port construction projects, Japanese contractors have been awarded contracts for the construction of MPA's Thilawa ODA Terminal Phase I and other private grain terminals in Thilawa Area.

Concrete pile jetties have mainly been constructed in Yangon Port as a fixed type structure due to ease of procuring materials and construction. This kind of structure can be constructed in developing countries using rather low-level technology.

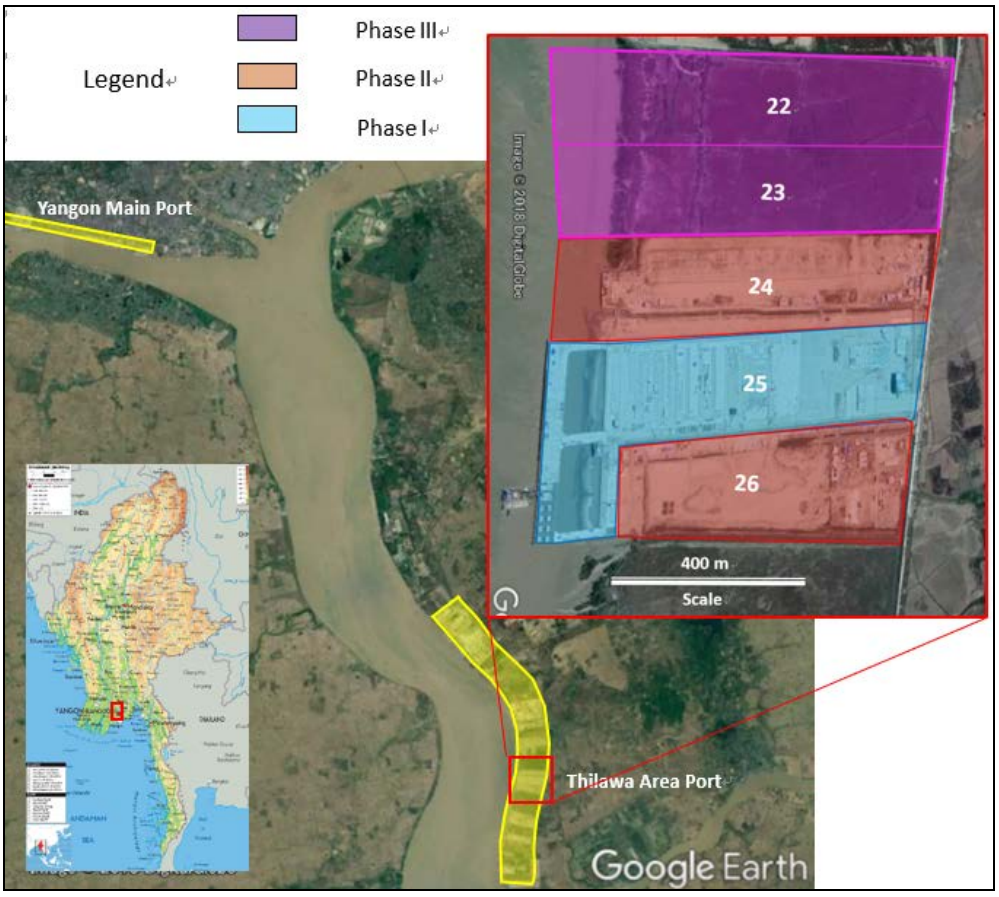
The jacket type structure, an indigenous technology to Japan, is applied for the MPA ODA Terminal Phase 1 project in Thilawa Area Port in order to shorten the construction period. As a result, a Japanese contractor was able to win the contract. The technology transfer including welding technology and precise positioning piling is conducted to Myanmar engineers in the course of the construction progress. This technology transfer is valued by MPA and the Ministry of Transport and Communications.

In order to promote participation of Japanese companies in projects in developing countries, it is not only necessary to apply technology indigenous to Japan that is indispensable to developing countries and cost-competitive but also provide opportunities for technical transfer and capacity building.

2 Formulation of Yangon Port Development Plan

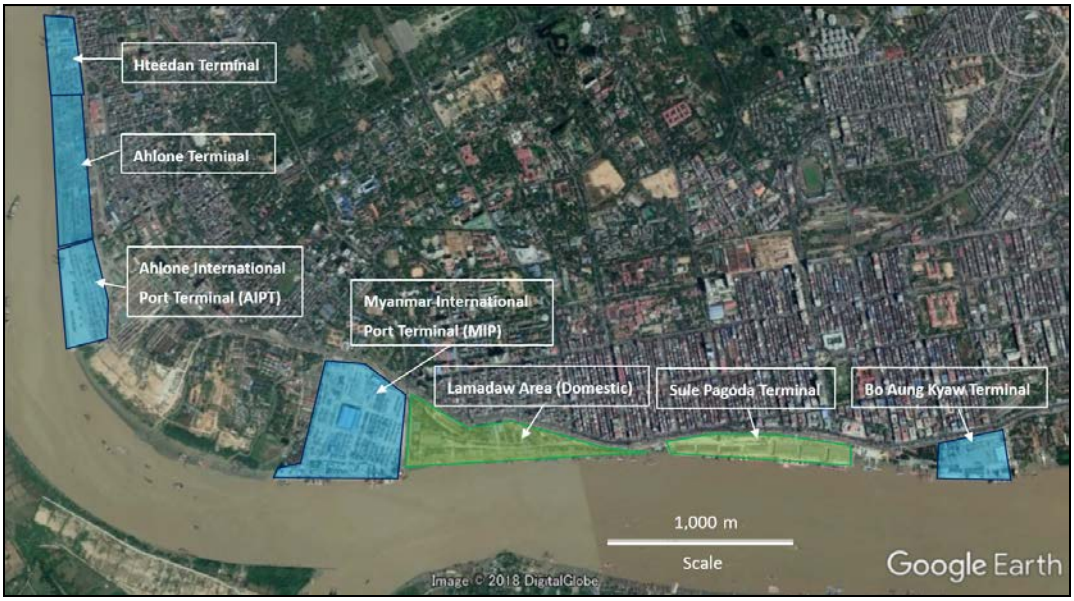
2.1 Study Area

The study area includes Yangon Main Port and Thilawa Area Port shown in Figures 2.1.1 and 2.1.3.



Source; Study Team (Google Earth)

Figure 2.1.1 Location of Yangon Main Port and Thilawa Area Port



Source; Study Team (Google Earth)

Figure 2.1.2 Major Terminals of Yangon Main Port

Source; Study Team (Google Earth)

Figure 2.1.3 Thilawa Area Port and Container terminals

2.2 Current Situation and Direction of Port Development at Yangon Port

The main port facilities of Yangon Port are divided into Yangon Inner Harbor and Thilawa Area Port. Yangon Inner Harbor is located on the left bank of the Yangon River approximately 32 km inland from the river mouth; facilities extend over an area of 9 km. Thilawa Area Port is located on the left bank approximately 16 km downstream from the Yangon Inner Harbor.

2.2.1 Yangon Inner Harbor

Yangon city area lies behind Yangon Inner Harbor and thus the configuration of the port is rather narrow; despite this, there are seven container terminals located along the left bank. The specifications of each terminal are shown in Table 2.2.1.

Table 2.2.1 Specifications of Yangon Inner Harbor's Terminals

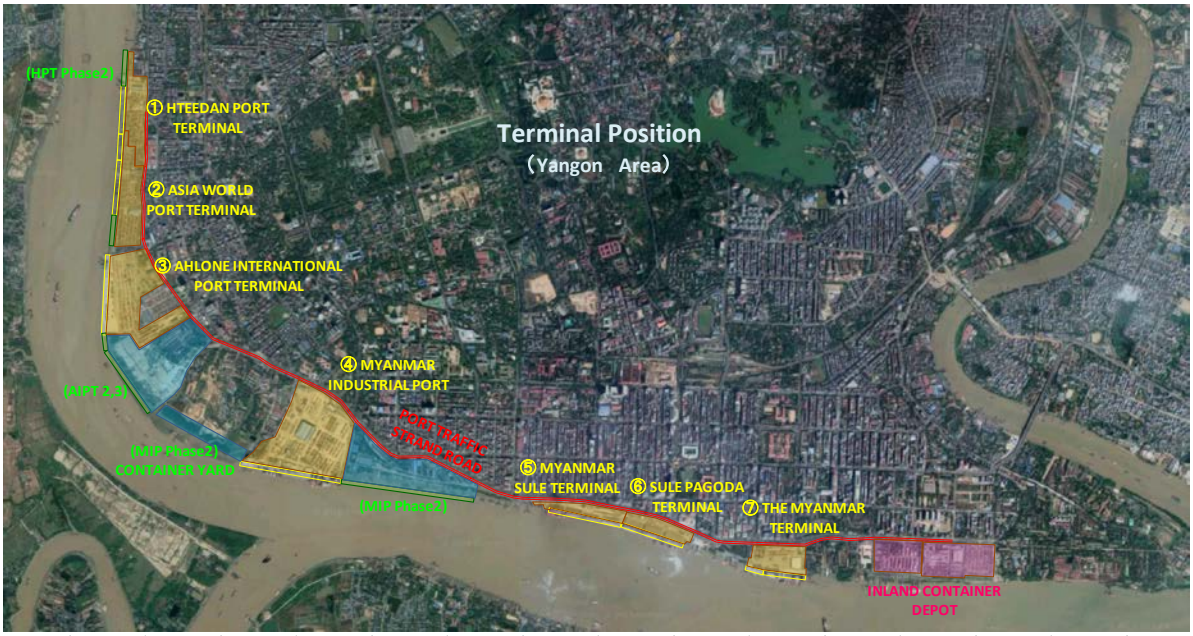
No.	Yangon Inner Harbor	Cargo Type	Length (m)	Draft (m)	Burth Numbers	Max. DWT	Current Situation
1	Hteedan Port Terminal (Phase 1)	GC, CTNR	366	9.0	1	15,000	Operation
	Hteedan Port Terminal (Phase 2)	GC, CTNR	69	9.0	1	15,000	Operation
			181	9.0			Under Planning
2	Asia World Port TML No.1 Wharf	GC, CTNR	198	9.0	1	15,000	Operation
	Asia World Port TML No.2 Wharf	GC, CTNR	156	9.0	1	15,000	Operation
	Asia World Port TML No.3 Wharf	GC, CTNR	260	9.0	1	15,000	Operation
	Asia World Port TML No.4 Wharf	GC, CTNR	238	9.0	1	15,000	Under Planning
3	Ahlone International Port TML (1)	GC, CTNR	600	9.0	3	15,000	Operation
4	Myanmar Industrial Port	CTNR	310	9.0	5	15,000	Operation
	Myanmar Industrial Port (Phase 1)	CTNR	450	9.0		15,000	Operation
	Myanmar Industrial Port (Phase 2)	CTNR	1,000	9.0	5	15,000	Under Planning
5	Myanmar Sule Terminal	GC, CTNR	545	9.0	4	15,000	Operation
6	Sule Pagoda Terminal No.5	GC, CTNR	168	9.0	1	15,000	Operation
	Sule Pagoda Terminal No.6	GC, CTNR	162	9.0	1	15,000	Operation
	Sule Pagoda Terminal No.7	GC, CTNR	148	9.0	1	15,000	Operation
7	The Myanmar Terminal	GC, CTNR	457	9.0	3	15,000	Operation

Note: GC stands for 'general cargo' and CTNR 'container'

Source: Study Team

As of September 2018, a total of 22 berths extending across a length of 3.9 km. In addition, 7 berths with a total length of 1.4 km are being planned (indicated in blue in Table 2.2.1) Accordingly, the total number of berths will eventually be 29 spanning a length of 5.3 km.

The location of each terminal is shown in Figure 2.1.1.



Source: Study Team (Google Earth)

Figure 2.2.1 Terminal Position in Yangon Area

As these facilities are connected on a port road linking Hteedan Port Terminal from the Inland Container Depot, the efficiency of container transport is relatively high. The total length of the road is approximately 9 km, while it is approximately 20 m in width. The plans of these facilities are shown in Figure 2.2.2 and Figure 2.2.3.

Source: Study Team Google Earth)

Figure 2.2.2 Myanmar Industrial Port Terminal (Phase 1)

Source: Study Team (Google Earth)

Figure 2.2.3 Myanmar Sule Terminal & Sule Pagoda Terminal

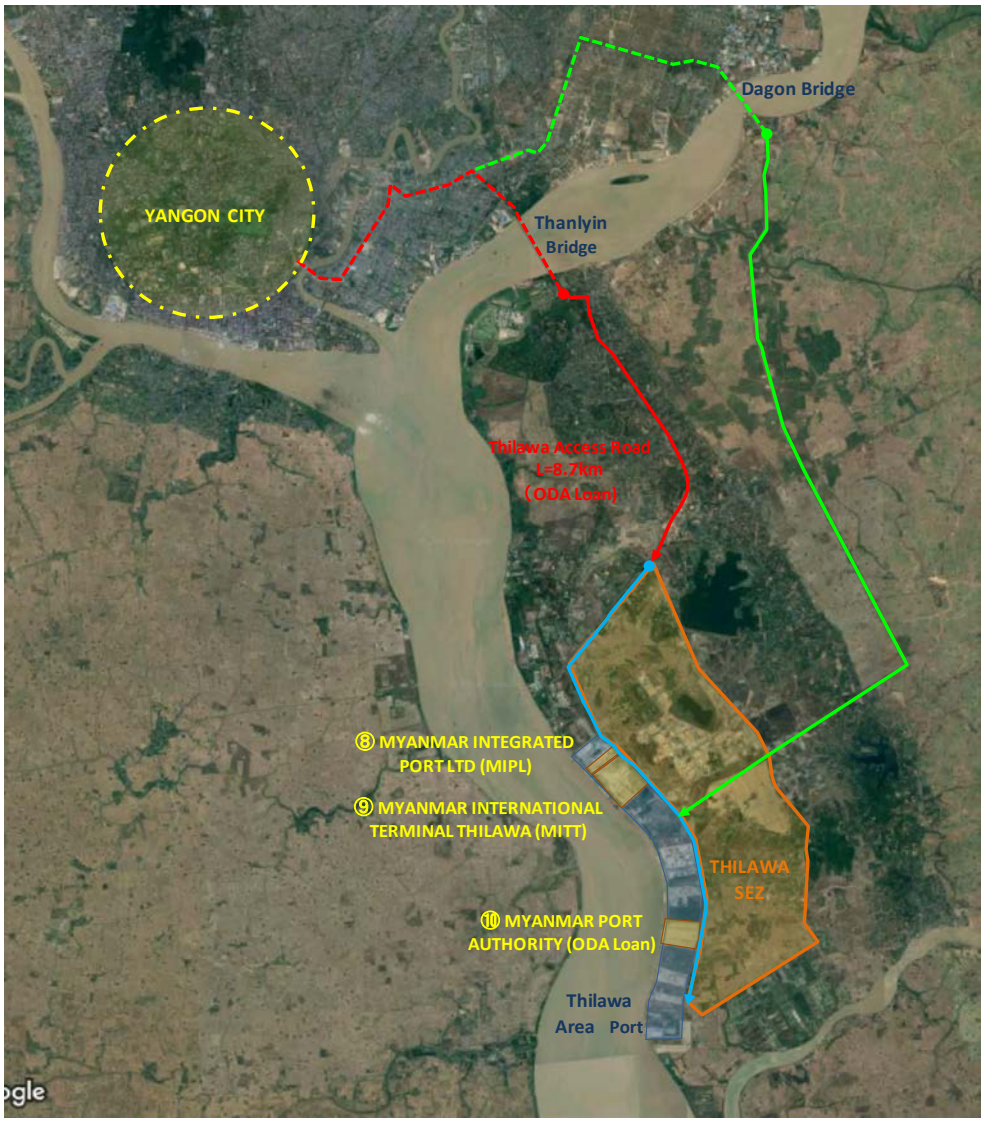
2.2.2 Thilawa Area Port

Thilawa Area is located about 16km downstream of the Yangon River from the main port area. Behind Thilawa Area Port, the development of the Thilawa Special Economic Zone (SEZ) is ongoing with some parts of the SEZ already in operation. The total area of the SEZ is 2,400 ha.

Vehicles must cross a bridge built over the Bago river from Yangon city. However, because large vehicles cannot use the Thanlyin Bridge on the down-stream side, it is necessary for large vehicles such as trailers and trucks to use the Dagon Bridge on the side of the upper reaches.

The route from Yangon city to Thilawa SEZ and the location of Thilawa Area Port are shown in Figure 2.2.4. The specifications of each terminal are shown in Table 2.2.2.

Thilawa Area Port is comprised of 37 plots (each Plot has a width of 200m and a depth of 750m) along the left bank of the Yangon River. Management of most of the plots has been transferred to private companies by concession contract. Therefore, each plot is being individually developed. Myanmar Integrated Port Ltd. (MIPL, Plot 4) and Myanmar International Terminal Thilawa (MITT, Plot 5～9) are cargo terminals under operation as of September 2018.



Source: Study Team (Google Earth)

Figure 2.2.4 Course from Yangon City to Thilawa SEZ & Thilawa Area Port

Table 2.2.2 Specifications of Thilawa Area Port's terminal

No.	Thilawa Area Port	Cargo Type	Length (m)	Draft (m)	Burth Numbers	Max. DWT	Current Situation
8	Myanmar Integrated Port Ltd. (MIPL)	GC, CTNR	200	10.0	1	20,000	Operation
9	Myanmar International Terminal Thilawa (MITT)	GC, CTNR	1,000	10.0	5	20,000	Operation
10	MPA Terminal (Plot 22,23)	GC, CTNR	400	10.0	2	20,000	Under Planning
	MPA Terminal (Plot 24) ODA Loan	GC, CTNR	200	10.0	1	20,000	Under Planning
	MPA Terminal (Plot 25,26) ODA Loan	GC, CTNR	400	10.0	2	20,000	Under Construction

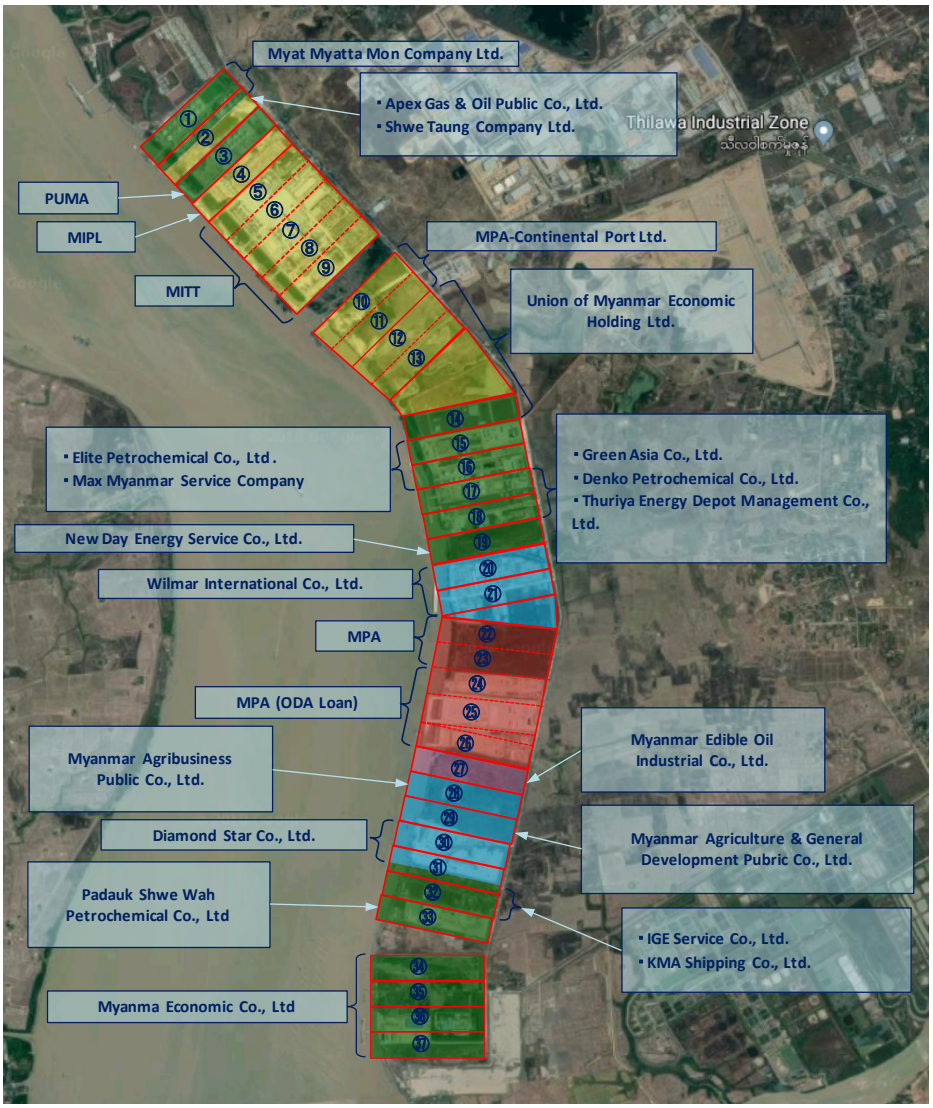
Source: Study Team

The blue shaded facilities in Table 2.2.2 are under planning stages. Figure 2.2.5 shows the brief layout plan of MPA ODA Loan Terminal (Plot25).

Source:Study Team

Figure 2.2.5 MPA ODA Loan Terminal (Plot 25)

The plan of Thilawa Area Port which is divided into 37 plots is shown in Figure 2.2.6 .



Source: Study Team (Google Earth)

Figure 2.2.6 37 Plots of Thilawa Area Port

MPA has transferred the overall management of most plots to private companies, however only some fuel terminals, a few terminals for oil products and a ship breaking yard are currently in operation . other than MIP and MITT. In addition, orderly port development has not been carried out because there is no zoning plan according to functions in this area.

The owners of each plot and operational status are shown in Table 2.2.3. Plots currently in operation are shaded in green.

Table 2.2.3 Owners of each plot and operational status in Thilawa Area Port

Plot No.	*Owner's Name*	*Situation*	*Main Cargo*
1	Myat Myatta Mon Company Ltd.	Operation	Fuel
2	・Apex Gas & Oil Public Co., Ltd ・Shwe Taung Company Ltd.	Under Construction	Fuel / General Cargo
3	PUMA Energy Group Pte., Ltd.	Operation	Bitumen and Petroleum Product
4	Myanmar Integrated Port Ltd.	Operation	Palm Oil
5～9	Myanmar International Terminal Thilawa	Operation	Container / General Cargo
10,11	MPA-Continental Port Ltd.	Under Construction	Container / General Cargo
12,13	Union of Myanmar Economic Holding Ltd.	Under Preparation	General Cargo
14	Union of Myanmar Economic Holding Ltd.	Under Preparation	Fuel
15,16	・Elite Petrochemical Co., Ltd ・Max Myanmar Service Company	Operation	Fuel
17,18	・Green Asia Co., Ltd ・Denko Petrochemi -cal Co., Ltd ・Thuriya Energy Depot Management Co., Ltd	Operation	Fuel
19	New Day Energy Service Co., Ltd	Under Preparation	Fuel
20,21	Wilmar International Co., Ltd	Under Construction	Agricultural Products
22,23	Myanmar Port Authority	Under Preparation	Container / General Cargo
24～26	Myanmar Port Authority （ODA Loan）	Under Construction	Container / General Cargo
27	Myanmar Edible Oil Industrial Co., Ltd	Under Preparation	Edible oil
28	Myanmar Agribusiness Public Co., Ltd	Under Preparation	Grain Terminal
29	Myanmar Agriculture & General Development Pubric Co., Ltd	Under Preparation	Grain Terminal
30,31	Diamond Star Co., Ltd	Under Construction	Grain Terminal
32	IGE Service Co., Ltd. Kaung Myanmar Aung Shipping Co., Ltd	Under Construction	Fuel
33	Padauk Shwe Wah Petrochemical Co., Ltd	Under Construction	Fuel
34～37	Myanma Economic Co., Ltd	Operation	Ship Breaking Yard

May-2018

Source: MPA

A container terminal being constructed with an ODA Loan in Plot 25 is scheduled to commence operations in February 2019. The terminal operator will be a Japanese company.

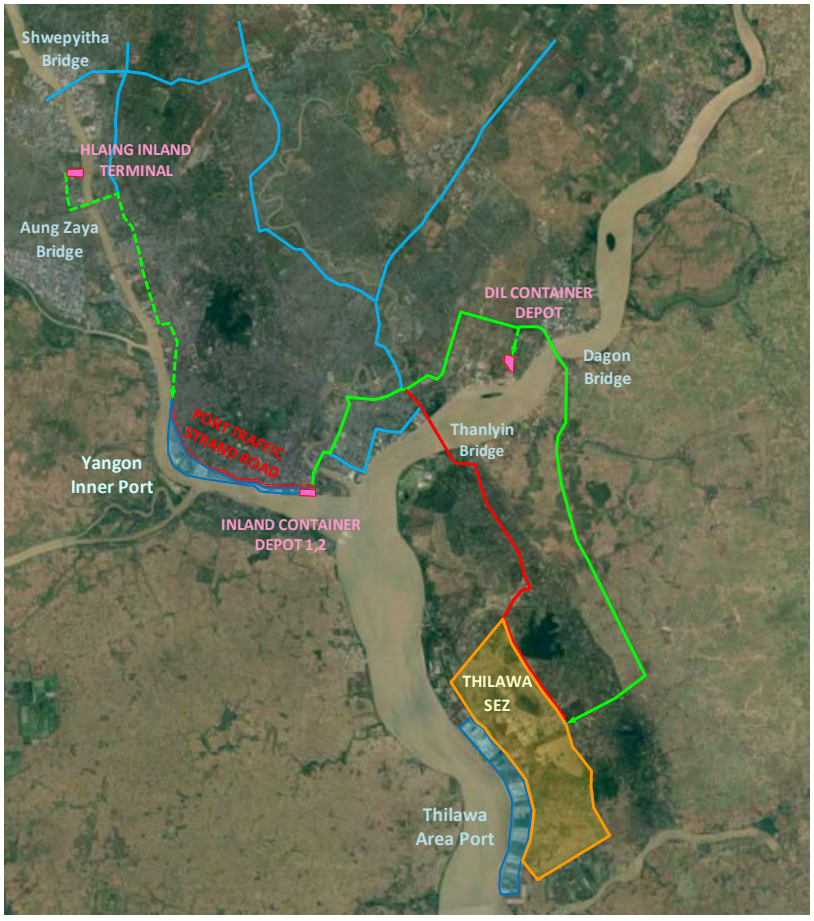
2.2.3 Inland Container Depot

Inland Container Depots have recently or will soon be established newly and are under construction around Yangon Port to cope with the increasing empty export containers. The specifications of inland container depots are shown in Table 2.2.4.

Table 2.2.4 Specifications of Inland Container Depots

No.	Container Depo	Main Handling Item	Area (ha)	Annual Container Throughput (TEU)		Current Situation
1	Inland Container Depot 1 (ICD1)	Empty Container	4.0	128,494	in 2017	Operation
2	Inland Container Depot 2 (ICD2)	Empty Container				Operation
3	Dagon Seikkan International Logistic Service (DIL)	Empty Container	5.2	18,000	in 2017	Operation
4	Hlaing Inland Terminal & Logistics Company (HITLC)	Laden / Empty Container	16.2	–	–	Under Construction

Source: Study Team



Source: Study Team (Google Earth)

Figure 2.2.7 Location Map of Inland Container Depots around Yangon City

Dagon Seikkan International Logistic Service (DIL) is located in the Thilawa Area Port approximately 20 km from Dagon Bridge. DIL has advantages over ICD1 2 for handling freight in the Thilawa Area Port due to the frequent traffic congestion in the Yangon city area and because large vehicles such as trailers and trucks cannot pass the Thanlyn Bridge.

Hlaing Inland Terminal & Logistics Company (HITLC) conducts container transport not only by truck but also by barge. Waterway transport has two advantages over land transport: it allows mass transport and is not subject to traffic congestion.

Location map of inland container depots is shown in Figure 2.2.8.

Source:Study Team (Google Earth)

Figure 2.2.8 Inland Container Depot 1,2

The volume of containers transported by DIL has been increasing since 2015. The role of DIL is expected to increase with development of the Thilawa Area Port. DIL plans to construct a pier on the Bago River to further expand inland waterway transport by barge in the future.

The HITL terminal has a quay with a length of 180m and water depth of 5-9m. A bonded warehouse is planned to be established in the terminal which will be used not only for container storage but also customs. The yard area will be 40 acres initially (approximately 16.2ha), but could be expanded to 100 acres (approximately 40.5ha) in future.

2.2.4 Thilawa SEZ

Thilawa SEZ (which will have a total area of 2,400 ha) is being developed behind the Thilawa Area Port in Yangon Port with Japan's assistance (see Figure 2.2.17). The developer of the SEZ is the Myanmar Japan Thilawa Development company (MJTD) which is a joint venture comprised of a Japanese consortium (Sumitomo Corporation, Mitsubishi Corporation, Marubeni, JICA and others, which hold a 49% share in the SEZ) and a Myanmar consortium (the Government and Myanmar enterprises, which hold a 51% share)

Zone A (about 400 ha) of the SEZ has already been developed. As of June 2018, 82 companies (including 36 Japanese companies: automobile related, electronic parts, sewing, shoes, logistics, etc.) have located there. Factories have been built by 55 companies.

Source: Study Team (Google Earth)

Figure 2.2.9 Plan of the Thilawa Special Economic Zone

Approved investors of the Thilawa SEZ are shown in Table 2.2.5. The mark "◯" in the table indicates that operations have already commenced or facilities are under construction.

Table 2.2.5 Approved Investors of the Thilawa SEZ in June, 2018

Permit No.	Approval Date	Operation & construction	Name of Investor	Country	Type of Business	Type
1	2014/11/25	○	KOYORAD MYANMAR CORPORATION CO., Ltd.	Singapore (Japan)	Manufacturing	Export
2	2014/11/26	○	LU THAI (MYANMAR) CO., Ltd.	China	Manufacturing	Export
3	2014/12/3		THILAWA CEMENT AND BUILDING MATERIALS Ltd.	France	Service	Domestic
4	2014/12/3	○	BALL ASIA PACIFIC (YANGON) METAL CONTAINER Ltd.	Singapore (USA)	Manufacturing	Import
5	2014/12/8	○	FOSTER ELECTRIC (THILAWA) CO., Ltd.	Singapore (Japan)	Manufacturing	Export
6	2014/12/19	○	INDORAMA VENTURES PACKAGING (MYANMAR) Ltd.	Singapore (Thailand)	Manufacturing	Import
7	2014/12/22	○	GOLDEN DOWA ECO-SYSTEM MYANMAR CO., Ltd.	Japan	Service	Domestic
8	2015/1/5	○	SHOWA GLOVE MYANMAR CO., Ltd.	Japan	Manufacturing	Export

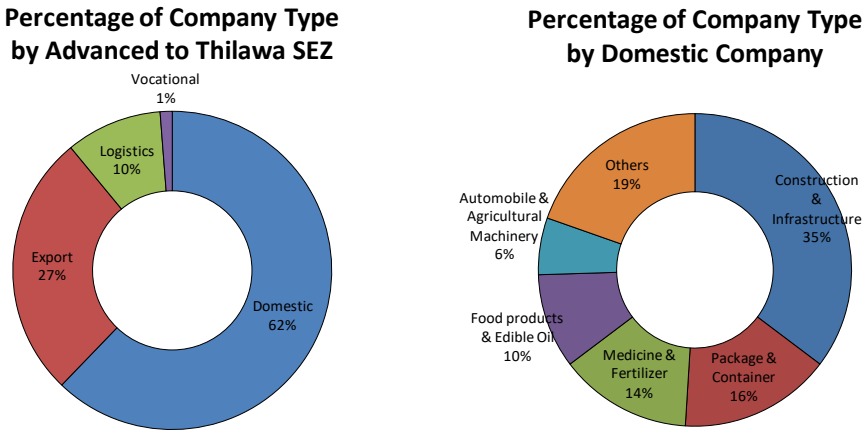
Permit No.	Approval Date	Operation & construction	Name of Investor	Country	Type of Business	Type
9	2015/1/5	○	ATSUMI MYANMAR	Japan / Myanmar	Manufacturing	Export
10	2015/1/5	○	CUTE MYANMAR THILAWA CO., Ltd.	Japan	Manufacturing	Export
11	2015/1/12	○	OJI MYANMAR PACKAGING COMPANY Ltd.	Japan / Malaysia	Manufacturing & Services / Trading	Import/ Wholesale
12	2015/2/11	○	FUJIWORK MYANMAR THILAWA SEZ CO., Ltd.	Japan	Services	Vocational
13	2015/2/11	○	GUSTON AMAVA Ltd.	Hong Kong	Manufacturing	Export
14	2015/2/11		UNIMITENGINEERING (MYANMAR) CO., Ltd.	Hong Kong (Thailand)	Manufacturing	Import
15	2016/11/11	○	MILLCON THIHA GEL LTD.	Singapore (Thailand)	Manufacturing	Export
16	2015/3/14	○	RK YANGON STEEL CO., LTD	Japan	Manufacturing	Domestic
17	2015/3/14	○	ACECOOK MYANMAR CO., Ltd.	Japan	Manufacturing / Services	Import
18	2015/3/14		ABBA ALUMINIUM THILAWA Ltd.	Hong Kong (Taiwan)	Manufacturing	Domestic
19	2015/3/14	○	MYANMAR CENTURY STEEL STRUCTURE Ltd.	Hong Kong (Taiwan / Myanmar)	Manufacturing	Domestic
20	2015/3/14		THILAWA GLOBAL LOGISTICS	Japan / Hong Kong	Services	Logistics
21	2015/3/14	○	MARKETECH INTEGRATED MANUFACTURING CO., Ltd.	Taiwan	Manufacturing	Export
22	2015/3/23	○	MYANMAR WACOAL CO., Ltd	Japan	Manufacturing	Export
23	2015/3/23		POPULAR PLASTIC GROUP (TSEZ) CO., Ltd	Myanmar	Manufacturing	Export
24	2015/3/23	○	SEIJI (MYANMAR) CO., LTD.	Japan	Manufacturing	Export
25	2015/3/23	○	VELBON MYANMAR CO., Ltd.	Japan	Manufacturing	Export
26	2015/4/8	○	STANDARD URAI PAINT CO., Ltd.	Thailand / Myanmar	Manufacturing	Import
27	2015/4/8	○	PACIFIC-PSP SYNTECH CO., Ltd.	Thailand / Myanmar	Manufacturing	Import
28	2015/5/4	○	MYARNAK CO., Ltd.	Japan	Manufacturing	Export
29	2015/5/4		TOYOTSU PARAGON CO., Ltd	Japan / Myanmar	Manufacturing	Import
30	2015/5/4	○	MATSUNAGA (MYANMAR) CO., Ltd	Japan	Manufacturing	Export
31	2015/5/4	○	VJP CO., LTD.	Japan / Myanmar	Manufacturing	Domestic

Permit No.	Approval Date	Operation & construction	Name of Investor	Country	Type of Business	Type
32	2015/4/4		ZIFAM PYREX MYAMAR CO., Ltd	Australia / Myanmar	Manufacturing	Import
33	2015/5/4	○	DAIZEN MYANMAR CO., Ltd	Japan	Services	Logistics
34	2015/5/15		HTUN-THILAWA MANAGEMENT CO., LTD	Japan	Manufacturing	Export
35	2015/5/22	○	YTL CEMENT MYANMAR CO., LTD.	Malaysia	Manufacturing	Domestic
36	2015/5/22		FREE TRADE INTEGRATED LOGISTICS LIMITED	Myanmar	Services	Logistics
37	2015/7/16		MINERVA CO., LTD.	Singapore (Taiwan)	Manufacturing	Export
38	2015/7/16	○	SUZUKI THILAWA MOTOR CO., LTD.	Japan	Manufacturing	Domestic
39	2015/7/21		THILAWA PROPERTY DEVELOPMENT LIMITED	Myanmar	Services/ Real Estate	Domestic
40	2015/9/4	○	KUBOTA MYANMAR CO., LTD.	Japan	Services/ Trading	Import
41	2015/9/14	○	CRECIMIENTO INDUSTRIAL MYANMAR CO., LTD.	Brunei (Taiwan)	Manufacturing	Export
42	2015/9/28	○	KAS CO., LTD.	Vietnam (ROK)	Manufacturing	Domestic
43	2015/11/3	○	PEB STEEL BUILDINGS MYANMAR LTD.	Singapore (Virgin island)	Manufacturing	Domestic
44	2015/11/20	○	NITTSU LOGISTICS MYANMAR CO., LTD.	Singapore (Japan)	Services	Logistics
45	2015/12/7		BOXPAK (MYANMAR) CO., LTD.	Singapore (Malaysia)	Manufacturing	Domestic
46	2012/7/15		KIANJOO CAN (MYANMAR) CO., LTD.	Singapore (Malaysia)	Manufacturing	Import
47	2015/12/11	○	FUJITRANS LOGISTICS (MYANMAR) CO., LTD.	Japan / Thailand	Services	Logistics
48	2015/12/11	○	A & N FOODS (MYANMAR) CO., LTD.	Thailand	Manufacturing	Export
49	2016/1/1	○	MARUBENI MYANMAR FERTILIZER CO., LTD.	Japan / Myanmar	Manufacturing/ processing	Domestic
50	2016/2/15	○	CJ FOODS MYANMAR CO., LTD.	Republic of Korea	Manufacturing	Domestic
51	2016/2/15	○	MYANMAR AJINOMOTO FOODS CO., LTD.	Thailand	Services/ Trading	Import
52	2016/2/15	○	S.P. PETPACK INTER GROUP (MYANMAR) CO., LTD.	Thailand	Manufacturing	Import
53	2016/2/26	○	KONOIKE MYANMAR CO., LTD.	Japan	Logistics services	Logistics
54	2016/2/26	○	YANMAR MYANMAR CO., LTD.	Singapore / Japan	Services/Trading	Import
55	2016/3/10		NIPPON KOUATSU ELECTRIC MYANMAR CO., LTD.	Japan	Manufacturing	Export

Permit No.	Approval Date	Operation & construction	Name of Investor	Country	Type of Business	Type
56	2016/3/10	○	YAKULT MYANMAR CO., LTD.	Japan	Manufacturing	Import
57	2016/3/10		AGRI FIRST CO., LTD.	Singapore & Myanmar	Manufacturing	Import
58	2016/3/31	○	ALIDAC PHARMACEUTICALS LTD.	India (Dubai)	Manufacturing	Domestic
59	2016/3/31	○	YUSEN LOGISTICS (THILAWA) CO., LTD.	Japan / Singapore	Services/ Logistics	Logistics
60	2016/3/31	○	RYOBI MYANMAR DISTRIBUTION SERVICES CO., LTD.	Japan	Services/ Logistics	Logistics
61	2016/3/31	○	NMD (MYANMAR) CO., LTD.	Japan / Hong-Kong	Manufacturing	Export
62	2016/5/20		MIZUNO (MYANMAR) CO., LTD.	Japan / Vietnam	100% export	Export
63	2016/6/1	○	YOJIN MYANMAR CO., LTD.	Singapore	Manufacturing	Domestic
64	2016/6/23	○	YANGON CAN MANUFACTURING CO., LTD.	Japan / Myanmar	Manufacturing	Domestic
65	2016/6/23		BURST MYANMAR CO., LTD.	Singapore	Services	Domestic
66	2016/6/23		KIM PAI PRINTING AND PACKAGING CO., LTD.	Thailand	Manufacturing	Domestic
67	2016/7/22	○	FUJIFILM MYANMAR INVESTMENT CO., LTD.	Singapore	Services	Import
68	2016/7/22		SCI METAL TECH (MYANMAR) CO., LTD.	Thailand and Myanmar	Manufacturing	Import
69	2016/8/18	○	NS BLUESCOPE LYSAGHT MYANMAR LTD.	Singapore	Manufacturing & Services	Domestic
70	2016/9/8	○	TAIYO NIPPON SANSO MYANMAR CO., LTD.	Singapore	Manufacturing	Import
71	2016/9/26		TOA PAINT (Thailand) CO., LTD	Thailand	Manufacturing	Domestic
72	2016/9/26	○	TCCC MYANMAR LTD.	Thailand	Services/Trading	Import
73	2016/10/27		CPP FERTILIZER CO., LTD.	Thailand	Manufacturing	Import
74	2016/10/27		BUHLER MYANMAR LIMITED	Singapore	Services/Trading	Import
75	2016/11/25	○	AKTIO MYANMAR CO., LTD.	Japan	Services/Rental	Domestic
76	2016/12/23	○	AJU MYANMAR CO., LTD	Korea	Manufacturing	Domestic
77	2017/1/2		KORYO CABLE MYANMAR CO., LTD.	Korea	Manufacturing	Domestic
78	2017/1/23	○	METRO WHOLESALE MYANMAR LTD.	Germany	Services/Trading	Import
79	2017/2/23		SAHADHARAWAT CAN (MYANMAR) CO., LTD.	Thailand	Manufacturing	Domestic

Permit No.	Approval Date	Operation & construction	Name of Investor	Country	Type of Business	Type
80	2017/2/23		SUPER HOTEL (THILAWA) CO., LTD.	Japan	Services/Hotel	Domestic
81	2017/2/23		SOILBUILD (THILAWA) CO., LTD.	Singapore	Manufacturing	Domestic
82	2017/4/24		LS- GAON CABLEL MYANMAR CO., LTD.	Korea	Manufacturing	Domestic

Source：Thilawa SEZ Website　http://www.myanmarthilawa.gov.mm/list-investors



Source: Thilawa SEZ Website　http://www.myanmarthilawa.gov.mm/list-investors

Figure 2.2.10　Percentage of Company Type

Of the 82 companies which are located in the Thilawa SEZ, 51 companies are Domestic-related, 22 companies are Export-related, eight companies are Logistics-related and there is one vocational company.

Of the 51 Domestic-related companies, there are 18 Construction & Infrastructure-related companies, eight Package & Container companies, seven Medicine & Fertilizer companies, five Food products & Edible Oil companies, three Automobile & Agricultural Machinery companies, while ten companies are categorized as ‘Others.’

Figure 2.2.11 shows plot divisions in the Zone A area.

Source：Thilawa SEZ Website

Figure 2.2.11 Plot Map of Thilawa SEZ Zone A

2.3 Yangon Port Development Plan

2.3.1 Cargo Demand Forecast

(1) Cargo handling volume of Myanmar ports

Table 2.3.1 shows the total cargo handling volume of containerized cargo and non-containerized cargo for international trade at ports in Myanmar.

Table 2.3.1 Myanmar ports' total cargo handling volume of containerized cargo and non-containerized cargo for international trade

unit: 000 ton

	2011	2012	2013	2014	2015	2016	2017
Import							
Containerized Cargo	2,830	3,356	4,229	5,657	6,456	8,609	7,843
Non Containerized Cargo	11,301	14,846	14,278	13,578	19,728	15,719	21,171
Total	14,131	18,202	18,507	19,236	26,184	24,328	29,014
Export							
Containerized Cargo	2,498	2,734	2,762	3,246	3,129	3,477	3,220
Non Containerized Cargo	7,333	6,369	7,373	7,723	5,558	6,537	5,142
Total	9,831	9,103	10,135	10,970	8,688	10,014	8,362
Grand Total	23,962	27,305	28,642	30,205	34,871	34,343	37,376

Source : MPA

(2) Cargo handling volume of Yangon Port

1) Import Cargo Volume of Yangon Port

Table 2.3.2 shows the import cargo volume of Yangon port.

Table 2.3.2 Import Cargo Volume of Yangon Port

unit: 000 ton

	2013	2014	2015	2016	2017
Container Cargo	4,229	5,657	6,456	8,609	7,843
Non Container Cargo					
Fuel	2,402	2,716	3,885	4,786	5,774
Aircraft fuel	86	106	123	125	152
Gasoline and other fuel	2,315	2,604	3,762	4,658	5,620
LPG	1	6	0	4	2
Others	9,872	10,939	14,113	10,130	6,702
Cement	234	580	1,588	1,041	279
Edible Oil	458	478	577	556	649
Iron & Steel Products	686	1,098	1,279	793	1,258
Vehicles	289	311	288	229	230
Concrete Products	9	24	28	21	31
Fertilizer	22	12	43	47	49
Sugar	0	15	9	328	166
General Cargo and Others	8,174	8,420	10,301	7,115	4,042
Total	16,503	19,312	24,454	23,525	20,319

Source: Study Team based on MPA data

2) Export Cargo Volume of Yangon Port

Table 2.3.3 shows the export cargo volume of Yangon port.

Table 2.3.3 Export Cargo Volume of Yangon Port

unit: 000ton

	2013	2014	2015	2016	2017
Container Cargo	2,762	3,246	3,129	3,447	3,220
Non Container Cargo	3,734	2,587	2,509	3,899	4,798
Timber	501	325			
Rice	391	471	242	687	1,956
General Cargo and Others	2,842	1,791	2,267	3,212	2,842
Total	6,496	5,833	5,638	7,346	8,018

Source: Study Team (based on MPA data)

3) Container Cargo Handling Volume of Yangon Port

Table 2.3.4 shows the container cargo handling volume of Yangon Port.

Table 2.3.4 Container Cargo Handling Volume of Yangon Port

Unit: TEU

		2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Import	Laden	224,751	296,156	365,548	443,916	507,335	491,062
	Empty	14,596	13,608	12,029	15,121	12,395	23,872
	Total	239,347	309,764	377,577	459,037	519,730	514,934
Export	Laden	120,516	132,493	136,383	137,998	175,069	206,922
	Empty	118,477	171,311	230,749	296,166	363,091	312,363
	Total	238,993	303,804	367,132	434,164	538,160	519,285
Total	Laden	345,267	428,649	501,931	581,914	682,404	697,984
	Empty	133,073	184,919	242,778	311,287	375,486	336,235
	Total	478,340	613,568	744,709	893,201	1,057,890	1,034,219

Source: MPA

Cargo handling volume of Myanmar ports had increased by 22% per annum from 2012 to 2016. However, the cargo handling volume in 2017 did not exceed the previous year's level.

Although Myanmar had maintained economic growth of 7% per annum since the transition to a civilian administration, annual growth dropped to 6.3% in 2016.

The impact of flood damage in various parts of the country, low productivity of agro products and sluggish foreign direct investment due to the lack of a concrete economic development policy are reasons given by ADB and WB for the deceleration of the economy.

However, in 2018, between the period of 1st to 27th of April, export value of Myanmar ports recorded US$784.6 million, an increase of US$ 150 million over the same period of the previous year The Global New Light of Myanmar (Saturday, 12, Tuesday 15, May 2018). Port cargo handling volume is showing an increasing tendency.

The demand forecast focuses on the correlation between TEU/capita and GDP/capita by examining the actual cargo handling demand in neighboring ASEAN countries from a macroscopic perspective. We have applied this correlation for conducting the demand forecast rather than applying the increase rate in the actual cargo volume starting from a certain year because the recent variations in cargo handling volume are considered to be a temporary phenomenon and not indicative of future growth. We believe a macroscopic demand forecast which applies the correlation derived from the cargo volume records in neighboring ASEAN countries will yield more reasonable and accurate results.

(3) Cargo Volume Demand Forecast

1) Container Cargo Volume Forecast

i) Target Years of Forecast

Target years for the forecast are 2025 as short term, 2030 as middle term and 2035 as long term.

ii) Socio-economic Frame

Population: 52,920,000 （October, 2016 ）

Growth rate 0.89%／year （ Myanmar Statistical Yearbook 2017 ）

Economic growth rate:

High Case 7.4%

（Average of actual GDP growth from 2012 to 2016 and IMF forecast from 2017 to 2022）

Low Case (5.3% + 6.1%)／2 = 5.7 %

(Average of value adopted in Phase 1 study and growth rate at 2016 (lowest after2012)）

GDP per capita: 702 US$ (Year 2010)

iii) Economic Scale and Population in each target year

Table 2.3.5 shows estimated economic scale and population in target years.

Table 2.3.5 Socio-economic Frame Work in Target Years

Target			2010	2025	2030	2035
Economic Scale	High Case	7.4%	1.00	2.86	4.09	5.85
	Low Case	5.7%	1.00	2.48	3.27	4.32
Population		0.89%		57,313,000	59,909,000	62,623,000

Source: Study Team

iv) Container Cargo Volume Forecast of Yangon Port

The forecast method adopted by the Study team utilizes the correlation between GDP per capita and TEU per capita in ASEAN countries.

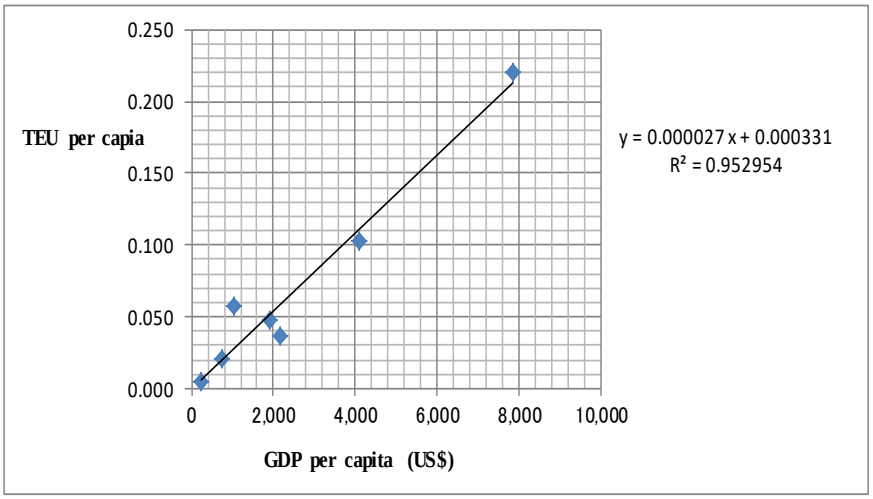
Correlation between GDP per capita and TEU per capita in ASEAN Countries

The economic development pattern of ASEAN countries is generally the same; there can be seen a shift from agriculture to manufacturing together with FDI. Container cargo handling volume tends increase in line with economic development. Container cargo handling volume per capita varies widely among ASEAN countries because economic growth levels are different. Correlation between GDP per capita and container cargo volume TEU per capita in AESAN countries shall be examined to forecast future container cargo volume in Myanmar with economic growth to some degree. Singapore and Brunei are excluded from this comparison because their huge GDP per capita is in a different class compared to other countries. Transship container cargo volume in Malaysian ports is also excluded. Correlation between GDP per capita and TEU per capita in ASEAN Countries in 2008 is shown in Table 2.3.6 and Figure 2.3.1.

Table 2.3.6 Correlation between GDP per capita and TEU per capita in ASEAN Countries in 2008

Country	GDP per capita (US$)	TEU per capita
Thailand	4,099	0.103
Malaysia	7,867	0.221
Philippines	1,908	0.048
Indonesia	2,181	0.036
Vietnam	1,047	0.058
Myanmar	233	0.004
Cambodia	742	0.021

Source: Study Team



Source: Study Team

Figure 2.3.1 Correlation between GDP per capita and TEU per capita in ASEAN Countries

Correlation between GDP per capita and TEU per capita is shown by the following formula.

TEU/capita = 0.000027 X + 0.000331 (R2 = 0.952)

X : GDP per capita

① Projection of future GDP per capita in target years

Year 2025

(High Case) GDP per capita : 702 × 2.86 = 2,008 US$

(Low Case) GDP per capita : 702 × 2.48 = 1,741 US$

Year 2030

(High Case) GDP per capita : 702 × 4.09 = 2,871 US$

(Low Case) GDP per capita : 702 × 3.27 = 2,296 US$

Year 2035

(High Case) GDP per capita : 702 × 5.85 = 4,107 US$

(Low Case) GDP per capita : 702 × 4.32 = 3,033 US$

② Container Cargo Volume Forecast in Target Years

Year 2025

（High Case） (0.000027 × 2,008 + 0.000331) × 57,313,000 = 3,126,252 TEU

(Low Case) (0.000027 × 1,741 + 0.000331) × 57,313,000 = 2,713,083 TEU

Year 2030

（High Case） (0.000027 × 2,871 + 0.000331) × 59,909,000 = 4,663,796 TEU

(Low Case) (0.000027 × 2,296 + 0.000331) × 59,909,000 = 3,733,709 TEU

Year 2035

（High Case） (0.000027 × 4,107 + 0.000331) × 62,623,000 = 6,964,931 TEU

(Low Case) (0.000027 × 3,033 + 0.000331) × 62,623,000 = 5,148,988 TEU

Cargo Handling Volume Ratio of Sea Trade and Border Trade

As the trade value ratio except for bulk cargo of sea trade and border trade of Myanmar is almost 8:2, the study team assumes that 80% of container cargo is transported by sea.

Target 2025

（High Case） 3,126,252 TEU × 0.8 = 2,504,000 TEU

(Low Case) 2,713,083 TEU × 0.8 = 2,171,000 TEU

Target 2030

（High Case） 4,663,796 TEU × 0.8 = 3,733,000 TEU

(Low Case) 3,733,709 TEU × 0.8 = 2,989,000 TEU

Target 2035

（High Case） 6,964,931 TEU × 0.8 = 5,568,000 TEU

(Low Case) 5,148,988 TEU × 0.8 = 4,116,000 TEU

v) Forecast of Cargo Volume related to Thilawa SEZ

① Thilawa SEZ Development Plan

The area of the Thilawa SEZ will be expanded to 867 ha in 2025 and 1,600 ha in 2030. The area in 2030 is a value assumed by the Study Team for the demand forecast purpose (see Table 2.3.7).

Table 2.3.7 Thilawa SEZ Area

Year	2025	2030
SEZ Development Area (ha)	867	1,600

Source: Study Team (information from Myanmar Japan Thilawa Development Ltd, (MJTD))

② Situation of Companies Operating in SEZ and Land Use

The ratio of export-oriented companies and domestic demand –oriented companies operating in Thilawa SEZ in Zone A (405 ha) is about 4:6 as of May 2018.

Domestic demand – oriented companies began operation early in order to seize a large portion of the local market even though the infrastructure in the SEZ was not fully developed. On the other hand, export –oriented companies have been more reluctant to locate over concerns of inadequate power supply etc.

However, power supply capacity of the SEZ has greatly improved with the introduction of a new power supply system in February 2018. Therefore, the number of export–oriented companies is expected to increase in Zone B and C.

Present land use situation is as follows.

1. Area used for utilities (road, sewage treatment facility, etc.): 13% of the total area
2. Area used by tertiary sector (hotel, commercial facilities, etc.): 10% of the total area
3. Non-productive area: 23％ of the total land area

③ Port Cargo Volume Forecast Related to SEZ Operation in 2025 and 2030

The ratio of export-oriented companies to domestic demand – oriented companies

Study team assumes the the ratio of export-oriented companies to domestic demand–oriented companies will become 6:4 when Zone C land reclamation is completed and the entire site becomes sold out around 2025.

Total area of manufacturing companies

Year 2025： 867 ha ×0.77 = 668 ha

Year 2030：1,600 ha ×0.77 = 1,232 ha

④ Port Cargo Handling Volume related to SEZ

Study team adopts Phase 1 values of unit weight of material and product per unit area of factory.

Product volume：1,859 ton／ha

Material volume：1,804 ton／ha

Year 2025 ：

Import cargo

Study team assumes that 90% of total materials for companies operating in the SEZ are imported from Yangon port

1,804ton／ha ×668 ha ×0.9 = 1,084,565 tons

Export cargo

Study team assumes that only export – oriented companies export products from Yangon port

1,859ton／ha ×668 ha ×0.6 = 745,087 tons

Total 1,829,6526 tons

Year 2030：

Import cargo

1,804 ton／ha ×1,232 ha ×0.9 = 2,000,275 tons

Export cargo

1,859ton／ha ×1,232 ha ×0.6 = 1,374,173 tons

Total 3,374,448 tons

⑤ Conversion to TEU

To convert to TEU from cargo weight, study team adopts 14.4 ton/ TEU for import cargo and 7.4 ton/TEU for export cargo.

Year 2025：

Import container cargo volume 1,084,565 ÷14.4 ＝75,317 TEUs

Export container cargo volume 745,087 ÷7.4 ＝100,687 TEUs

Total 176,004TEUs (201,374 TEUs: including empty containers)

Year 2030：

Import container cargo volume 2,000,275 ÷14.4 ＝138,908 TEUs

Export container cargo volume 1,374,173 ÷7.4 ＝185,699 TEUs

Total 324,607 TEUs (371,398 TEUs: including empty containers)

(4) Yangon port cargo handling volume forecast

Cargo handling volumes of Yangon port are forecast for the years 2025, 2030 and 2035.

1) Forecast of total cargo handling volume of Myanmar ports

The study team forecasts cargo volume in target years based on the expected economic scale. Total cargo volume of ports in Myanmar in 2010 is 21,455,574 tons.

Cargo handling volume forecast in target years

Year 2025

（High Case） 21,455,574 × 2.86 = 61,362,942 tons

（Low Case） 21,455,574 × 2.48 = 53,209,824 tons

Year 2030

（High Case） 21,455,574 × 4.08 = 87,538,741 tons

（Low Case） 21,455,574 × 3.27 = 70,159,927 tons

Year 2035

（High Case） 21,455,574 × 5.85 = 125,515,108 tons

（Low Case） 21,455,574 × 4.32 = 92,688,080 tons

Table 2.3.8 shows forecast volume of total cargo handling volume of Myanmar ports.

Table 2.3.8 Forecast Volume of Total Cargo Handling Volume of Myanmar Ports

unit: 000ton

	2025	2030	2035
High Case	61,363	87,539	125,515
Low Case	53,210	70,160	92,688

Source: Study Team

Yangon port handled 85.5% of Myanmar's total cargo handling volume from 2012 to 2016. Study team assumes that this proportion will not change in target years.

① Total cargo handling volume of Yangon port

Year 2025

（High Case） 61,362,942 × 0.855 = 52,465,315 ton

（Low Case） 53,209,824 × 0.855 = 45,494,400 ton

Year 2030

（High Case） 87,538,741 × 0.855 = 74,845,624 ton

（Low Case） 70,159,927 × 0.855 = 59,986,738 ton

Year 2035

（High Case） 125,515,108 × 0.855 = 107,315,417 ton

（Low Case） 92,688,080 × 0.855 = 9,248,308 ton

② Forecast of international trade cargo volume of Yangon port

Yangon port international trade cargo handling volume occupies 96.1 % of total cargo handling volume from 2012 to 2016. Study team assumes that this proportion will not change in target years.

Year 2025

（High Case） 52,465,315 × 0.961 = 50,419,168 tons

（Low Case） 45,494,400 × 0.961 = 43,720,118 tons

Year 2030

（High Case） 74,845,624 × 0.961 = 71,926,645 tons

（Low Case） 59,986,738 × 0.961 = 57,647,255 tons

Year 2035

（High Case） 107,315,417 × 0.961 = 104,130,116 tons

（Low Case） 79,248,308 × 0.961 = 76,157,624 tons

Import cargo volume at Yangon port accounts for approximately 75% of the total international trade volume from 2012 to 2016. Study team assumes that this proportion will not change in target years.

Year 2025

（High Case） Import：50,419,168 × 0.75 = 37,814,376 tons

Export：50,419,168 × 0.25 = 12,604,793 tons

（Low Case） Import：43,720,118 × 0.75 = 32,790,089 tons

Export：43,720,118 × 0.25 = 10,930,030 tons

Year 2030

（High Case） Import：71,926,645 × 0.75 = 53,944,984 tons

Export：71,926,645 × 0.25 = 17,981,661 tons

（Low Case） Import：57,647,255 × 0.75 = 43,235,441 tons

Export：57,647,255 × 0.25 = 14,411,814 tons

Year 2035

（High Case） Import：104,130,116 × 0.75 = 78,097,587 tons

Export：104,130,116 × 0.25 = 26,032,529 tons

（Low Case） Import： 76,157,624 × 0.75 = 57,118,218 tons

Export： 76,157,624 × 0.25 = 19,039,406 tons

2) Forecast by Main Commodities (Micro Estimation)

Main import commodities in Yangon port are containerized cargo, liquid fuel (gasoline, diesel and jet fuel), cement, cooking oil, iron material (billet) and steel products, car and general cargo. On the other hand, main export commodities are containerized cargo and rice.

Border trade with neighboring countries is active, especially with Yunnan province in China and Thailand. It is said border trade accounts for 20% of Myanmar's total international trade on a money basis. Study team assumes that import cargo will continue to come from border trade even in 2025, 2030 and 2035 as border trade will not decline for the time being.

i) Main Import Commodities

① Containerized Cargo Volume

Containerized cargo volume is converted from TEU to weight base referring to MPA Trade Statistics of 2016.

Import Container：1 TEU = 8,608,773 tons ／503,710 = 17.09 tons

Export Container：1 TEU = 3,447,240 tons ／522,506 = 6.60 tons

Table 2.3.9 shows import container cargo volume of Yangon Port.

Table 2.3.9 Import Container Cargo Volume Forecast of Yangon Port

unit: TEU

	2025	2030	2035
High Case	1,250,500	1,865,500	2,786,000
Low Case	1,085,000	1,493,500	2,059,500

Source: Study Team

Table 2.3.10 shows import containerized cargo volume (weight).

Table 2.3.10 Import Containerized Cargo Volume (weight) of Yangon Port

unit: 000 ton

	2025	2030	2035
High Case	21,371	31,881	47,613
Low Case	18,543	25,524	35,197

Source: Study Team

② Fuel

Consumption volume of fuel is considered to increase in proportion to future economic scale. Table 2.3.11 shows the fuel import volume of Yangon port.

Table 2.3.11 Fuel Import Volume of Yangon Port

unit: 000ton

		2013	2014	2015	2016	2017
Fuel	Aircraft fuel	86	106	123	125	152
	Gasoline and other fuel	2,315	2,604	3,762	4,658	5,620
	LPG	1	6	0	4	2
	Total	2,402	2,716	3,885	4,786	5,774

Source：MPA

Table 2.3.12 shows the estimated economic scale in target years.

Table 2.3.12 Estimated Economic Scale of each Target Year

	2017	2025	2030	2035
High Case	1.00	1.77	2.53	3.62
Low Case	1.00	1.56	2.06	2.71

Source: Study Team

Table 2.3.13 shows the forecast fuel import volume in target years.

Table 2.3.13 Import Fuel Volume Forecast in each Target Year

unit:000ton

	2017	2025	2030	2035
High Case	5,774	10,220	14,609	20,903
Low Case		9,008	11,895	15,648

Source: Study Team

③ Cement

Import volume of cement recorded 1,600,000 tons in 2015; however, it decreased to 1,000,000 tons in 2016 and 270,000 tons in 2017. The recent decline was due to an increase in domestic production and a short-term decrease in demand.

Study team estimates demand volume of cement consumption based on the correlation between the GDP per capita and cement consumption volume per capita from the report of Professor Ouchi of Kochi University of Technology.

Table 2.3.14 shows GDP per capita and cement consumption volume per capita in target years.

Table 2.3.14 GDP per Capita and Cement Consumption Volume per Capita in Target Years

		2025	2030	2035
GDP per capita (US$)	High Case	2,008	2,871	4,107
	Low Case	1,741	2,296	3,033
Cement Consumption per capita (kg)	High Case	272	297	402
	Low Case	227	264	300

Source: Study Team

Table 2.3.15 shows Cement Consumption Volume of Myanmar in target years.

Table 2.3.15 Cement Consumption Volume of Myanmar in Target Years

unit: 000ton

		2025	2030	2035
Cement Consuption Volume (ton)	High Case	15,589	17,793	25,174
	Low Case	13,010	15,816	18,787

Source: Study Team

Import cement volume depends on local production volume and consumption volume. Annual consumption volume in 2017 is said to be 8,000,000 ton.

In 2017, Siam cement of Thailand started operation of new cement factory in Mon state with an annual production capacity of 1,800,000 tons. In the Thilawa SEZ, a Malaysian company and Korean company are currently constructing cement factories. Both factories will have a production capacity of 1,000,000 tons.

In Mandalay, TMM (Than Taw Myat) is increasing its daily production capacity by 10,000 tons and plans to further increase production capacity in 2018. In addition, more local cement production is expected due to Myanmar's rich limestone resources. Therefore, the study team assumes that most of the consumption demand will be covered by local production.

The import volume of clinker is expected to increase due to the increase in cement production in the Thilawa SEZ and elsewhere. Study team assumes that a quarter of the clinker volume to be used in the Thilawa SEZ will be imported by the port in 2025. After that the import volume will increase in proportion to economic scale.

Year 2025 : High Case, Low case 500,000 tons

Year 2030 : High Case 715,000 tons
: Low Case 660,000 tons

Year 2035 : High Case 1,025,000 tons
: Low Case 865,000 tons

④ Edible Oil

Table 2.3.16 shows the edible oil import volume of Yangon port.

Table 2.3.16 Edible Oil Import Volume of Yangon Port

unit:000ton

	2013	2014	2015	2016	2017
Edible Oil	458	478	577	556	649

Source: MPA

Table 2.3.17 shows the population forecast of Myanmar.

Table 2.3.17 Population Forecast of Myanmar

	2025	2030	2035
Popultion	57,313,000	59,909,000	62,623,000

Source: Study team prepares from Central Statistical Organization data

Annual consumption volume per capita of cooking oil is 12.4 kg in Myanmar. Table 2.3.18 shows the forecast consumption volume of edible oil in target years.

Table 2.3.18 Forecast Consumption Volume of Edible Oil

unit:000ton

	2016	2025	2030	2035
Edible Oil Consumtion Volume	656	711	743	777

Source: Study Team

Peanut oil and sesame oil used to be the main cooking oils, however, palm oil consumption has increased. Study team assumes that 90% of consumption volume will be imported in target years. Table 1.2-19 shows edible oil import volume forecast.

Table 2.3.19 Edible Oil Import Volume Forecast

unit:000ton

	2025	2030	2035
Edible Oil	640	669	699

Source：Study Team

⑤ Iron Material (Billet) and Steel Products

Table 2.3.20 shows the import volume of iron & steel products of Yangon port until 2017.

Table 2.3.20 Import Volume of Iron & Steel Products of Yangon Port

unit: 000ton

	2013	2014	2015	2016	2017
Iron & Steel Products	686	1,098	1,279	793	1,258

Source：MPA

In general, consumption volume of steel products increases to a certain level due to the development of social infrastructure, houses, office buildings and factories in accordance with economic development. The demand for steel products demand in Myanmar is expected to increase for the time being as Myanmar

requires improvement and development of many social assets.

The study team examines the correlation between consumption per capita of steel products and GDP per capita from the consumption records of Indonesia, the Philippines, Thailand and Vietnam (source: South East Asia Iron & Steel Institute)

Y= 0.000030 X + 0.02173

Y：Steel Product Consumption Volume per capita (tons)

X：GDP per capita（US$）

Year 2025

High Case : GDP per capita 2,008 US$

Consumption volume per capita (0.00003 x 2,008 + 0.02173) = 0.082 tons

Total consumption volume 0.082 x 57,313,000＝4,699,666 tons

Low Case : GDP per capita 1,741 US$

Consumption volume per capita (0.00003 x 1,741 + 0.02173) = 0.074 tons

Total consumption volume 0.074 x 57,313,000＝4,242,162 tons

Year 2030

High Case : GDP per caipta 2,871 US$

Consumption volume per capita (0.00003 x 2,871 + 0.02173) = 0.108 tons

Total consumption volume 0.108 x 59,909,000＝6,470,172 tons

Low Case : GDP per caipta 2,296 US$

Consumption volume per capita (0.00003 x 2,296 + 0.02173) = 0.091 tons

Total consumption volume 0.091 x 59,909,000＝5,451,719 tons

Year 2035

High Case : GDP per capita 4,107 US$

Consumption volume per capita (0.00003 x 4,107 + 0.02173) = 0.145 tons

Total consumption volume 0.145 x 62,623,000＝9,080,335 tons

Low Case : GDP per capita 3,033 US$

Consumption volume per capita (0.00003 x3,033 + 0.02173) = 0.113 tons

Total consumption volume 0.113 x 2,623,000＝7,076,399 tons

The production volume of steel products is expected to increase to meet the increasing local demand. However, there are many problems in expanding the steel industry business in a developing country such as the small scale domestic market, difficulty of fundraising, insufficiency of technical experts and so on.

Study team refers to the share of steel products import volume of the total consumption volume of Vietnam to estimate the future import volume share of Myanmar.

The ratio of import steel products and local products is almost 1:1 in Vietnam. Therefore, study team assumes that 50% of steel products consumption volume will be imported in future.

Study team examines the import volume of steel products and iron material assuming the following. Ratio of import steel products volume and iron material volume 1:1. 100 % of steel products volume will be imported as containerized cargo

Year 2025

High Case: Total import volume 4,699,666 x 1/2 = 2,349,833 tons
Import volume at port 2,349,833 x 0.80 =1,879,866 tons
Iron material 939,933 tons

Low Case: Total import volume 4,242,162 x 1/2 = 2,121,081 tons
Import volume at port 2,121,081 x 0.80 =1,696,865 tons
Iron material 848,432 tons

Year 2030

High Case: Total import volume 6,470,172 x 1/2 = 3,235,086 tons
Import volume at port 3,235,086 x 0.80 =2,588,069 tons
Iron material 1,294,034 tons

Low Case: Total import volume 5,451,719 x 1/2 = 2,725,860 tons
Import volume at port 2,725,860 x 0.80 =2,180,688 tons
Iron material 1,090,344 tons

Year 2035

High Case: Total import volume 9,080,335 x 1/2 = 4,540,168 tons
Import volume at port 4,540,168 x 0.80 =3,632,134 tons
Iron material 1,816,067 tons

Low Case: Total import volume 7,076,399 x 1/2 =3,538,200 tons
Import volume at port 3,538,200 x 0.80 =2,830,560 tons
Iron material 1,425,280 tons

⑥ Vehicles

In accordance with economic growth, the number of cars will increase in general. Almost all imported cars of Myanmar are used cars from Japan, however, it is expected that the market for new cars will improve in the near future. Generally, when GDP per capita exceeds US$ 4,000, the number of cars tends to sharply increase.

Study team forecast the number of cars from the correlation between GDP per capita and the number of cars per 1,000 people (from the data of Professor Shioji of Kyoto University, Asia Keiei Kenkyu No. 22, 2016).

Standard number of cars owned from GDP per capita

Relation between GDP per capita and number of car owners per 1,000 people

$Y = 0.02 X$

Y : Number of car owners per 1,000 people

X : GDP per capita (US$)

Table 2.3.21 shows the population forecast in target years.

Table 2.3.21 Population Forecast

	2020	2025	2030	2035
Population	54,829,252	57,313,000	59,909,000	62,623,000

Source: Study Team

Table 2.3.22 shows the estimated GDP per capita in target years.

Table 2.3.22 GDP per Capita in target years

		2025	2030	2035
GDP per capita (US$)	High Case	2,008	2,871	4,107
	Low Case	1,741	2,296	3,033

Source: Study Team

Table 2.3.23 shows the estimated number of car owners in target years.

Table 2.3.23 Estimated Number of Car Owners

unit:number

		2020	2025	2030	2035
Vehicles	High Case	1,570,310	2,301,690	3,439,975	5,143,853
	Low Case	1,447,492	1,995,639	2,751,021	3,798,711

Source: Study Team

Table 2.3.24 shows the forecast result of number of cars and number of trade-in cars from 2020 to 2035. Study team assumes that the average life of an imported car is 15 years in Myanmar for the trade volume forecast.

Table 2.3.24 Forecast Result of Annual Increase in the Number of Cars (including Trade-ins)

		2020	2025	2030	2035
High Case	Numbers of cars	1,570,310	2,301,690	3,439,975	5,143,853
	Number of annual increase		146,276	227,657	340,776
	Number of trade-ins		153,446	229,332	342,924
	Increase total numbers		299,722	456,989	683,699
Low Case	Numbers of cars	1,447,492	1,995,639	2,751,021	3,798,711
	Number of annual increase		109,629	151,076	209,538
	Number of trade-ins		133,043	183,401	253,247
	Increase total numbers		242,672	334,478	462,785

Source: Study Team

It is expected that the domestic car production will increase in Myanmar in future. Study team assumes that the domestic car production in 2025, 2030 and 2035 is 50,000, 75,000 and 100,000 units respectively. The conversion weight is 1 ton/ unit.

Table 2.3.25 shows import car handling volume forecast of Yangon port.

Table 2.3.25 Import Cargo Handling Volume Forecast

unit: 000ton

		2025	2030	2035
Vehicles	High Case	270	382	584
	Low Case	213	259	363

Source: Study Team

⑦ Wheat

Wheat consumption volume is expected to increase. Wheat has been imported as container cargo, however, it is expected to be transported as bulk cargo when port facilities for bulk cargo are developed.

As port development to handle agro products is being carried out, consumption volume of wheat is expected to increase in the near future.

Consumption volume of wheat per capita is 50kg/year in Japan. Study team assumes that the consumption volume per capita in 2025, 2030 and 2035 will be 10kg/year, 12.5 kg/ year and 15 kg/year respectively.

Import volume of wheat

Year 2025: 0.010 ×57,313,000 = 573,130 ton

Year 2030: 0.0125×59,909,000 = 748,863 ton

Year 2035: 0.015 ×62,623,000 = 939,345 ton

⑧ Forecast Results of Main Import Commodities of Yangon Port

Tables 2.3.26 to 2.3.28 shows the forecast results of main import commodities of Yangon port in target years.

Table 2.3.26 Forecast Results of Main Import Commodities of Yangon Port（Year 2025）

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	21,371	19,957	18,543
Non Container Cargo			
Fuel	10,220	9,614	9,008
Others	6,223	5,731	5,239
Cement & Clinker	500	500	500
Edible Oil	639	639	639
Iron & Steel Products	940	894	848
Vehicles	270	242	213
Wheat	573	573	573
General Cargo and Others	3,301	2,884	2,466
Total	37,814	35,302	32,790

Source: Study Team

Table 2.3.27 Forecast Results of Main Import Commodities of Yangon Port (Year 2030)

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	31,881	28,703	25,524
Non Container Cargo			
Fuel	14,609	13,252	11,895
Others	7,455	6,636	5,816
Cement & Clinker	715	658	600
Edible Oil	669	669	669
Iron & Steel Products	1,294	1,192	1,090
Vehicles	382	321	259
Wheat	749	749	749
General Cargo and Others	3,646	3,048	2,449
Total	53,945	48,590	43,235

Source: Study Team

Table 2.3.28 Forecast Results of Main Import Commodities of Yangon Port (Year 2035)

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	47,613	41,405	35,197
Non Container Cargo			
Fuel	20,903	18,276	15,648
Others	9,582	7,928	6,273
Cement & Clinker	1,025	945	865
Edible Oil	699	699	699
Iron & Steel Products	1,816	1,621	1,425
Vehicles	584	474	363
Wheat	939	939	939
General Cargo and Others	4,519	3,251	1,982
Total	78,098	67,608	57,118

Source: Study Team

ii) Main Export Commodities

① Containerized Cargo Volume

Table 2.3.29 shows the export container cargo volume forecast of Yangon port.

Table 2.3.29 Export Container Cargo Volume Forecast of Yangon Port

unit: TEU

	2025	2030	2035
High Case	1,250,500	1,865,500	2,786,000
Low Case	1,085,000	1,493,500	2,059,500

Source: Study Team

Table 2.3.30 shows the export containerized cargo volume (weight).

Table 2.3.30 Export Containerized Cargo Volume (weight) of Yangon Port

unit: 000ton

	2025	2030	2035
High Case	8,253	12,312	18,388
Low Case	7,161	9,857	13,593

Source: Study Team

② Timber

Myanmar government placed an embargo on timber exports from 2015. Therefore, the study team assumes that there are no timber exports in target years.

③ Rice

As rice is a staple food, the average annual rice consumption volume per capita is over 100 kg in Asia. According to the FAO Food Balance Sheet 2007, Myanmar's average annual rice consumption volume is estimated as 157 kg per capita.

Domestic Consumption Volume in Year 2025

Foodstuff	0.157 ton/capita x 57,313,000＝8,998,141 tons
Animal food	4,000,000 tons
Seed	670,000 tons
Total	13,668,1413 tons

Production Volume （from FAO report 2008-2010 average）

Cultivation area 8,040,000 ha

Production Volume 32,820,000 ton （Chaff） 19,690,000 ton （Polished）

Unit production volume 4.08 ton/ha

Table 2.3.31 shows the rice export volume of Myanmar. Export volume steadily increased from 2013 to 2017.

Table 2.3.31 Rice Export Volume of Myanmar

unit: 000ton

		2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Rice Export	By Sea	609	391	471	242	687	1,719
	By Border	846	843	1,342	1,232	1,060	1,858
	Total	1,454	1,233	1,812	1,474	1,747	3,577

Source: Myanmar Rice Federation

There may be 5,000,000 – 6,000,000 tons remaining that could be exported, however, it is unlikely that the export volume would reach 5,000,000 tons due severe price competition, foreign exchange fluctuations and so on. Therefore, study team assumes that the maximum export rice volume is 4,000,000 ton and that the port handles half.

According to the information from Myanmar Rice Federation, about 40% of rice export volume by sea has been containerized. Therefore, study team assumes that rice export volume as break bulk is about 1,200,000

tons in target years.

iii) Forecast Results of Main Export Commodities of Yangon Port

Table 2.3.32 shows the forecast results of main export commodities of Yangon port in target years.

Table 2.3.32 Forecast Results of Main Export Commodities of Yangon Port（Year 2025）

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	8,253	7,707	7,161
Non Container Cargo	4,352	4,061	3,769
Rice	1,200	1,200	1,200
General Cargo and Others	3,152	2,861	2,569
Total	12,605	11,768	10,930

Source: Study Team

Table 2.3.33 Forecast Results of Main Export Commodities of Yangon Port（Year 2030）

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	12,312	11,085	9,857
Non Container Cargo	5,670	5,113	4,555
Rice	1,200	1,200	1,200
General Cargo and Others	4,470	3,913	3,355
Total	17,982	16,197	14,412

Source: Study Team

Table 2.3.34 Forecast Results of Main Export Commodities of Yangon Port（Year 2035）

unit:000ton

	High Case	Middle Case	Low Case
Container Cargo	18,388	15,991	13,593
Non Container Cargo	7,645	6,546	5,446
Rice	1,200	1,200	1,200
General Cargo and Others	6,445	5,346	4,246
Total	26,033	22,536	19,039

Source: Study Team

2.3.2 Port Development Plan

(1) Yangon Main Port

Based on the JICA report titled “The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area” (2014.6), the basic development policy of Yangon Port is set as below;

① No additional large terminal development at Yangon Main Port should be conducted but the

existing and planned port facilities for international trade cargo should be utilized as extensively as possible.

② Increase cargo handling productivity.

③ Enhance navigation security including the maintenance of channel depth.

④ The remaining water front areas should be used for facilities which directly benefit the lives of citizens such as passenger terminals, domestic transport terminals, promenades, shopping centers and office buildings.

⑤ Thilawa Area Port should be well utilized for port facilities which will handle future increasing international trade cargo.

⑥ Promotion of a new road network development connecting Thilawa area and the city and other areas should be contemplated in order to improve the existing poor road network.

⑦ The development of a deep water port near Yangon and the relocation of container terminals in Yangon Main Port shall be considered by Myanmar Government as a long term issue.

In line with the above mentioned basic development policy, it is realistic to handle the international cargo such as the containerized cargo at the four container terminals mentioned in section 1.2.1 (5) Yangon Port before concentrating the container handling operation at a new deep water port in Yangon. It is necessary to conduct a study on the development of a new container terminal at the northern part of Thilawa area as soon as possible in order to relieve the expected shortage of container handling capacity at Yangon Port even after the completion of the MPA Thilawa Terminal (ODA project) and the full operation of MITT Terminal. It is necessary to commence the study on a container terminal development project as soon as possible. The development of new container terminals will be needed even after the completion of MITT and MPA (ODA) terminals in Thilawa.

1) Future Cargo Demand and Necessary Facilities

The coastal cargo volume handled mainly at the Lamandaw Area since 2009 has remained at one million tons per annum level figure. On the other hand, the inland water cargo volume shows a declining trend since 2004, registering 600 thousand tons per annum in 2015. The demand of those cargoes is expected to increase due the economic development of the country, however, the annual increase rate of cargo demand is estimated at 3.8% in the report entitled “The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (2014.6) ”. According to this estimate, the annual demand of coastal shipping cargo and inland water transport cargo in 2030 can be estimated at 1.75 million tons and 1.05 million tons respectively as shown in Table 2.3.35.

The cargo handling productivity of coastal ships which employ mechanical handling and inland water transport ships which employ manual handling is estimated at about 500 tons per day and 120 tons per day respectively according to the Team’s observations. Assuming that berth utilization rate is 80%, annual cargo handling capacity of coastal ships is estimated at about 146 thousand tons. Consequently, 12 coastal shipping berths will be required to handle the annual cargo demand of 1.75 million tons. In case of the manual handling operation, 30 inland water transport berths would be required. If the manual handling is converted to mechanical handling, however, the annual cargo handling capacity per one inland water ship

berth becomes 105 thousand tons which is 3 times the manual handling capacity. Thus, the required number of the inland water transport berths becomes 10. Since existing 4 berths at Botataung can be used for inland water transport, the total number needed becomes 7.

The results of the above examination are shown in Table 2.3.35.

Table 2.3.35 Required Number and Total Length of Berths for Coastal and Inland Water Ships

	Annual Cargo Volume（2030）('000 ton)	Annual Handling Capacity (mechanical handling)/Berth ('000 ton)	Required Number of Berth	Length of One Berth	Required Berth Length
Coastal Shipping	1,750	146	12	70m	850m
Inland Water	1,050	105	7	70m	500m

Source: Study Team

The standard size of coastal shipping vessels is shown in Table 2.3.36.

Table 2.3.36 Dimensions of Typical Coastal Ship

Ship Type		Length		Width		Draft	
		feet	meter	feet	meter	feet	meter
Large Size	Steel	200	60	32	9.6	16	4.8
	Wooden	200	60	32	9.6	18	5.4
Small Size	Wooden/ Steel	99	30	20	6.0	12	3.6

Source: Myanmar Coastal Cargo Shipping Association

1) Port Facility Development Plan

The coastal and inland water transport of cargo and passengers are handled at such areas as Lamadaw, Pansodan and Botathaung. Pansodan and Botathaung where passenger transport is the major operation are situated very close to the city area. MPA has a plan to convert these areas into urban development areas including shopping centers, office buildings and passenger terminals by making use of the amenity-rich waterfront nature of these areas. Lanmadaw area (total length of about 1,500 m as shown in Figure 2.3.2) where the cargo handling area is quite narrow (maximum width is 150 m and minimum width is 20 m) handles almost all domestic cargo. In order to improve the cargo handling productivity, it is necessary to redevelop this area. Since this area is adjacent to the city area, it is recommended to use this area as an amenity-rich waterfront urban development space including shopping centers and office buildings. In addition to Lamadaw area, the port area at Kyeemyindang (total length of about 350 m as shown in Figure 2.3.3) which exclusively handles bananas is recommended to be redeveloped similar to Lamadaw area redevelopment.

Source : Study Team（Google Earth）

Figure 2.3.2　Location of Port Facilities at Lamadaw Area

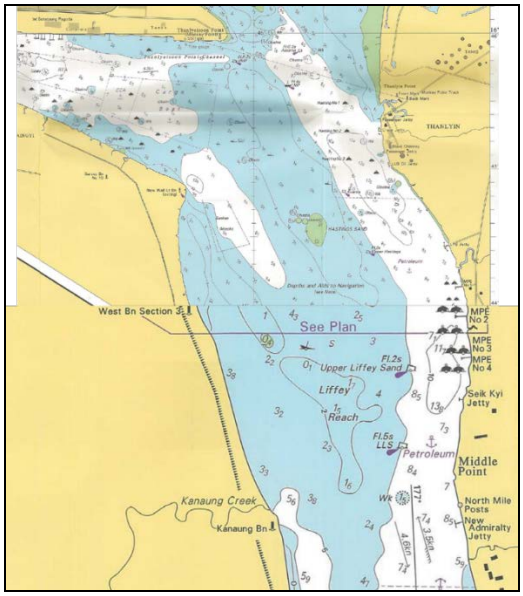
Source : Study Team（Google Earth）

Figure 2.3.3　Location of Port Facilities at Kyeemyindang Area

If the port facilities at Lamadaw and Kyeemyigang area are to be relocated, candidate areas for the relocation would have to have a sufficient water depth and be as close as possible to Yangon (large market). From this viewpoint, the eastern area of Thanlyin where sufficiently deep water area and land area are available was once evaluated as a candidate site (see Figure 2.3.3).

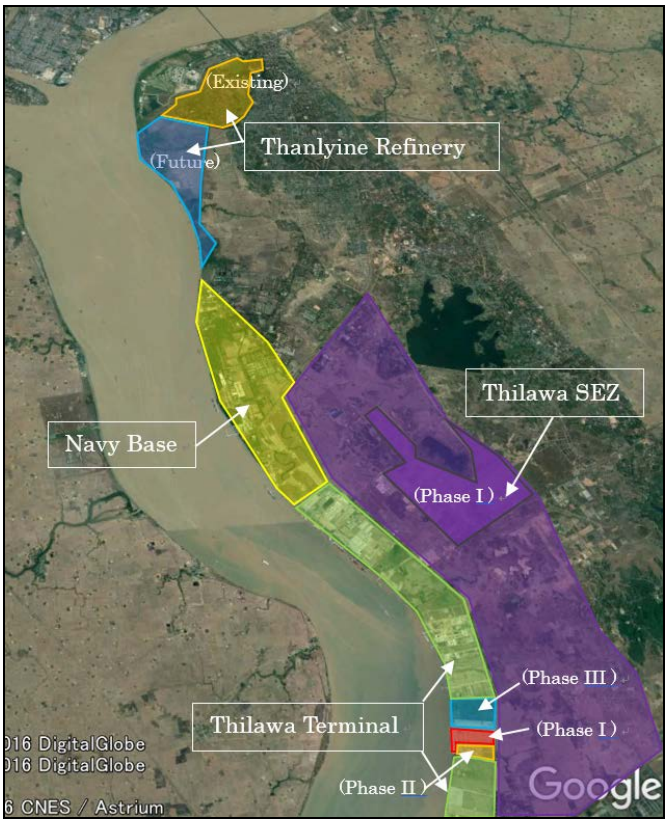
However, the Myanma Petrochemical Enterprise (MPE) of the Ministry of Electricity and Energy owns the area shaded in orange in Figure 2.3.5 and operates the refinery (production capacity is 20 thousand barrels per day). The refinery expansion project is expected at this area to increase production capacity to 100 thousand barrels per day by the year 2020. In addition, a further expansion project is expected in future by utilizing the area shaded in green in Figure 2.3.4. Further south of this area, there is a sufficiently deep water area for port development. However, this area cannot be used for the port development because it is owned and occupied by the navy.

Therefore, it is not possible to relocate the port facilities at Lamadaw and Kyeemyigang area in the vicinity of Yangon. The redevelopment of Lamadaw and Kyeemyigang area at their present locations is only solution that satisfies the requirement of providing space for urban development including waterfront amenity while still maintaining port function.



Source : Chart

Figure 2.3.4 Chart around Thanlyin Area



Source : Study Team (Google Earth)

Figure 2.3.5 Land use plan of Thanlyin Area

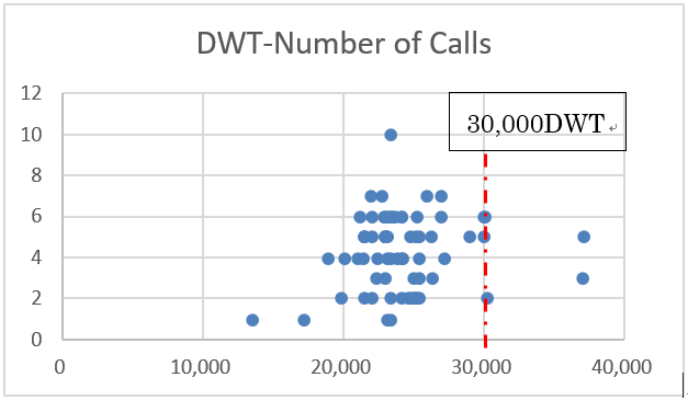
(2) Thilawa Area Port

1) Objective Ship for Planning

Based on the dimensions of ships calling at a port in the Bay of Bengal with similar navigation restrictions in draft (-9m), the size of objective ship for port planning is set as below;

i)Dead Weight Tonnage（DWT）

The relation between DWT and number of ship calls is shown in Figure 2.3.6.



Source: Study Team

Figure 2.3.6 Relation between DWT and Number of Ship Calls

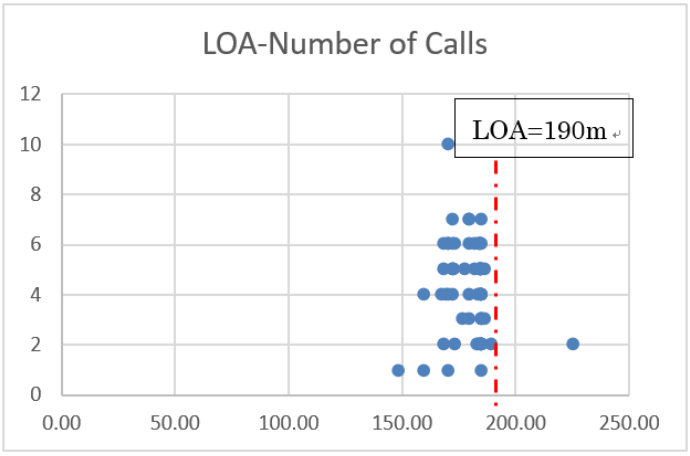
The maximum size is 37,000 DWT but the number of calls is not frequent. If 37,000DWT ship is adopted as the design ship, the design structure will be stronger than required and the construction cost will significantly increase. Therefore, the design ship is set at 30,000 DWT which is the maximum size among most ships as shown in Figure 2.3.6.

In case a ship of 37,000 DWT calls Thilawa Area Port, the berthing speed shall be reduced so that the berthing force falls below the design value.

ii) Length Overall（LOA）

The relation between LOA and number of ship calls is shown in Figure 2.3.7.

It is necessary for the terminal to accommodate all calling ships. Large ships with a LOA greater than 190 m can be accommodated by using continuous berth together with shorter LOA ships on the rare occasions when such vessels call. Therefore, the planned LOA is set at 190 m which is the maximum LOA among most ships.

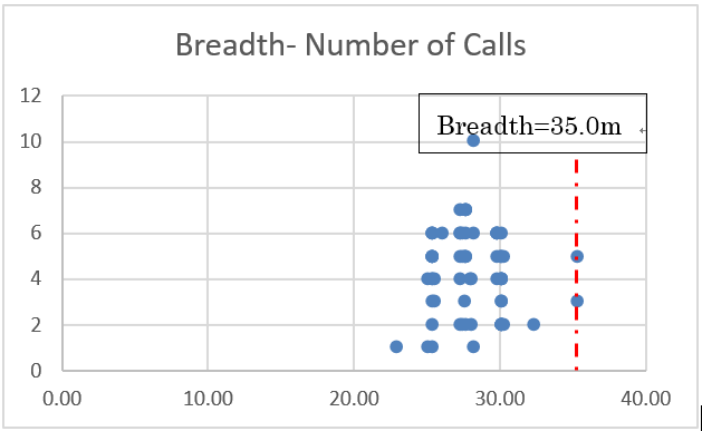


Source: Study Team

Figure 2.3.7 Relation between LOA and Number of Ship Calls

iii) Breadth of Ship

The cargo handling equipment (quay gantry crane) shall be prepared for any expected ship call; otherwise the port will lose business to competitors. Accordingly, the expected maximum breadth of 35 m is set as the design breadth based on the relation between the breadth and number of ship calls shown in Figure 2.3.8.



Source: Study Team

Figure 2.3.8 Relation between Breadth and Number of Ship Calls

iv) Ship Draft

The design ship draft shall be set at the draft restriction of -9 m at Thilawa Area Port.

2) Dimensions of Existing and Future Facilities

Table 2.3.37 shows area, number of slots in the container yard, length of berth, depth of berth and number of berths at each terminal.

Table 2.3.37 Dimensions of Major Terminals in Yangon Main Port and Thilawa Area Port

Name of Terminal	status	Area (ha)	Storage Capacity (Slots)	Length of Berth (m)	Depth of Berth (m)	Number of Berth
Hteedan Terminal		9.3	1,781	360	9.0	2
Hteedan Terminal (Yard Expansion)	future	3.7	225	270	9.0	1
Ahlone Terminal		9.5	2,629	614	9.5	3
Ahlone Terminal (Berth Extension)	future	—	0	238	9.5	1
Ahlone International Port Terminal (AIPT)		19.0	1,674	600	9.0	3
Myanmar Industrial Port Terminal (MIP)		43.0	5,000	750	10.0	3
Bo Aung Kyaw Terminal		9.6	1,000	457	9.0	2
Sule Pagoda Terminal		General Cargo	0	1,026	9.0	5
Myanmar International Terminals Thilawa		75.0	1,000	400	10.0	2

(MITT)						
MITT (Yard Expansion and Additional Gantry Crane Installation Phase I)	future	—	2,000	200	10.0	1
MITT (Yard Expansion and Additional Gantry Crane Installation Phase II)	future	—	5,000	400	10.0	2
MPA ODA Terminal (Phase I, Plot 25)		15.0	1,800	200	10.0	1
MPA ODA Terminal (Phase II, Plots 24 and 26)	future	30.0	3,600	400	10.0	2
MPA ODA Terminal (Phase III, Plots 22 and 23)	future	30.0	3,600	400	10.0	2
Total				6,315		30

Source: Study Team

i) Container Handling Capacity of Terminals at Yangon Main Port and Thilawa Area port

The container handling capacity of terminals is equivalent to the capacity of either the yard or berth, whichever is smaller. Those two capacities can be estimated as below;

a) Container Handling Capacity of Berth

Factors used to estimate the container handling capacity of a berth are described below (letters in brackets correspond with those in Table 2.3.40);

① Ship：・Number of loading/unloading containers per ship（a）
・Box Ratio (b)
・Number TEU of loading/unloading containers per ship (c)=(a) x (b)

② Crane：・Number of crane per berth (d)
・Number of box handled by a crane per hour (e)
・Handling efficiency of crane (f)
・Number of TEU handled by a crane per hour (g)=(d) x (b) x (e) x (f)
・Crane working hour per day (h)
・Berthing time for container handling with one ship call (i)= (c)/(g)/(h) x 24

③ Berthing Time：・Waiting time before unberthing including tide waiting (j)
・Total berthing time of one ship call (k)=(i) + (j)

④ Operation：・Annual operation days (l)
・Berth occupancy rate (%) (m)
・Annual berthing time (n)=(l) x (m)
・Number of annual ship calls (o)=(n)/(k)

⑤ Handling capacity of berth：Annual container handling capacity per berth (TUE/year/berth)
(p)= (c) x (o)

Monthly average number of ship calls and loading/ unloading containers are obtained from MPA's ship calling record for the two years between April 2016 and March 2018 at Yangon Main Port and Thilawa

Area Port (see Table 2.3.38).

Table 2.3.38 Container Ship Calling Records at Yangon Main Port and Thilawa Area Port

	Yangon Main Port	Thilawa Area Port
Number of Ships	63	22
Unloading（TEU）	597	256
Loading（TEU）	601	319
Total	1,198	574

Source: Study Team (prepared from MPA's record)

Ships entering Yangon Port must navigate shallow channels at the mouth of the Yangon River and at the entrance of Yangon Main Port. Therefore, ships make use of the tidal elevation to maintain sufficient water depth during port entry. Ships entering Thilawa Area Port can enter the port with one flood tide due to the short distance (16 km) from the river mouth but ships entering Yangon Main Port must wait for an additional flood tide due to the long navigation distance (32 km). One third of ships to Yangon Main Port loads and unloads a half of loaded containers at Thilawa Area Port by making use of tide waiting time as shown in Table 2.3.38.

When terminals in Thilawa Area Port become fully operational, all loaded containers will likely be handled at either Yangon Port or Thilawa Area Port. In other words, the current 600 TEUs of containers being handled at Thilawa Area Port by one third of the calling ships are expected to be handled at Yangon Port. Consequently, each ship calling Yangon Main Port will on average be carrying an additional 200 TEUs. Based on this assumption, the number of loading/unloading containers per one ship at Yangon Port will increase to about 1,400 TEUs (1,198 TEUs + 200 TEUs). Similarly, ships entering to Thilawa Area Port are expected to handle 1,400 TEUs per ship.

Performance indicators of gantry cranes at Yangon Port which are needed to estimate the container handling volume per crane and handling capacity of yard are summarized in Table 2.3.39.

Table 2.3.39 Performance Indicators (Actual and Planning) used to Estimate Container Handling Capacity at Yangon Port

Survey Items \ Terminals			AWPT	MIP	MITT	Planning Value
Handling Productivity of Gantry Crane	Average number of container units per hour	units/hour	21	25	22	22 25 (MPA Terminal)
	Average crane working hours per day	hours/day	18	13	?	18
Empty Container	Proportion to Export Container	%	60%	30~40%	40~45%	30%
Stacking Tears	Laden Container	high	4	5	4	4
	Empty Container	high	6	7	5	—

Yard Dwelling Day		day	11	7~10	7~12	7
Box Ratio	Proportion of 40’ and 20’		32%:68%	40%:60%	30%:70%	—
	(No. of 40'x2+No. of 20') /(No. of 40'+20')		1.32	1.4	1.7	1.4
Ship Berthing Hour		hours/ship	40~52	?	42	46 （Yangon）
Berth Occupancy Rate	Average annual berth occupancy rate	%	55%	42%	88%	60%

Source: Study Team

The handling capacity of berths estimated based on the planning values in Tables 2.3.38 and 2.3.39 is given in Table 2.3.40.

In this estimation, the handling productivity per crane at MPA ODA Terminal is set at 25 boxes per hour since performance levels at this terminal will be expected to reach international standards under the operation by an experienced high performing operator.

Table 2.3.40 Estimation of Container Handling Capacity at Berth

Item			Unit	Yangon Port Terminals	Thilawa Area Port Terminals	MPA ODA Terminal
Ship	a	Container Lifts/Ship	Box/ship	1000	1000	1000
	b		Box Ratio	1.4	1.4	1.4
	c		TEU/ship	1400	1400	1400
Crane	d	Number of Cranes/Berths	Unit/berth	2	2	2
	e	Handling Productivity	Box/hour/crane	22	23	25
	f	Handling Efficiency		0.9	0.9	0.9
	g	Container Handling per Hour	TEU/hour	55	55	63
	h	Working Hours per Day	hour/day	18	18	18
	i	Handling Hours per Call	hour/call	33.7	33.7	29.6
Berthing	j	Average Idling Time per Call including tide waiting	hour/call	6	6	6
	k	Total Berthing Time of Call	hour/call	45.7	39.7	35.6
Operation Time	l	Terminal Operation Time	day	365	365	365
	m	Berth Occupancy Rate	%	60	60	60
	n	Total Berthing Time per Year	hour/year	5,256	5,256	5,256

Ship Call	o	Number of Calls per Year	ship/year	132	138	148
Berth Capacity	p	Annual Container Handling Capacity of Berth	TEU/berth/year	185,490	192,597	206,525

Source: Study Team

b) Container Handling Capacity at Yard

Containers loaded/unloaded from ships at berth are transported from/to origin/destination through container yard. The handling capacity of the yard depends on container dwelling time.

The container handling capacity of the yard can be estimated using the following factors and equation.

① Number of slots at yard (a)
② Stacking tiers of container (b)
③ Storage working ratio (c)
④ Yard use peak factor (d)
⑤ Container dwelling days at yard (e)
⑥ Yard turnover rate (f)=365/(e)

Container handling capacity at yard (g)＝(a) x (b) x (c) / (d) x (f)

Container handling capacity at each container terminal calculated using factors in Tables 2.3.37 is given in Table 2.3.41.

Table 2.3.41 Estimation of Container Handling Capacity at each Container Terminal

Name of Terminal	Area (ha)	Number of Slots	Average Stacking Highs	Storage Capacity (TEUs)	Storage Working Ratio	Peak Factor	Container Dwelling Days	Yard Handling Capacity (TEUs/Year)
		(a)	(b)	(a) x (b)	(c)	(d)	(e)	(g)
Hteedan Terminal	9.3	1,781	4.0	7,124	0.70	1.3	7	200,020
Hteedan Terminal (Yard Expansion)	3.7	225	4.0	900	0.70	1.3	7	25,269
Ahlone Terminal	9.5	2,629	4.0	10,516	0.70	1.3	7	295,257
Ahlone Terminal (Berth Extension)	0.0	0	4.0	0	0.70	1.3	7	0
Ahlone International Port Terminal (AIPT)	19.0	1,674	4.0	6,696	0.70	1.3	7	188,003
Myanmar Industrial Port Terminal (MIP)	43.0	5,600	4.0	22,400	0.70	1.3	7	556,470
Bo Aung Kyaw Terminal	9.6	1,000	4.0	4,000	0.70	1.3	7	112,308
Myanmar International Terminals Thilawa (MITT)	75.0	1,000	4.0	4,000	0.70	1.3	7	112,308
MITT (Yard Expansion Phase I)		2,000	4.0	8,000	0.70	1.3	7	224,615
MITT		5,000	4.0	20,000	0.70	1.3	7	561,538

(Yard Expansion Phase II)								
MPA ODA Terminal (Phase I)	15.0	1,800	4.0	7,200	0.70	1.3	7	202,154
MPA ODA Terminal (Phase II)	30.0	3,600	4.0	16,800	0.70	1.3	7	404,308
MPA ODA Terminal (Phase III)	30.0	3,600	4.0	16,800	0.70	1.3	7	404,308

Source: Study Team

c) Container Handling Capacity of Terminal

The container handling capacity of the terminal is equivalent to the 1) Container Handling Capacity of Berth or 2) Container Handling Capacity of Yard, whichever is smaller. The container handling capacity (TEUs/year) of existing terminals and planned terminals is given in Table 2.3.42.

Table 2.3.42 Present and Future Container Handling Capacity at each Terminal

unit:thousand TEUs/Year

	Yard Handling Capacity	Berth Handling Capacity	Present Terminal Capacity	Future Terminal Capacity
Hteedan Terminal	200	371	200	200
Hteedan Terminal (Yard Expansion)	25	185		25
Ahlone Terminal	295	556	295	295
Ahlone Terminal (Berth Extension)	0	185		
Ahlone International Port Terminal (AIPT)	188	556	188	188
Myanmar Industrial Port Terminal (MIP)	561	556	556	556
Bo Aung Kyaw Terminal	112	371	112	112
Myanmar International Terminals Thilawa (MITT)	112	385	112	112
MITT (Yard Expansion Phase I)	224			224
MITT (Yard Expansion Phase II)	562	578		562
MPA ODA Terminal (Phase I)	202	206	202	202
MPA ODA Terminal (Phase II)	404	413		404
MPA ODA Terminal (Phase III)	404	413		404
		Total	1,665	3,285

Source: Study Team

3) Scale of Necessary Facilities and Development Schedule

The required capacity of terminals is estimated based on the handling capacity of existing terminals (see Table 2.3.42) and the demand forecast (see2.3.1). The terminal development schedule is prepared for three cases: the High Case, Low Case and Middle Case in the demand forecast.

It shall be noted that the development schedule of MPA ODA Terminal (Phase II (Plot 24 and 26) and Phase III (Plot 22 and 23)) will be affected by the development progress of MIP Thilawa and MITT terminal development.

i)High Case Demand Forecast

Although a capacity shortage is expected in 2022, MPA ODA Terminal Phase II will not be operational in time to cover the expected shortage due to the period needed for the implementation process and construction. However, capacity can be increased at MITT through container yard development and the installation of an additional gantry crane as MITT has a 1,000 m quaywall and a sufficiently wide yard area. It should be noted, however, that the capacity shortage can be covered by MITT Phase II-1 only until 2023. The operation of a new terminal will be needed in 2024. The MPA ODA Terminal II (404 thousand TEUs /year) will come into operation at that time to meet the demand.

A capacity shortage will surface again in 2027 even with the addition of the MITT Yard Expansion Phase II-2 (282 thousand TUEs/year). The commencement of terminal operation of MPA ODA Terminal Phase III (404 thousand TEUs /year) will be needed in 2027 in order to cover the shortage.

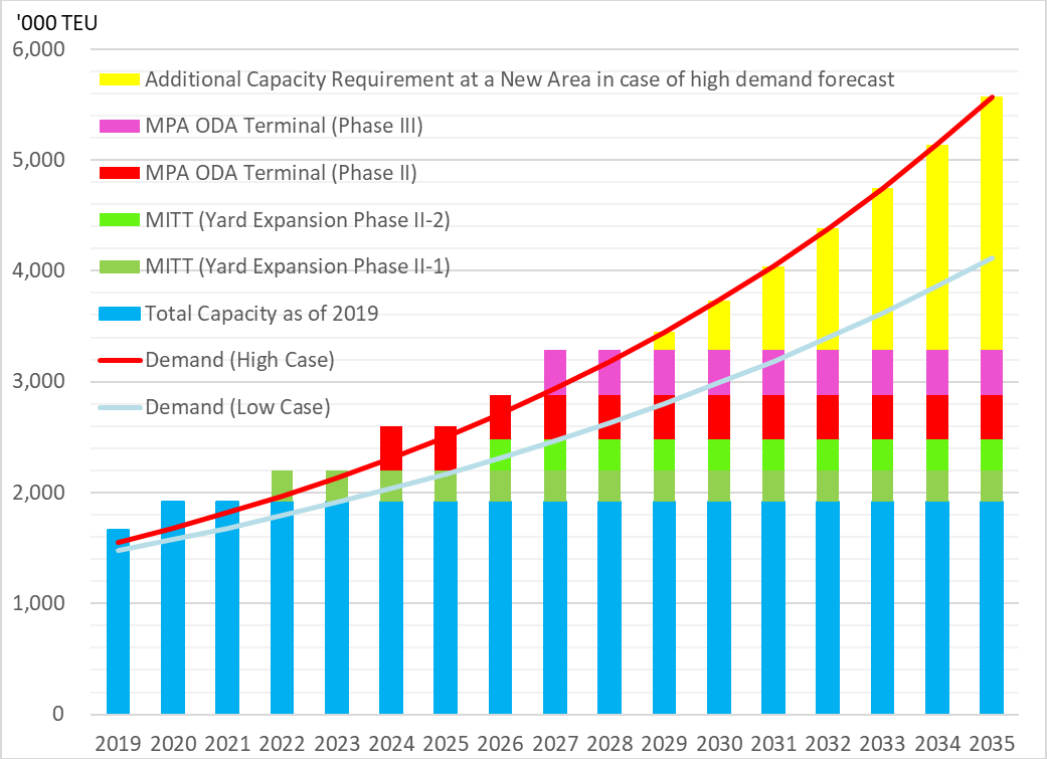
Even after the completion of all container terminal development projects in Yangon and Thilawa areas, a capacity shortage will be expected in 2029. In order to cover this shortage, it will be necessary to develop new terminals at a brand new location. The new location would ideally be in the vicinity of Yangon which represents the biggest market. The new location will be selected by carefully examining water depth requirements, channel sedimentation and other natural environmental conditions. The results of the above examination are shown in Table 2.3.43 and Figure 2.3.9

Table 2.3.43 Present and Future Container Handling Capacity of Terminals and Development Schedule (Demand Forecast: High Case)

unit: thousand TEUs

Terminals \ Carendar Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hteedan Terminal	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Hteedan Terminal (Yard Expansion)		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Ahlone Terminal	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295
Ahlone International Port Terminal (AIPT)	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188
Myanmar Industrial Port Terminal (MIP)	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556
Bo Aung Kyaw Terminal	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Myanmar International Terminals Thilawa (MITT)	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
MITT (Yard Expansion Phase I)		225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225
MPA ODA Terminal (Phase I)	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202
Total Capacity as of 2019	**1,665**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**
MITT (Yard Expansion Phase II-1)				280	280	280	280	280	280	280	280	280	280	280	280	280	280
MITT (Yard Expansion Phase II-2)								282	282	282	282	282	282	282	282	282	282
MPA ODA Terminal (Phase II)						404	404	404	404	404	404	404	404	404	404	404	404
MPA ODA Terminal (Phase III)									404	404	404	404	404	404	404	404	404
Total Capacity	**1,665**	**1,915**	**1,915**	**2,195**	**2,195**	**2,599**	**2,599**	**2,881**	**3,285**	**3,285**	**3,285**	**3,285**	**3,285**	**3,285**	**3,285**	**3,285**	**3,285**
Demand (High Case)	**1,552**	**1,680**	**1,820**	**1,971**	**2,134**	**2,311**	**2,504**	**2,712**	**2,937**	**3,181**	**3,446**	**3,733**	**4,043**	**4,380**	**4,745**	**5,140**	**5,568**
Demand (Middle case)	1,518	1,631	1,753	1,885	2,026	2,178	2,342	2,517	2,706	2,910	3,128	3,363	3,616	3,888	4,180	4,495	4,833
Demand (Low Case)	1,480	1,577	1,681	1,792	1,910	2,036	2,171	2,314	2,467	2,630	2,803	2,989	3,186	3,397	3,621	3,861	4,116
Additional Capacity Requirement at a New Area in case of high demand forecast											161	448	758	1,095	1,460	1,855	2,283

Source: Study Team



Source: Study Team

Figure 2.3.9 Development Schedule of terminals（Demand Forecast: High Case）

ii) Low Case Demand Forecast

Similar to the High Case Demand Forecast, provided that MITT Phase II-1 (280 thousand TEUs/year) becomes operational in 2024, MPA ODA Terminal Phase II (404 thousand TEUs/year) which is scheduled to be operational in 2026 can meet the demand. MPA ODA Terminal Phase III (404 thousand TEUs/year) which is scheduled to be operational in 2030 can meet the demand since the operation of MITT Phase II-2 (282 thousand TEUs/year) is expected in 2028. Terminal development at a new location will be needed after 2032.

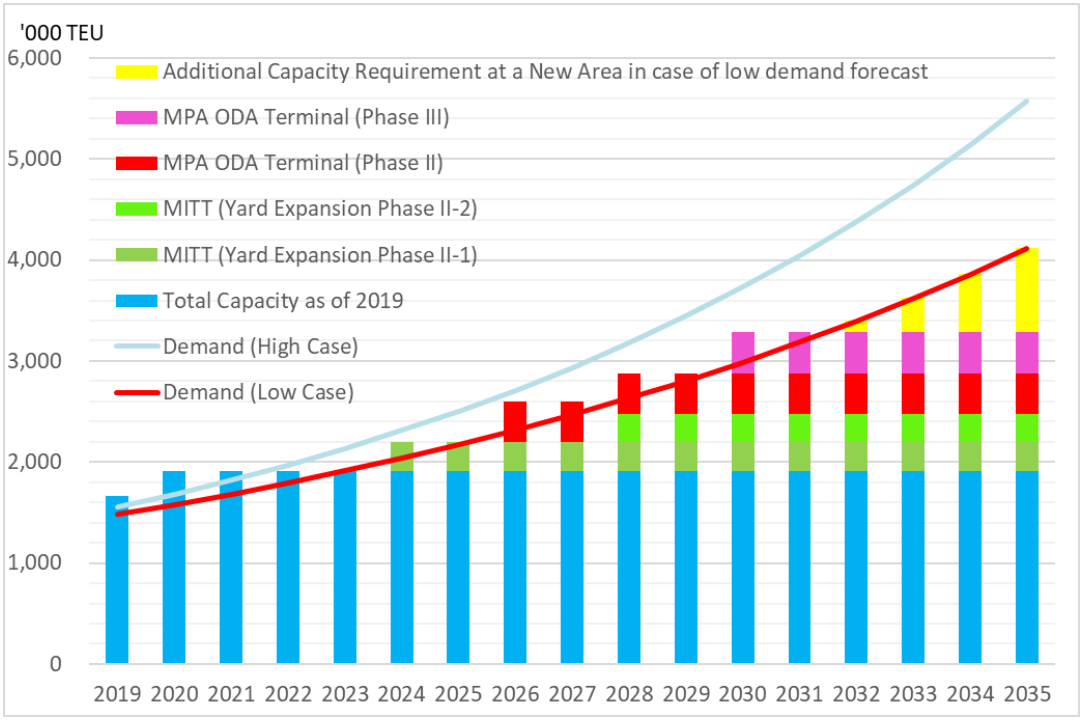
The results of the above examination are shown in Table 2.3.44 and Figure 2.3.10.

Table 2.3.44 Present and Future Container Handling Capacity of Terminals and Development Schedule (Demand Forecast: Low Case)

unit:thousand TEUs

Terminals \ Carendar Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hteedan Terminal	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Hteedan Terminal (Yard Expansion)		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Ahlone Terminal	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295
Ahlone International Port Terminal (AIPT)	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188
Myanmar Industrial Port Terminal (MIP)	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556
Bo Aung Kyaw Terminal	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Myanmar International Terminals Thilawa (MITT)	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
MITT (Yard Expansion Phase I)		225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225
MPA ODA Terminal (Phase I)	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202
Total Capacity as of 2019	**1,665**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**	**1,915**
MITT (Yard Expansion Phase II-1)						280	280	280	280	280	280	280	280	280	280	280	280
MITT (Yard Expansion Phase II-2)										282	282	282	282	282	282	282	282
MPA ODA Terminal (Phase II)								404	404	404	404	404	404	404	404	404	404
MPA ODA Terminal (Phase III)												404	404	404	404	404	404
Total Capacity	**1,665**	**1,915**	**1,915**	**1,915**	**1,915**	**2,195**	**2,195**	**2,599**	**2,599**	**2,881**	**2,881**	**3,285**	**3,285**	**3,285**	**3,285**	**3,285**	**3,285**
Demand (High Case)	1,552	1,680	1,820	1,971	2,134	2,311	2,504	2,712	2,937	3,181	3,446	3,733	4,043	4,380	4,745	5,140	5,568
Demand (Middle Case)	1,518	1,631	1,753	1,885	2,026	2,178	2,342	2,517	2,706	2,910	3,128	3,363	3,616	3,888	4,180	4,495	4,833
Demand (Low Case)	**1,480**	**1,577**	**1,681**	**1,792**	**1,910**	**2,036**	**2,171**	**2,314**	**2,467**	**2,630**	**2,803**	**2,989**	**3,186**	**3,397**	**3,621**	**3,861**	**4,116**
Additional Capacity Requirement at a New Area in case of low demand forecast														112	336	576	831

Source: Study Team



Source: Study Team

Figure 2.3.10 Development Schedule of Terminals (Demand Forecast: Low Case)

iii) Middle Case Demand Forecast

The terminal development schedule in case of middle case demand forecast can be estimated as shown in Table 2.3.45 and Figure 2.3.11.

The start of operation of MPA ODA Terminal Phase II can be postponed until 2025 one year behind the schedule of High Case estimate. For Phase III operation, it can be postponed until 2030 one year behind the schedule of High Case.

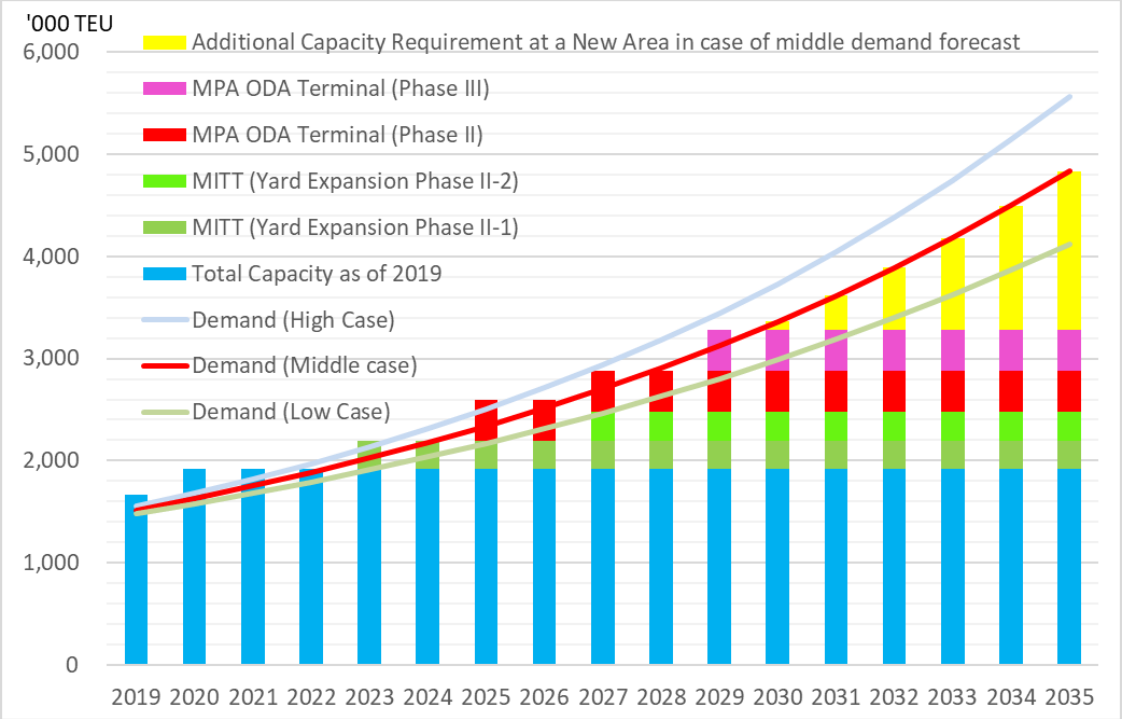
The operation of new port terminals at a brand new location is required after 2030.

Table 2.3.45 Present and Future Container Handling Capacity of Terminals and Development Schedule (Demand Forecast: Middle Case)

unit:thousand TEUs

Terminals \ Carendar Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hteedan Terminal	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Hteedan Terminal (Yard Expansion)		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Ahlone Terminal	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295	295
Ahlone International Port Terminal (AIPT)	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188
Myanmar Industrial Port Terminal (MIP)	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556
Bo Aung Kyaw Terminal	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Myanmar International Terminals Thilawa (MITT)	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
MITT (Yard Expansion Phase I)		225	225	225	225	225	225	225	225	225	225	225	225	225	225	225	225
MPA ODA Terminal (Phase I)	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202	202
Total Capacity as of 2019	1,665	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915	1,915
MITT (Yard Expansion Phase II-1)					280	280	280	280	280	280	280	280	280	280	280	280	280
MITT (Yard Expansion Phase II-2)									282	282	282	282	282	282	282	282	282
Total Expected Expansion by MIP &MITT	0	0	0	0	280	280	280	280	562	562	562	562	562	562	562	562	562
MPA ODA Terminal (Phase II)							404	404	404	404	404	404	404	404	404	404	404
MPA ODA Terminal (Phase III)											404	404	404	404	404	404	404
Total Capacity	1,665	1,915	1,915	1,915	2,195	2,195	2,599	2,599	2,881	2,881	3,285	3,285	3,285	3,285	3,285	3,285	3,285
Demand (High Case)	1,552	1,680	1,820	1,971	2,134	2,311	2,504	2,712	2,937	3,181	3,446	3,733	4,043	4,380	4,745	5,140	5,568
Demand (Middle Case)	1,518	1,631	1,753	1,885	2,026	2,178	2,342	2,517	2,706	2,910	3,128	3,363	3,616	3,888	4,180	4,495	4,833
Demand (Low Case)	1,480	1,577	1,681	1,792	1,910	2,036	2,171	2,314	2,467	2,630	2,803	2,989	3,186	3,397	3,621	3,861	4,116
Additional Capacity Requirement at a New Area in case of middle demand forecast												78	331	603	895	1,210	1,548

Source: Study Team

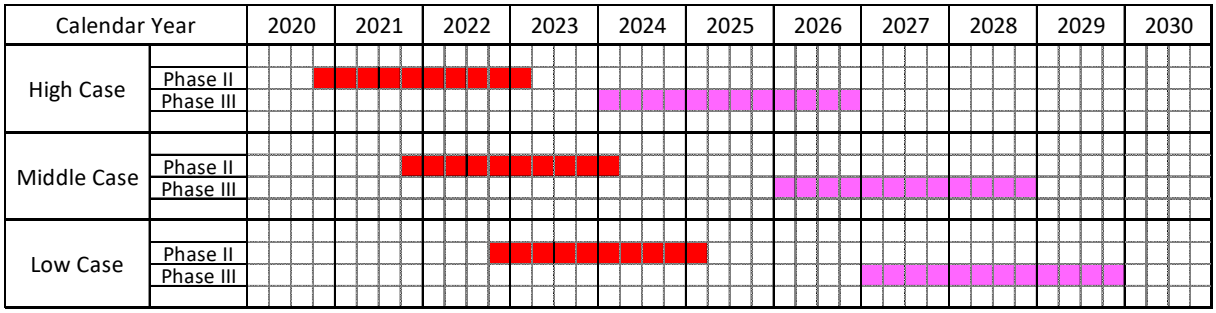


Source: Study Team

Figure 2.3.11 Development Schedule of Terminals (Demand Forecast: Middle Case)

iv) Summary

The construction schedule of MPA ODA Terminal Phase II (Plots 24 and 26) and MPA ODA Terminal Phase III (Plots 22 and 23) can be set based on the current and expected cargo handling capacity of existing terminals and expected expansion plans and future cargo demand. Yearly construction schedule of Phase II and Phase III terminals based on the demand forecast for three scenarios (High Case, Middle Case and Low Case) is summarized as shown in Figure 2.3.12.



Source: Study Team

Figure 2.3.12 Yearly Construction Schedule of Phase II and Phase III Terminals based on Three Different Demand Forecast Scenarios

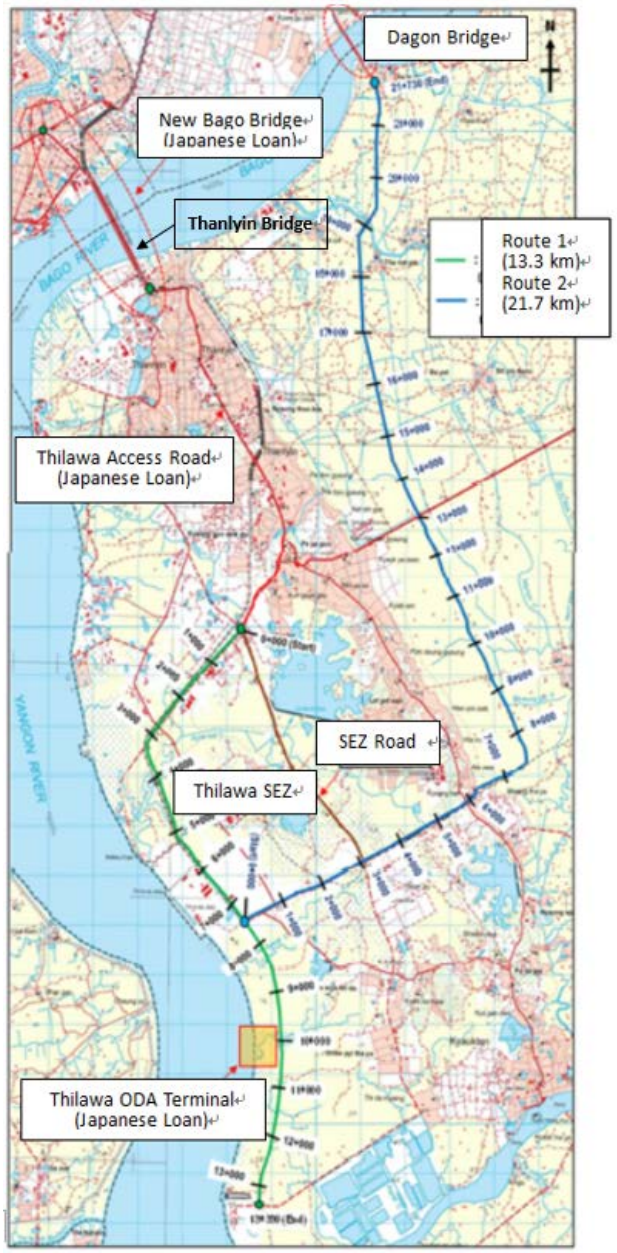
4) Access

i)Road

There are two road routes from Yangon to Thilawa area, namely Route 1 via Thanlyin bridge and Route 2

via Dagon bridge (see Figure 2.3.13). Truck traffic is prohibited at Thanlyin bridge (a two-lane road cum railway bridge) due to the load restriction of 20 t. Currently, construction of the new Bago bridge (1,224m in length and four lanes) downstream of Thanlyin bride is being carried out as a Japanese Yen loan project. In addition, a Japanese Yen loan road improvement project (8.7 km in length and four lanes) from this bridge to Thilawa area has been underway.

Due to the recent sudden increase in the number of cars, Yangon city is suffering from chronic traffic congestion. As a countermeasure to ease traffic congestion, truck traffic is restricted between 06:00 and 20:00 in the city area.



Source: Infrastructure Development Plan Study around Thilawa SEZ in Myanmar (METI, 2018.3)

Figure 2.3.13 Proposed Road Improvement Routes

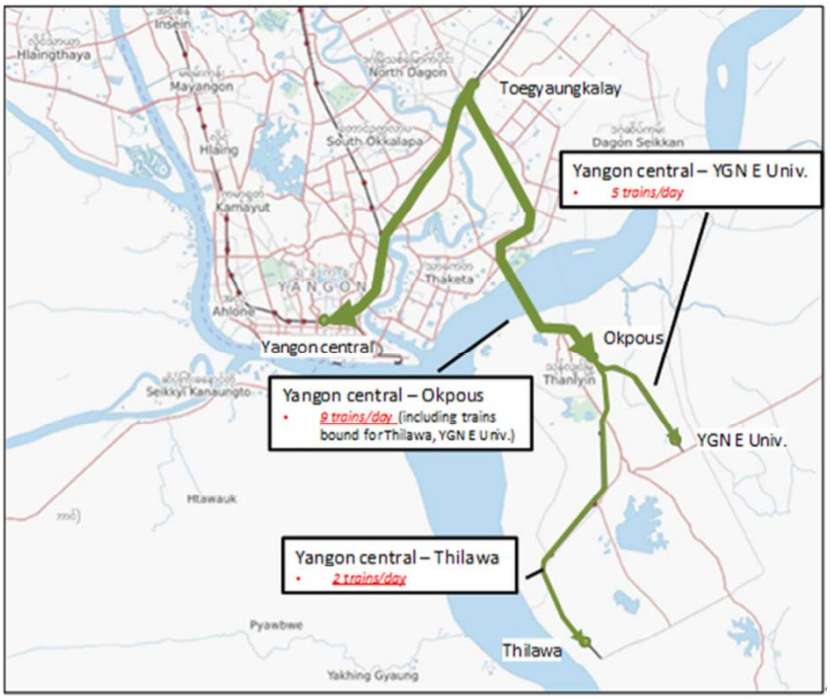
In the report entitled “Infrastructure Development Plan Study around Thilawa SEZ in Myanmar (METI,

2018.3)", two access routes from Thanlyin bridge to Thilawa Area Port are proposed as shown in Figure 2.3.13, namely Route 1, 13.3 km in length and 6 lanes (4 lanes in some sections) and Route 2, 21.7 km in length and 6 lanes, (also 4 lanes in some sections).

In order to operate Thilawa Area Port and SEZ efficiently, it is necessary to develop a road network by completing both current road projects and other road development projects which will be undertaken in the near future.

ii) Railway

The railway access to Thilawa Area through Thanlyin railway bridge is extended to both MMU direction and MITT direction as shown in Figure 2.3.14.



Source: Infrastructure Development Plan Study around Thilawa SEZ in Myanmar (METI, 2018.3)

Figure 2.3.14 Railway Access to Thilawa Area

All seaborne containers for Myanmar are handled in Yangon Port. According to the report entitled "Infrastructure Development Plan Study around Thilawa SEZ in Myanmar (METI, 2018.3)", it is assumed that the origin/destination of containers in Yangon area accounts for 60% of all containers, while Mandalay accounts for 30% and other areas account for 10%.

Generally, railway transport has an advantage over road transport when the hauling distance exceeds 500 km. Since the distance between Yangon and Mandalay is about 620 km, railway transport is a suitable transport mode in this section. However, due to insufficient development of the railway network compared to the road network, the cargo transport share in this section by railway is still low. It is expected that the share of railway cargo transport will increase in accordance with the increase in cargo transport demand

and the development of the railway network. For the time being, the government cargo is transported once a week to Mandalay from the railway terminal in MITT.

The major origin/destination of container cargo in Yangon is Mingaladon Industrial Area. The possibility of utilizing railway transport in the Yangon area as an alternative transport means is expected to increase because the daytime truck traffic in the city area is restricted as explained in section i) above.

Considering the expected increase in railway container transport in the future, the possibility of the realization of the railway network extension project for Thilawa SEZ and Thilawa Area Port needs to be examined. A separate feasibility study covering the items shown in Table 2.3.46 will be required.

There will be several alternative plans for the railway extension project. Among them, Plan A (railway container transfer terminal is to be located in Phase III ODA terminal area) and Plan B (to be located in Thilawa SEZ area) are shown in Figures 2.3.15 and 2.3.16 respectively. The detailed layout plan for Plan A is shown in section 3.3 for reference.

Source: Study Team (Google Earth)

Figure 2.3.15 Railway Development Plan A
(located in Phase III area, Exclusive use for ODA terminal)

Source: Study Team (Google Earth)

Figure 2.3.16 Railway Development Plan B
(located in SEZ area, common use with other cargo from SEZ and other terminals)

Table 2.3.46 Concept and Examination Items of Railway Development Plan

	Plan A **(to be developed at ODA terminal)**	**Plan B** **(to be developed at SEZ area)**
Concept	① Exclusive use for ODA terminal ② To be located in Phase III area (plot 23)	① To be used for ODA terminal cargo, SEZ cargo and other Thilawa terminal cargo including container break bulk and bulk cargo ② To be located in SEZ area
Items to be examined	① Demand forecast and transport capacity of railway ② Possible conflict between railway site and future road expansion site ③ Loading capacity of Thanlyin railway bridge ④ Project implementation entity and fund raising ⑤ Impact to the capacity of Phase III terminal	① Demand forecast and transport capacity of railway ② Possible conflict between railway site and future road expansion site ③ Loading capacity of Thanlyin railway bridge ④ Project implementation entity and fund raising ⑤ Possibility of interference between railway traffic and road traffic and crossing method between railway and road

Source: Study Team

3 Facility Development Plan of Yangon Port

3.1 Natural Conditions

In the study, natural conditions of the survey area were analyzed based on the existing information collected by the Study Team. The reference natural condition data from existing survey is shown in Table 3.1.1.

Table 3.1.1 Existing Natural Condition Data

Item		Implementation period	Implementation area	Reference	Chapter
Oceanographic Survey		-	Survey report of "Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport"	JICA Survey	3.1.1
Weather Observation /Disaster	Earthquake	-	Seismic hazard map	Myanmar Civil Engineering Society	3.1.2 (2)
	Tsunami	-	Survey report of "Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport"	JICA Survey	3.1.2 (3)
	Cyclone	-	Survey report of "Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport"	JICA Survey	3.1.2 (4)
Geotechnical Investigation		2012-2014	Thilawa port Plot 22-26：(Land)27 sites(Offshore)24 sites	JICA Survey	3.1.3
		2018	Thilawa port Plot 24, Plot 26：(Land)5 sites	MPA Survey	3.1.3
Bathymetric Survey		2012rainy season	Thilawa port Plot 22-26：about 900 m × 800 m	JICA Survey	3.1.4
		2018	Thilawa port Plot 22-24：about 600 m × 600 m	MPA Survey	3.1.4
Topographic Survey		2012rainy season	Thilawa port Plot 22-26：1km×1km	JICA Survey	3.1.5

Source: Study Team

Each of the detailed natural conditions is described below.

3.1.1 Hydraulic Condition

(1) Current

Thilawa Area Port is a river port and located about 20 km from the mouth of the Yangon River. Prominent features of the port are the tide difference over 6 m and the strong current resulted by the tide difference. Current speed of the Yangon River is very fast and according to the previous study “Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area” it could reach at 6 knot/hour at maximum when the adverse conditions occur simultaneously.

(2) Tide

The Myanmar Port Authority (MPA) and the Navy individually issue the tide table of Yangon Port. The tide levels applied in the previous study “Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area” is utilized as the design condition of the study. The tide levels of the design condition are as shown in Table 3.1.2.

Table 3.1.2 Tide Levels at Thilawa Area Port

Tide	HHWL	HWL	MWL	LWL	CDL
Hight (m)	+7.10 m	+6.24 m	+3.28 m	+0.33 m	+0.00 m

Source: Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area

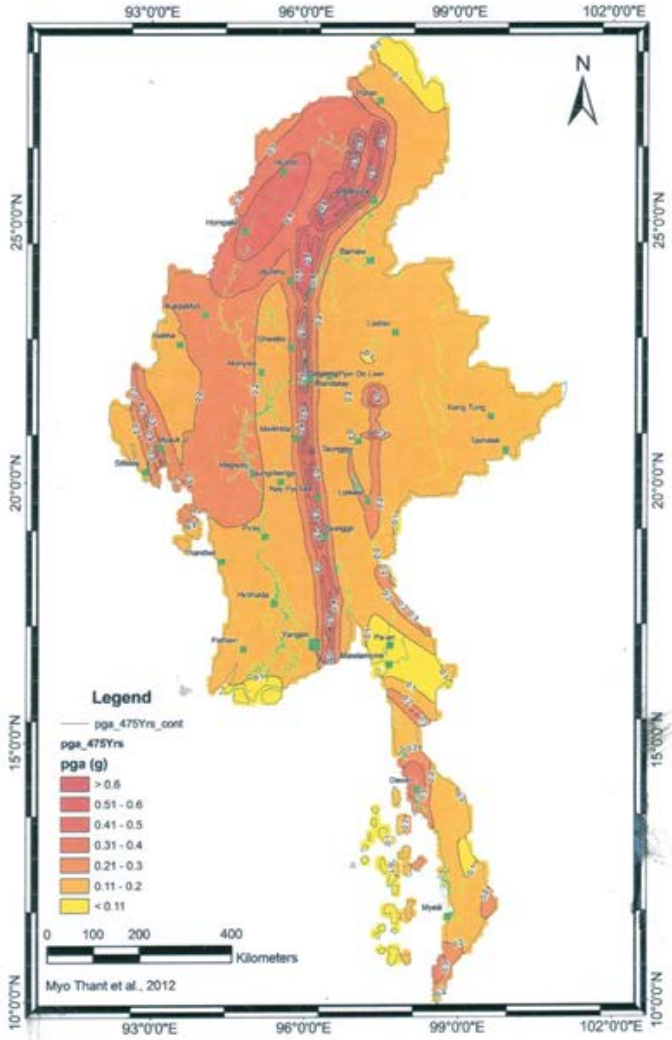
3.1.2 Climate Condition and Natural Disaster

(1) Climate

There are three seasons in Myanmar. Rainy season is from June to October when South West monsoon is dominant. In the rainy season, the monthly average rainfall is over 500 mm, the water volume is increased and the water level of Yangon River is increased by about 70 cm compared with the other seasons. Dry season is from November to March when North East monsoon is dominant and there is almost no rainfall between December and February. April and May are the Summer season with the temperature nearly 40 degrees Celsius.

(2) Earthquake

Myanmar is located on the border of Indian-Australian Plate and Eurasian Plate and the active fault runs from North to South. The Seismic Zone Map, issued by the Myanmar Earthquake Committee, is shown below. The area-wise peak ground acceleration (PGA) of Thilawa Area is 0.20 based on the figure above.



Probabilistic Seismic Hazard Map of Myanmar for 10% probability of exceedance in 50 years (475 years recurrent interval), the seismic hazard is described in term of peak ground acceleration (PGA) in g (firm rock).

Source: Myanmar Earthquake Committee

Figure 3.1.1 Updated Seismic Zone Map of Myanmar (2012)

(3) Tsunami

In Myanmar, earthquakes are occurred in the ocean because there are borders of tectonic plates existed around the country as described in the section (2) Earthquake above. According to the survey for "Urgent Project for Rehabilitation of Yangon Port and Main Inland Water Transport", the 2004 Indian Ocean Earthquake recorded the death toll as 60, affected people as 3,600 and financial damage as USD 265 million in Myanmar. However, there was no notable damage in Yangon.

(4) Wind and Cyclones

The wind in Yangon is very calm with yearly average wind speed is between 2.5 m/second and 3.5 m/second excluding May. From May to November, cyclones are developed in the Bengal Bay, and some of them sometimes attack Myanmar. According to the Joint Typhoon Warning Center, a joint organization by

United States Navy – Air Force command, there were 290 cyclones developed in the Bengal Bay in the past 65 years and 10% of them landed on Myanmar.

The Cyclone Nargis, which landed on Myanmar in May 2008, caused an enormous damage centered on Ayeyarwady Delta Area. According to the "Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area", when the Cyclone Nargis landed, the observation record of wind velocity at Thilawa Area Port was as shown in Table 3.1.3.

Table 3.1.3 Wind Velocity of Thilawa Area Port

	When Cyclone Nargis Landed
Maximum Wind Velocity	59.2 m/s
Maximum Instantaneous Wind Velocity	72 m/s

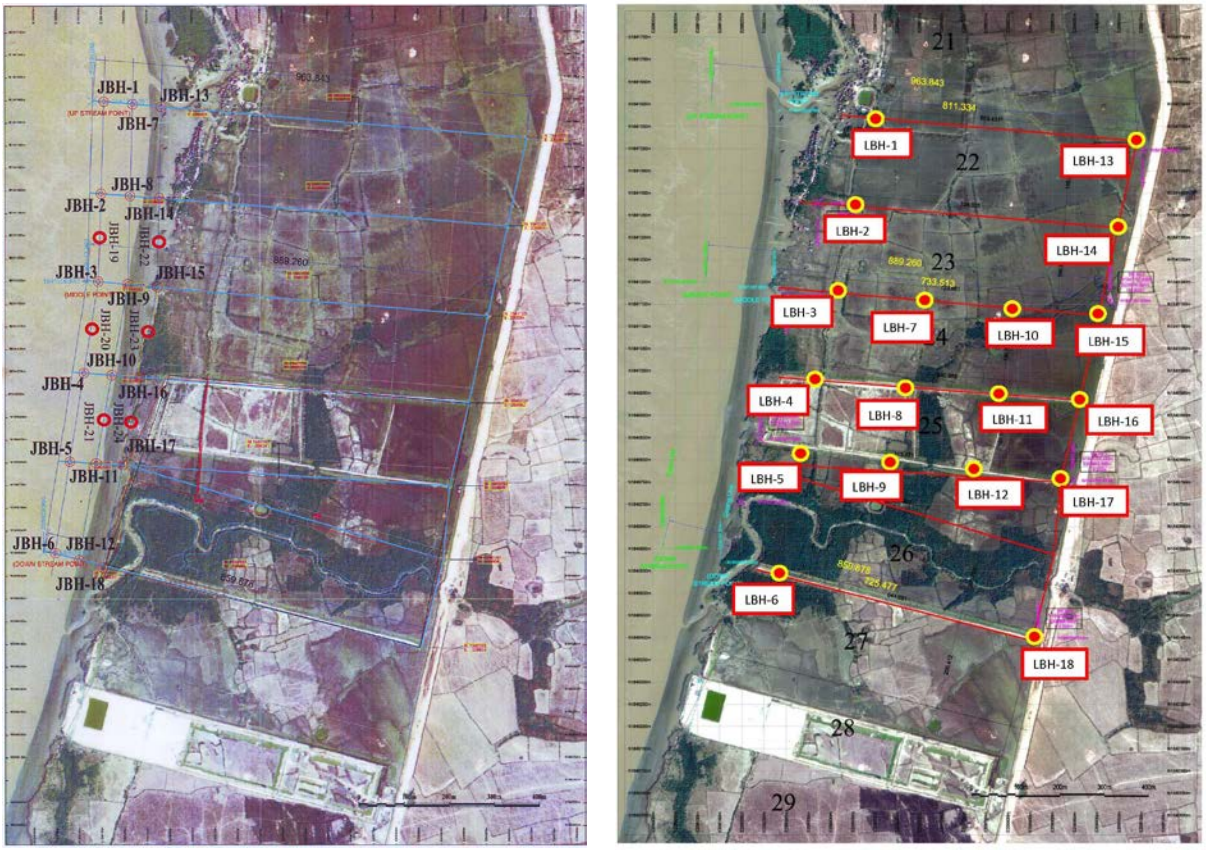
Source: Study Team

3.1.3 Soil Investigation

Soil condition of the Thilawa Area Port from Plot 22 to Plot 26 was examined based on the result of soil investigation carried out in 2013 in the "Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area".

(1) Investigation Area

Boring survey was carried out at 18 points on land area and 24 points at water area from Plot 22 to Plot 26 of Thilawa Area Port in 2013. The surveyed locations are shown below.



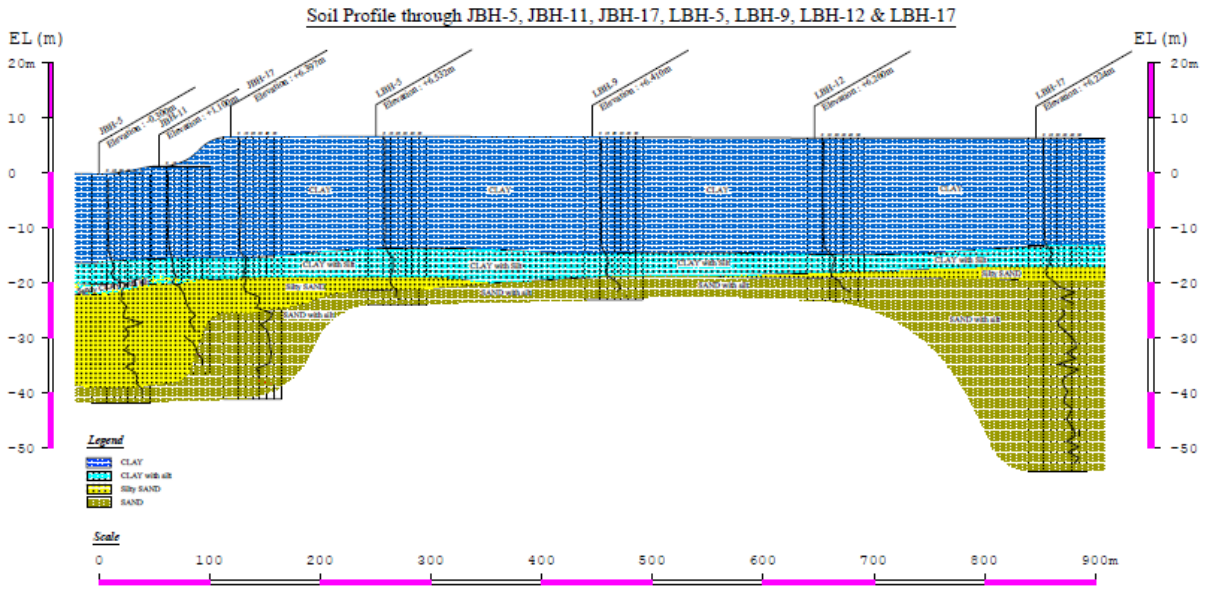
(a) Location Map of Water Area (b) Location Map of Land Area

Source: Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (JICA, 2014.6)

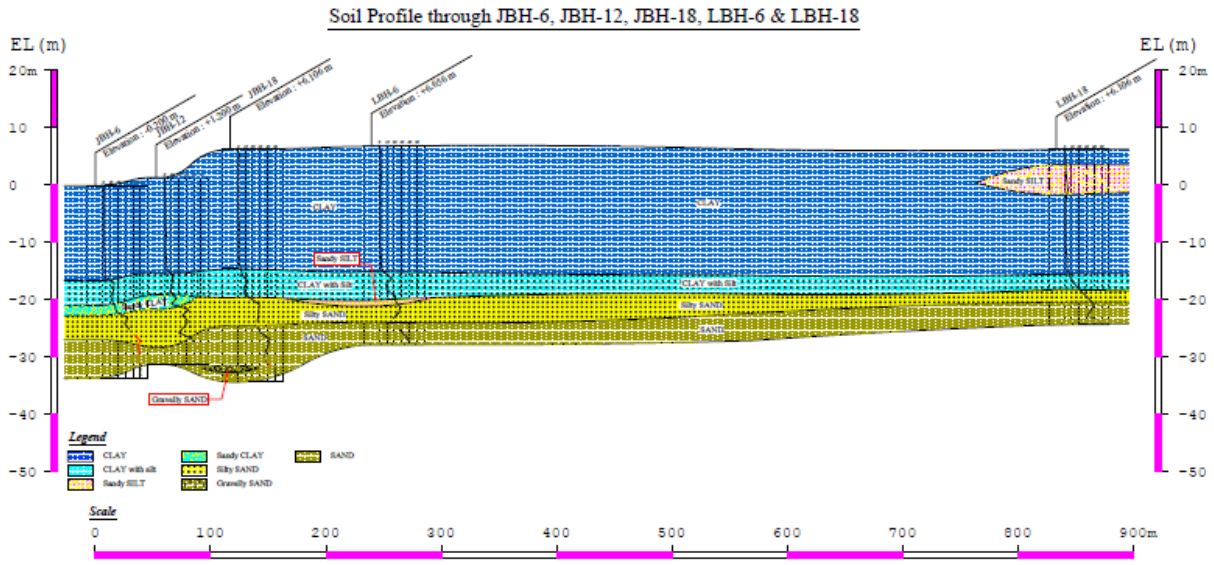
Figure 3.1.2 Location Map of Soil Investigation from Plot 22 to Plot 26 of Thilawa Area Port

(2) Results of Soil Investigation

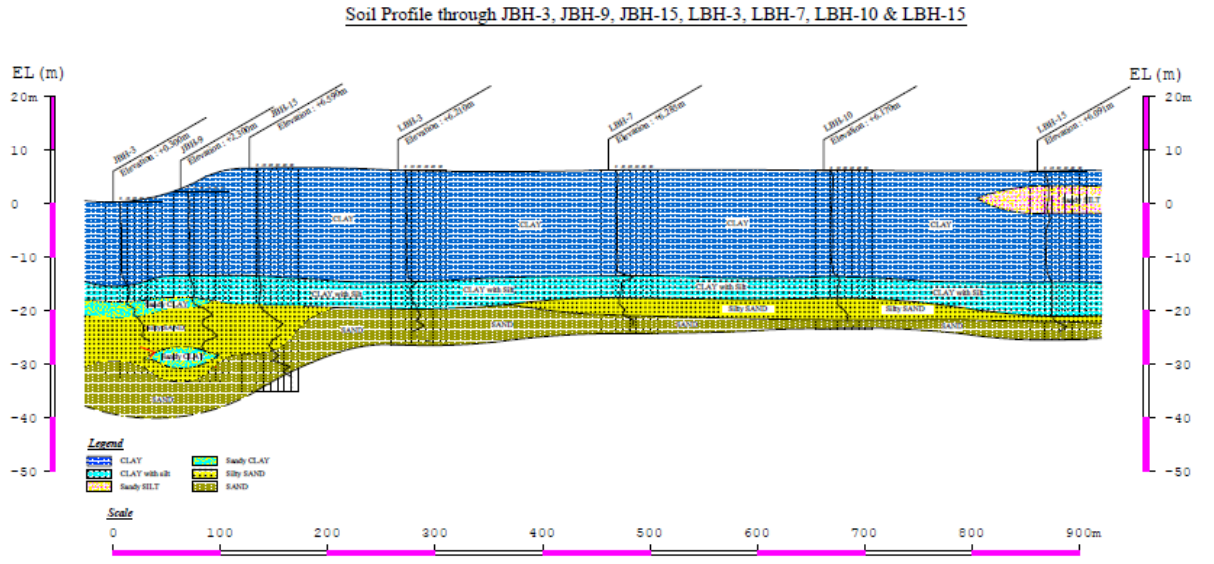
Soil profiles obtained by boring survey are shown below.



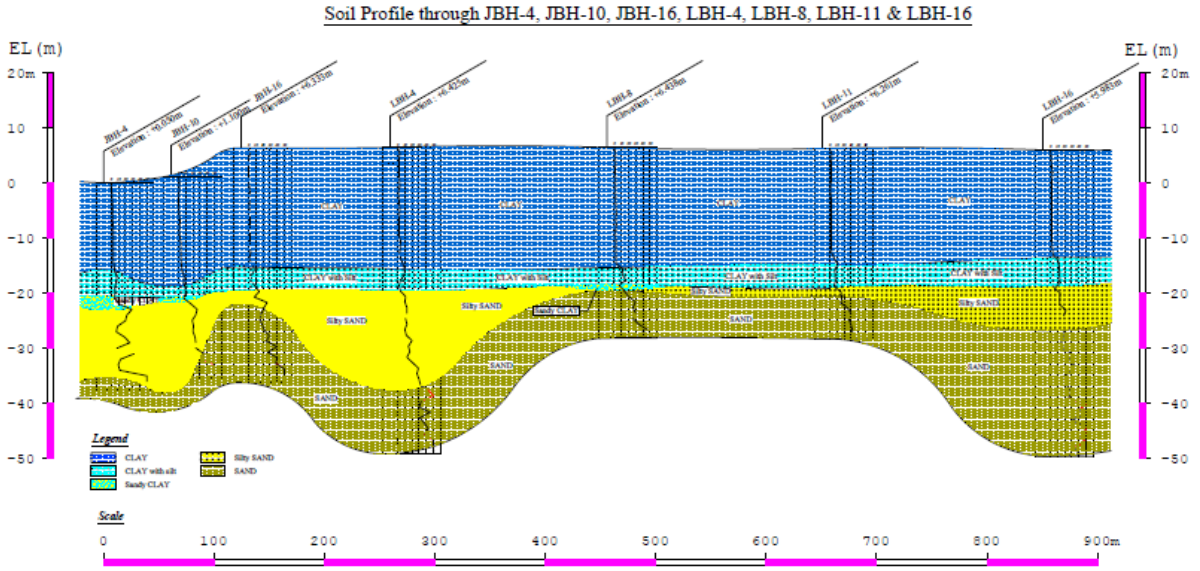
(a) Plot 26 North



(b) Plot 26 South



(c) Plot 24 North



(d) Plot 24 South

Source: Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (JICA, 2014.6)

Figure 3.1.3 Soil Profiles of Plot 24 and Plot 26 of Thilawa Area Port

From the soil profiles above, following points are confirmed on the soil condition of the surveyed area.

- From the upper layer to around CDL-20m, clay with N-value of 1 to 5 and silty clay with N-value of 10 are evenly accumulated.
- Most of the land side from around CDL-20m~-30m to the bottom are accumulated by sand which could be a bearing stratum.
- The N-value of the sand layer is varied from 20 to 50, and it tends to be higher when the location is deeper.
- The river side of Plot 24 South is the single point where silty sand with N-value of 10 to 20 is accumulated down to CDL-37m. The bearing stratum is around CDL-40m.
- At the river side, accumulated condition varies at the locations. Alternate layering of silt and sand is also confirmed. The bearing stratum is around CDL-30m~-40m or deeper.

(3) Results of Soil Laboratory Test

Based on the soil laboratory test, soil characteristics on the major test items at jetty (river side) and at yard (land side) are shown in Table 3.1.4 and Table 3.1.5.

Table 3.1.4 Soil Characteristics at Jetty

Test Item	Description of Test Result	Figure No.
Unit Weight γ (kN/m^3)	For upper clay layer, unit weight (γ) ranges from 16 kN/m^3 to 18 kN/m^3. For stiff silty clay layer, unit weight (γ) is approximately 20 kN/m^3.	3.1.4
Grain size: Fine content Fc (%)	For clay layer, fine content (Fc) is 100%. For sand layer, fine content (Fc) ranges from 10% to 40%	3.1.5
Unconfined Compression Strength qu (kN/m^2)	For upper clay layer, unconfirmed compression strength (qu) ranges from 50 kN/ m^2 to 100 kN/ m^2 which tend to increase toward a deep direction. For stiff silty clay layer, unconfirmed compression strength (qu) ranges from 100 kN/m^2 to 130 kN/m^2.	3.1.6
Direct Shear Strength Cuu (kN/m^2)	This test is carried out for upper clay layer with Un-drained condition. Cohesion (Cuu) ranges from 20 kN/m^2 to 30 kN/m^2.	3.1.7
Pre-consolidation Yield Stress Py (kN/m^2)	For upper clay layer, pre-consolidation yield stress (Py) ranges from 100 kN/m^2 to 180 kN/m^2 which distribute with depth widely. For stiff silty clay layer, pre-consolidation yield stress (Py) is 260 kN/m^2.	3.1.8
Compression Index (Cc)	For upper clay layer, compression index (Cc) ranges from 0.4 to 0.8. For stiff silty clay layer, compression index (Cc) is approximately 0.2.	3.1.9

Source: Study Team

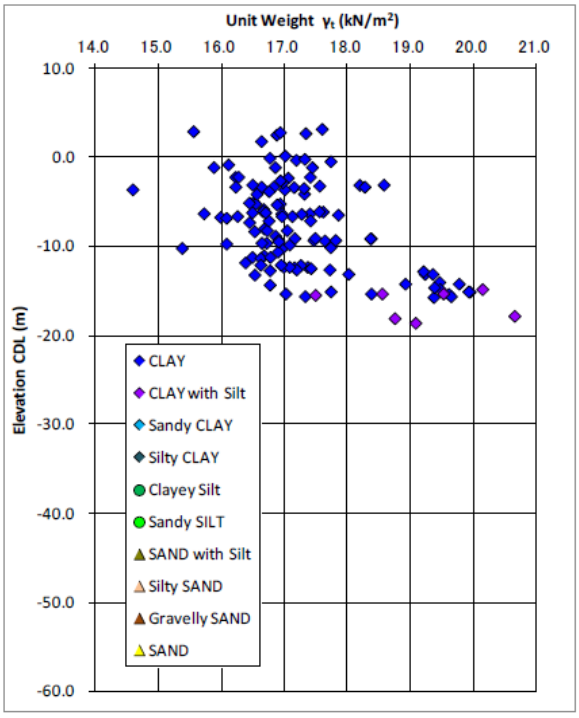


Figure 3.1.4 Unit weight (γ) with Depth

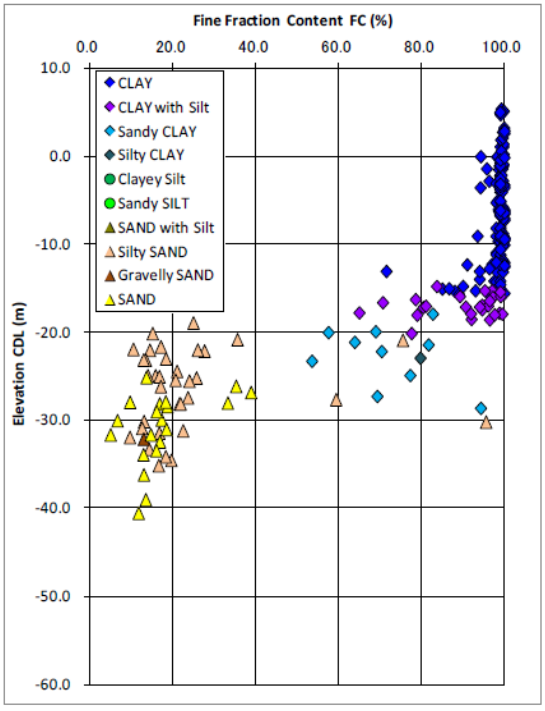


Figure 3.1.5 Fine Content (Fc) with Depth

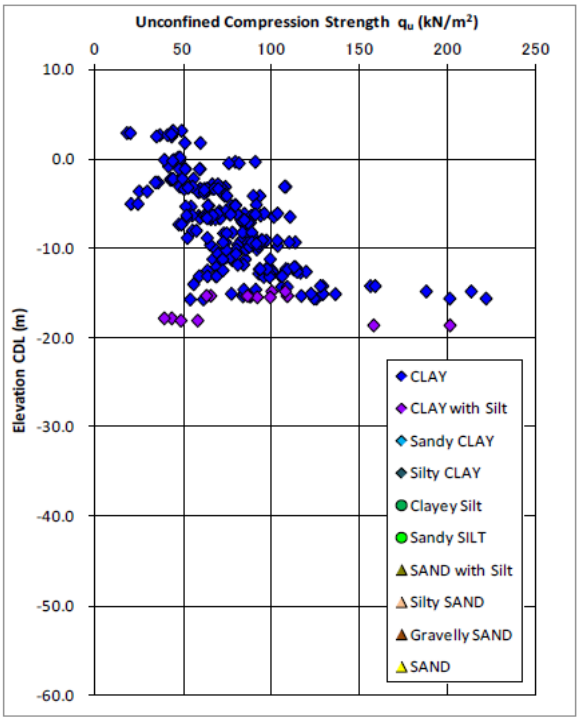


Figure 3.1.6 Unconfined Compression Strength (qu) with Depth

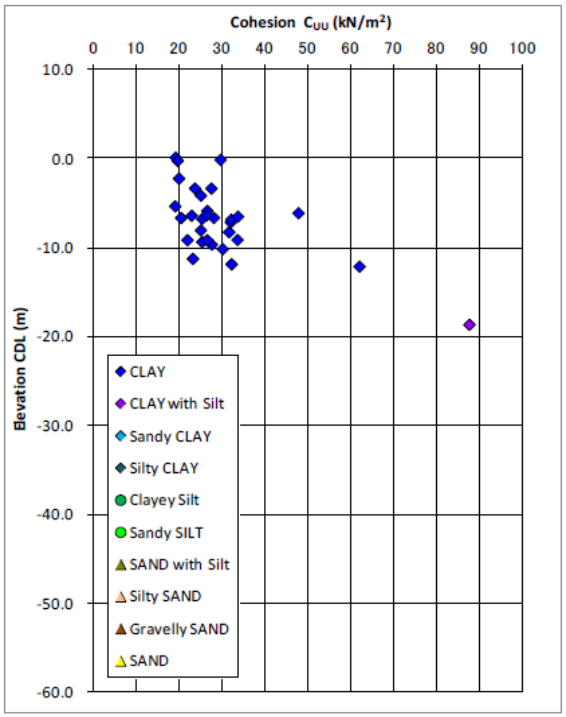


Figure 3.1.7 Cohesion (Cuu) with Depth

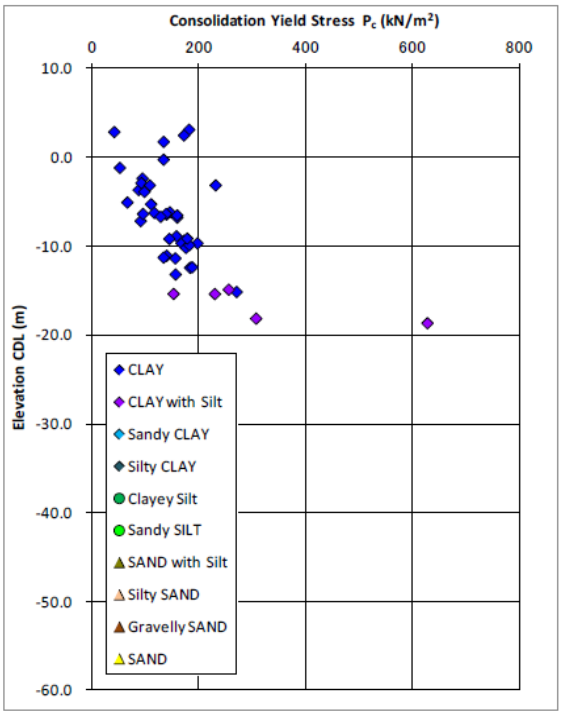


Figure 3.1.8 Pre-consolidation Yield Stress (Py) with Depth

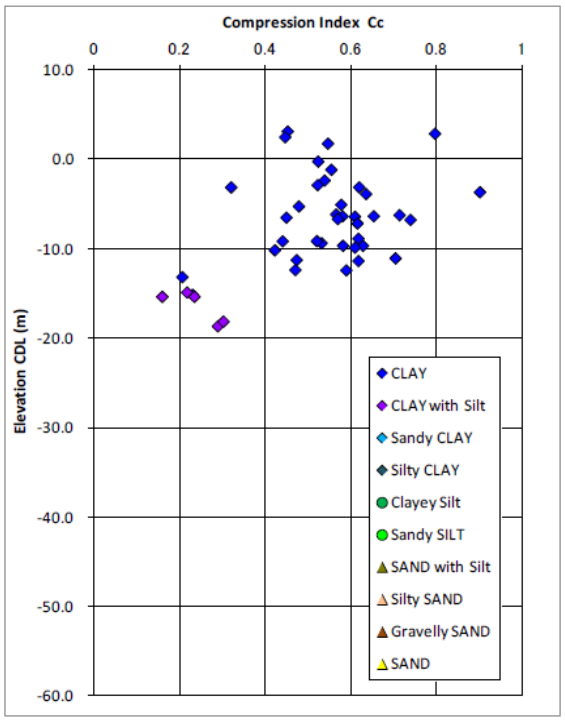


Figure 3.1.9 Compression Index (Cc) with Depth

Source: Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (JICA, 2014.6)

Table 3.1.5 Soil Characteristics at Yard

Test Item	Description of Test Result	Figure No.
Unit Weight γ (kN/m^3)	For upper clay layer, unit weight (γ) ranges from 16 kN/m^3 to 18 kN/m^3. For stiff silty clay layer, unit weight (γ) ranges from 19 kN/m^3 to 20 kN/m^3.	3.1.10
Grain size: Fine content Fc (%)	For upper clay layer, fine content (Fc) ranges from 95% to 100%. For stiff silty clay layer, fine content (Fc) ranges from 90% to 95%. For sand layer, fine content ranges from 10% to 20%.	3.1.11
Unconfined Compression Strength qu (kN/m^2)	For upper clay layer, unconfined compression strength (qu) ranges from 50 kN/m^2 to 100 kN/m^2 which tend to increase toward a deep direction. For stiff silty clay layer, unconfined compression strength (qu) ranges from100 kN/m^2 to 200 kN/m^2.	3.1.12
Direct Shear Strength Cuu (kN/m^2)	This test is carried out for upper clay layer with Un-drained condition. Cohesion (Cuu) is obtained from the test. Cuu tanges from 15 kN/m^2 to 30 kN/m^2.	3.1.13
Pre-consolidation Yield Stress Py (kN/m^2)	For upper clay layer, pre-consolidation yield stress (Py) ranges from 70 kN/m^2 to 200 kN/m^2 which tend to increase toward a deep direction. For stiff silty clay layer, pre-consolidation yield stress (Py) is more than 200 kN/m^2.	3.1.14
Compression Index (Cc)	For upper clay layer, compression index (Cc) ranges from 0.3 to 0.9. For stiff silty clay layer, compression index (Cc) is approximately 0.2.	3.1.15

Source: Study Team

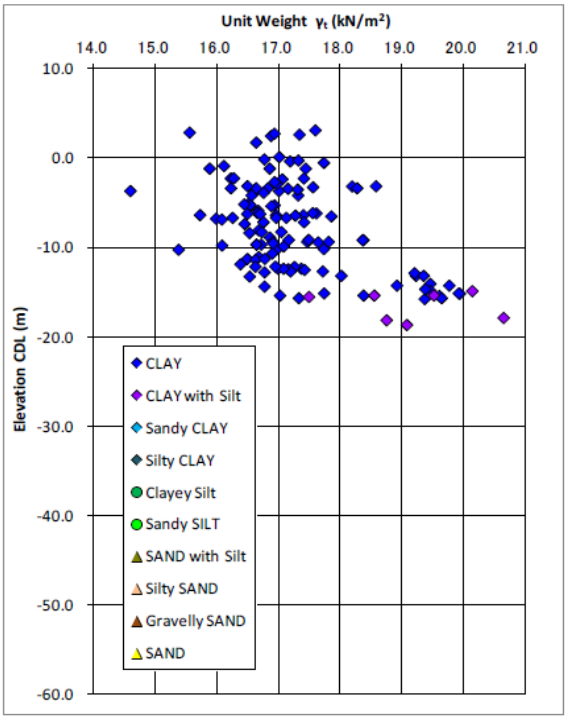


Figure 3.1.10 Unit weight (γ) with Depth

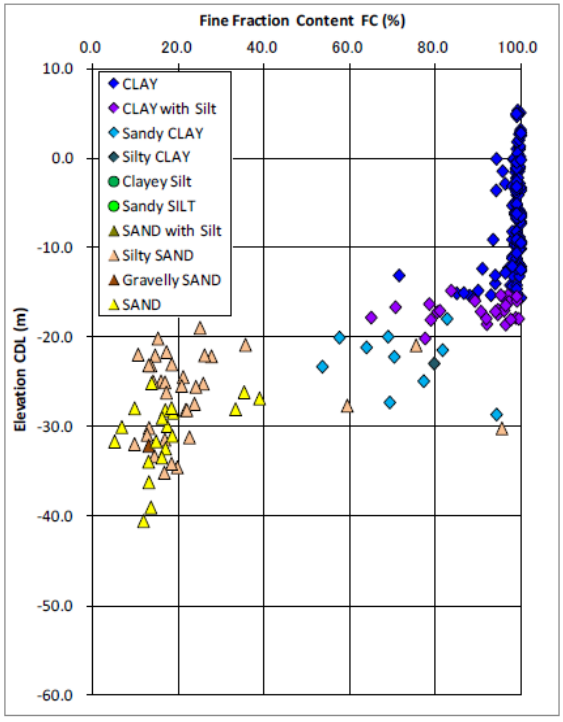


Figure 3.1.11 Fine Content (Fc) with Depth

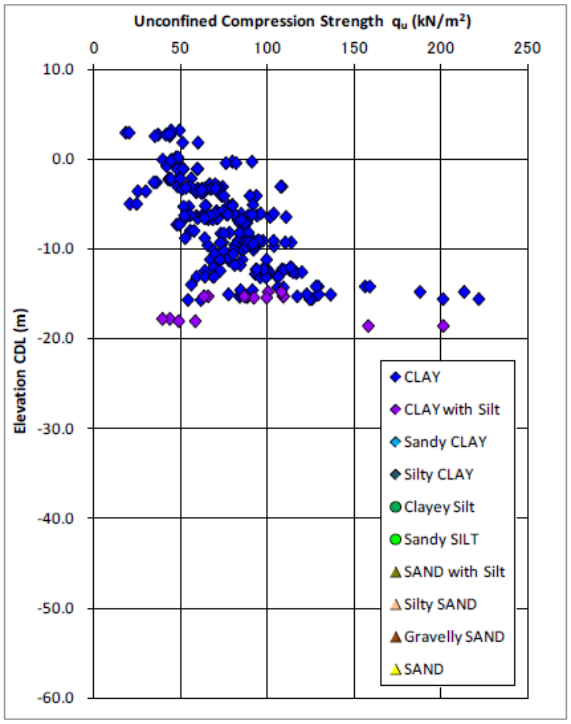


Figure 3.1.12 Unconfined Compression Strength (qu) with Depth

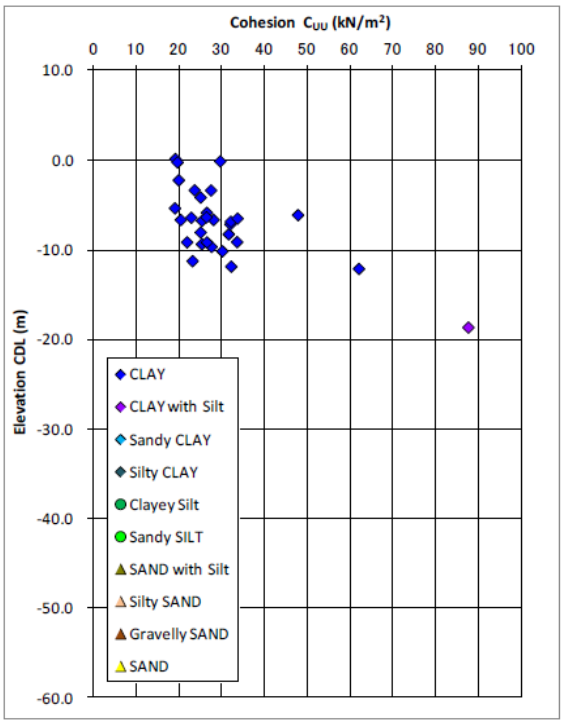


Figure 3.1.13 Cohesion (Cuu) with Depth

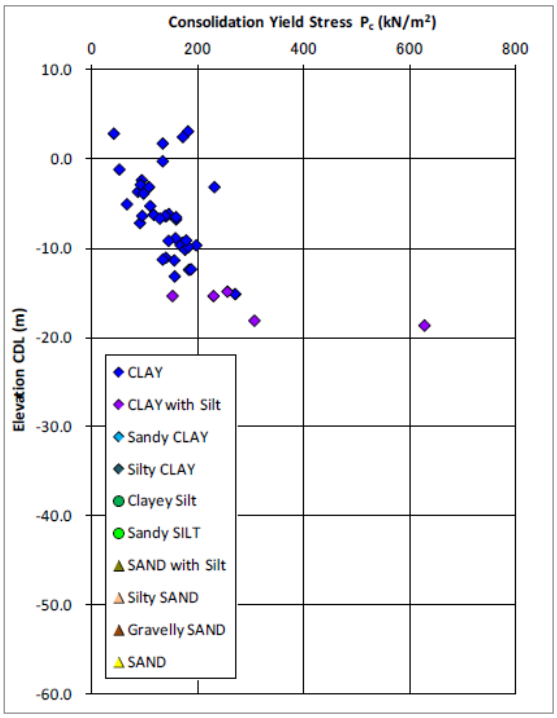


Figure 3.1.14 Pre-consolidation Yield Stress (Py) with Depth

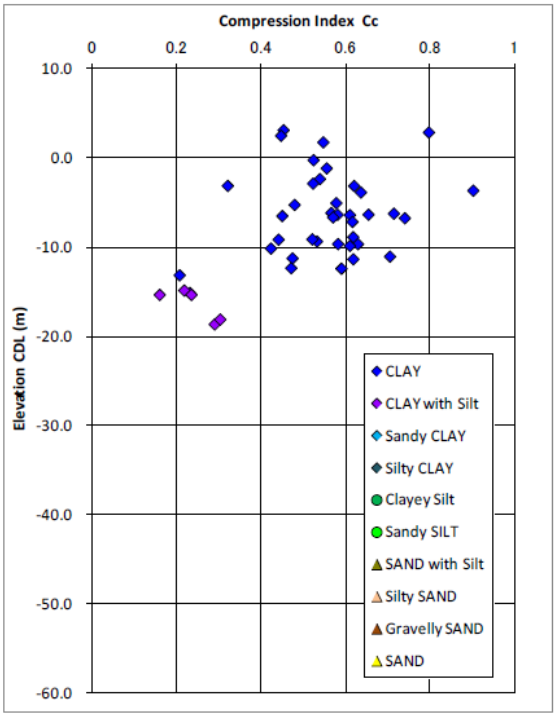


Figure 3.1.15 Compression Index (Cc) with Depth

Source: Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area

(4) MPA's Supplemental Survey in 2018

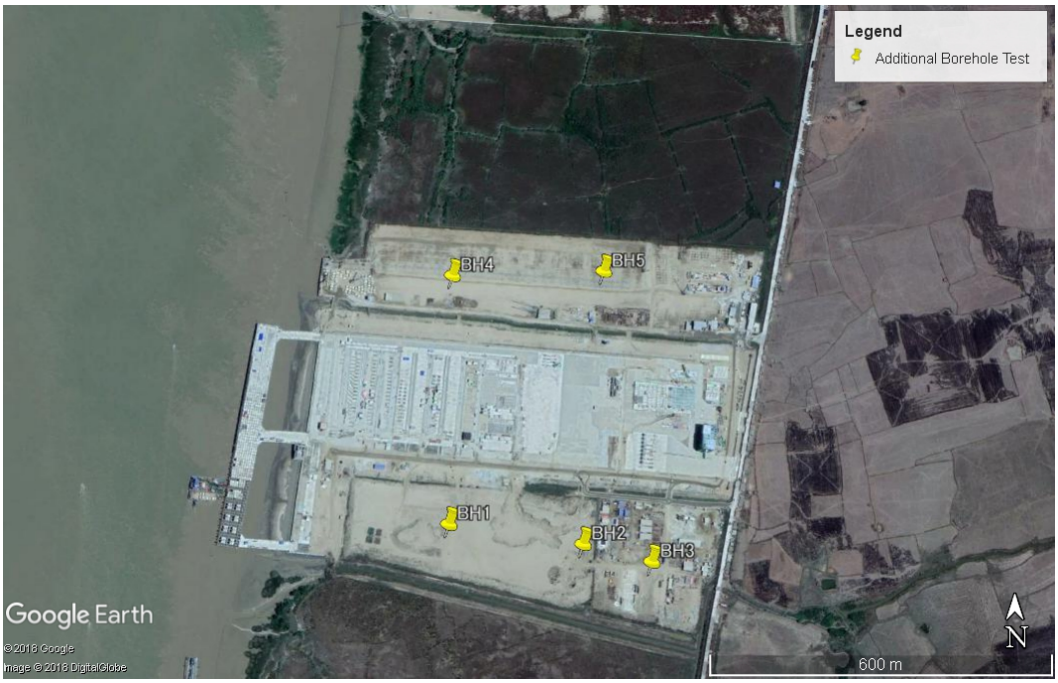
As a supplemental survey, the 5 boring tests in Plot 24 and Plot 26 were conducted in May and June, 2018 by MPA. The contents and location of the supplemental survey are as shown in Table 3.1.6 and

Figure 3.1.16.

Table 3.1.6 The Contents of the Boring Test

No.	Location	Objective	Drilling Length	Surveyed Period
BH1	Plot 26	To investigate influence of the reclamation sand and the old stream through the Plot 26	45.5 m	May/June, 2018
BH2	Plot 26		41.5 m	May/June, 2018
BH3	Plot 26		40.5 m	May/June, 2018
BH4	Plot 24	To investigate influence of the construction work of the Phase I project in Plot 25	40.5 m	May/June, 2018
BH5	Plot 24		42.5 m	May/June, 2018

Source: MPA



Source: MPA Survey (Google Earth)

Figure 3.1.16 Location Map of Boring Test

In result, soil profile and characteristics are as follows.

- From the upper layer to around CDL-15 m, very soft silty clay with N-value of 1 to 5 is evenly accumulated. From around CDL-15 m to around CDL-20 m, stiff silty clay with N-value of 10 to 20 is evenly accumulated.
- Around the surface layer (CDL -1 m to -3 m), the medium stiff clay layer with N-value of 5 to 11 is accumulated. Stiffness of the surface layer is considered due to construction work.
- From around CDL-20 m to the bottom are accumulated by sand which could be a bearing stratum.
- The N-value of the sand layer is varied from 20 to 50, and it tends to be higher when the location is deeper.
- According to the result in 2013, the point where silty sand with N-value of 10 to 20 is accumulated down to -30 m or more was at the river side of Plot 24. However, the survey in 2018 shows the soil condition of Plot 24 was stable. The soil deposition condition observed in the previous survey was not

found.

(5) Summary of the Soil Condition

- There is little difference between the results in 2013 and 2018 excluding the N-value of the surface layer. Therefore, the construction work of Phase I project is hardly influenced on the soil condition.
- At Plot 22 to 26, the soil condition of the yard area is not so different. But, the soil condition at riverside is different from place to place. Therefore, additional survey at riverside is necessary at the stage of detailed design.

3.1.4 Bathymetric Survey / Channel Sedimentation

The condition of water depth and channel sedimentation of the Thilawa Area Port from Plot 22 to Plot 26 was examined based on the results of bathymetric survey carried out in 2013 in the “Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area”. And the result of bathymetric survey carried out in 2018 as a supplemental survey by MPA also considered.

(1) Survey Area

The survey areas in 2013 and 2018 are as shown in Figure 3.1.17. The survey in 2013 was carried out in a wide range, from Plot 22 to Plot 26 because its purpose was for designing jetty and navigation channel. The survey in 2018 was carried out at the area from Plot 22 to Plot 24.

Source: Study Team (Google Earth)

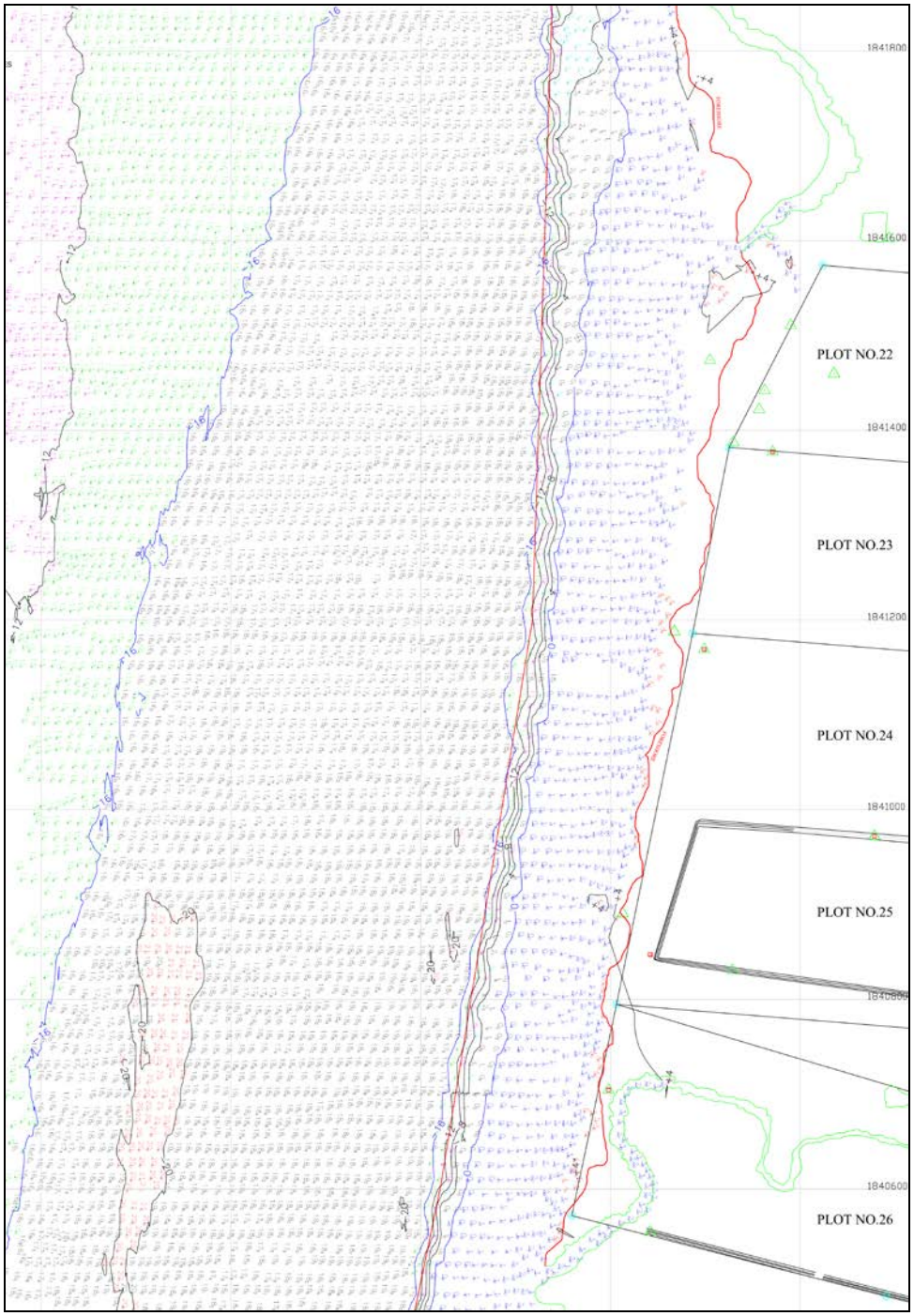
Figure 3.1.17 Location Map of Bathymetric Survey from Plot 22 to Plot 26 of Thilawa Area Port

(2) Results of Bathymetric Survey

The plain view of the bathymetric survey in 2013 is shown in Figure 3.1.18. The plain view of the

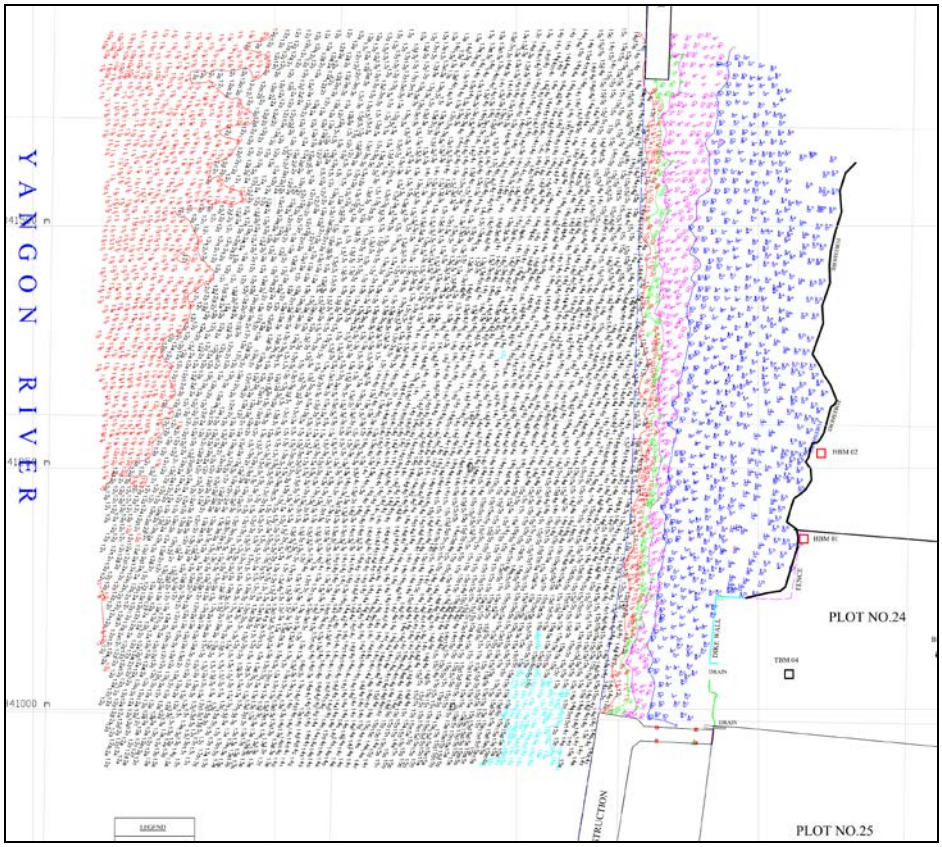
bathymetric survey in 2018 is shown in Figure 3.1.19.

In order to consider the sedimentation condition, comparison was made for the Yangon River water depth in 2013 and 2018 in front of Plot 24 where both surveys were carried out. The cross section views in 2013 and 2018 were prepared at the location indicated in blue lines in Figure 3.1.20. The cross section views are shown in Figure 3.1.21 and 3.1.22.



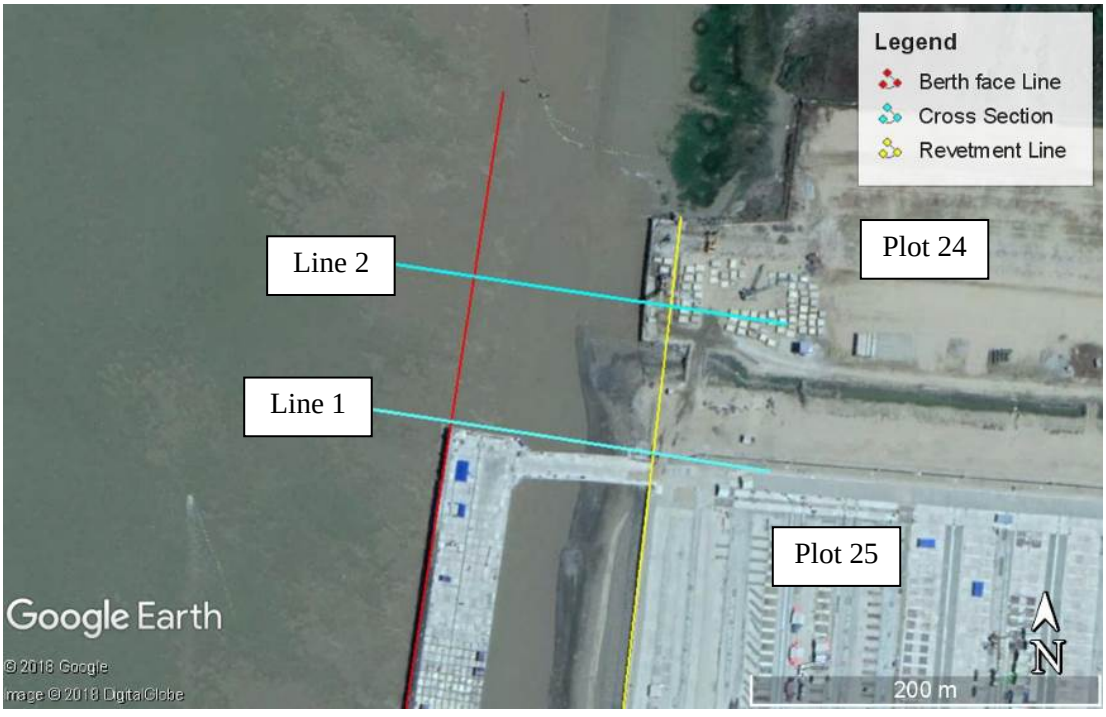
Source: Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (JICA, 2014.6)

Figure 3.1.18 The Plain View of the Bathymetric Survey in 2013



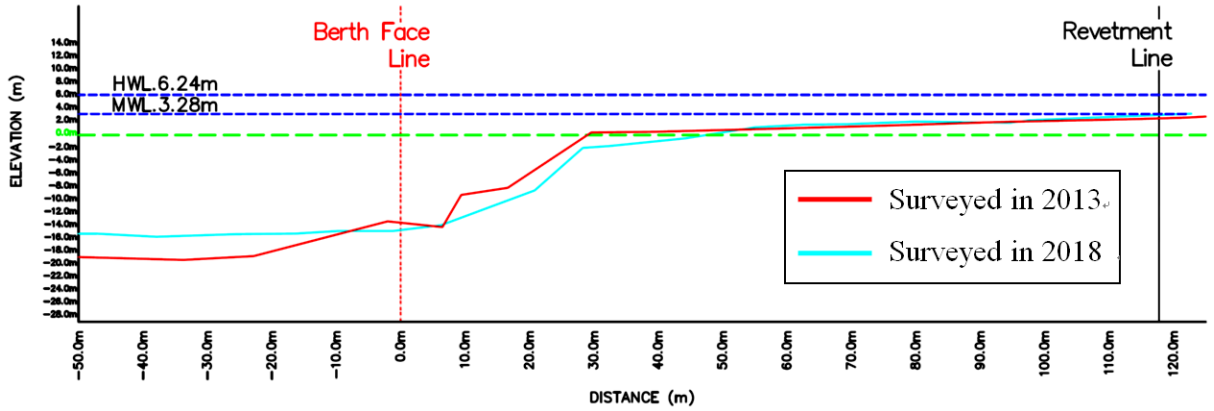
Source: MPA's Suevey

Figure 3.1.19 The Plain View of the Bathymetric Survey in 2018



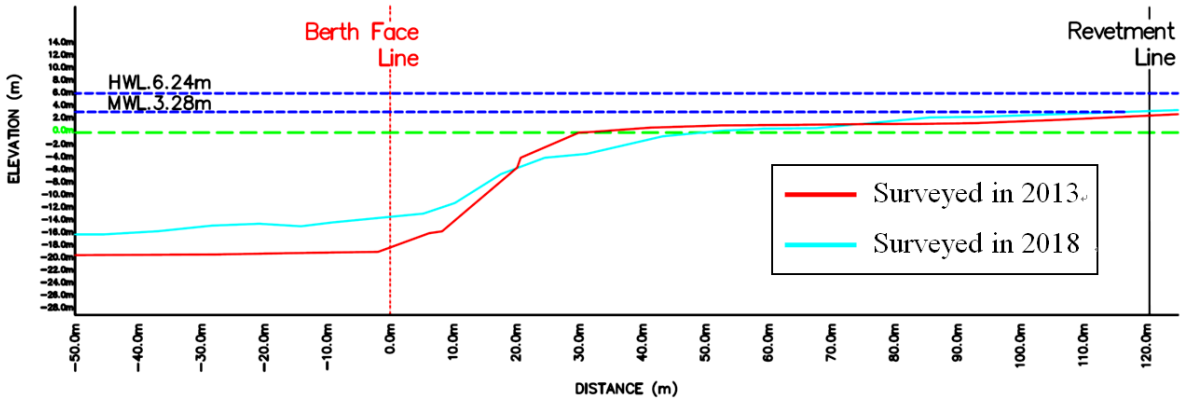
Source: Study Team (Google Earth)

Figure 3.1.20 Location of Cross Section Views in front of Plot 24



Source: Study Team

Figure 3.1.21 Line 1 Cross Section View



Source: MPA Survey

Figure 3.1.22 Line 2 Cross Section View

(3) Summary of Survey Results

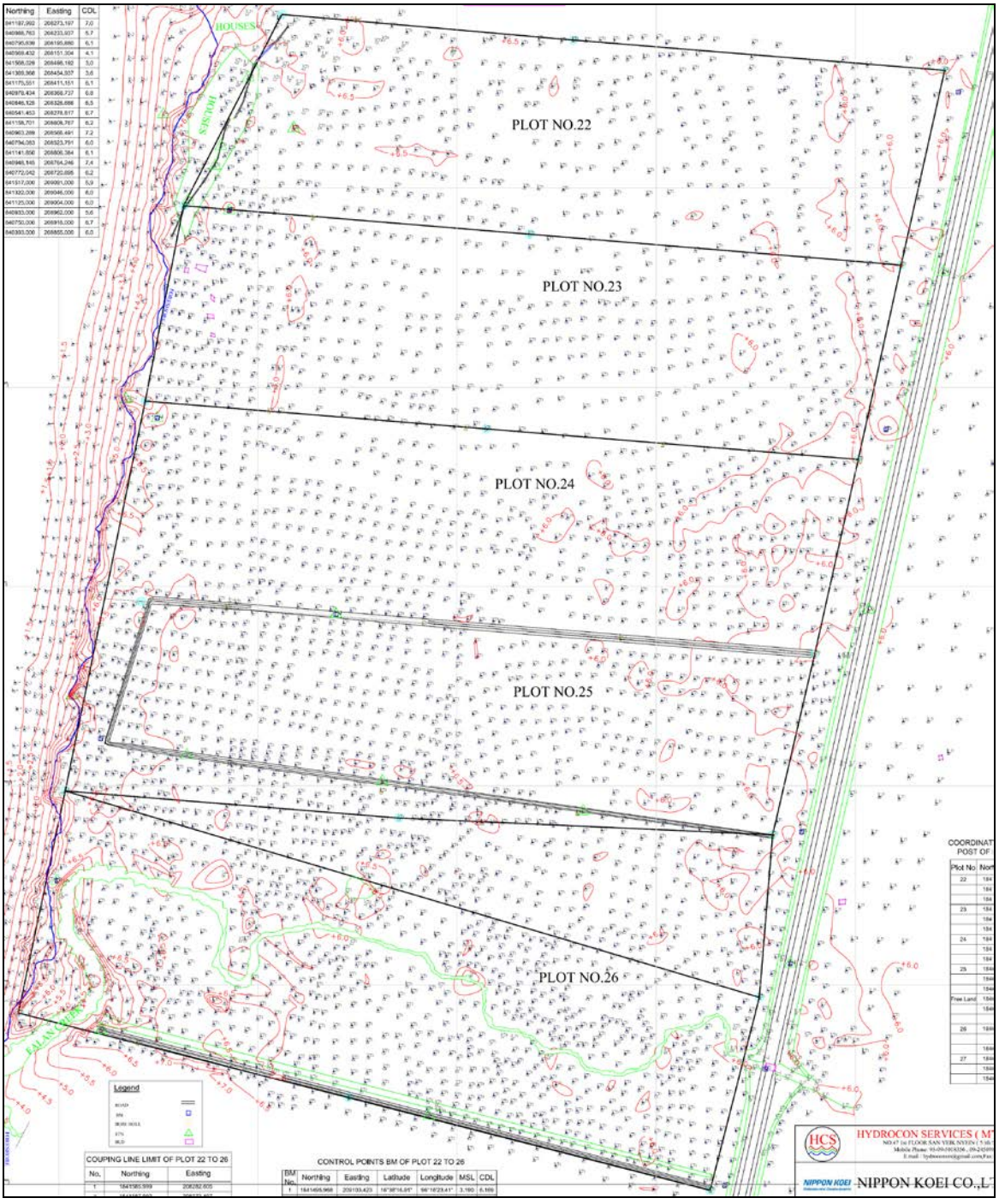
From the cross section views above, following points were confirmed on the condition of water depth and channel sedimentation of the Yangon River.

- Water depth is suddenly changed in the 30 m range between the Berth Face Line and the inner area. The other areas are almost flat.
- At the area where water depth is suddenly changed, there is a deference of almost 2 m by comparing the survey result in 2013 and 2018. So, the design condition at the jetty become strict by the erosion.
- Water depth at the outer area from the Berth Face Line is shallower in 2017 than in 2013. It was -19 m in 2013 but decreased to -15 m in 2018.
- According to the surveys, the massive change of water depth in Yangon river is found. As the period will be taken up to the start of detail design, it is necessary to implement bathymetric survey again at the time of detailed design.

3.1.5 Topographic Survey

(1) Survey Area

The condition of topography of the Thilawa Area Port from Plot 22 to Plot 26 was examined based on the results of topographic survey carried out in 2013 in the "Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area". The plain view of the Plot 22 to Plot 26 is shown in Figure 3.1.23.



Source: Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (JICA, 2014.6)

Figure 3.1.23 The Plain View of the Topographic Survey in 2013

(2) Results of Topographic Survey

According to the topographic survey, the elevation of Plot 22 to Plot 26 is about 6, 7 m. Then, it is so flat. However, the topographic survey in 2013 was carried out before the construction stage of Phase I Project. Therefore, the influence of the construction work is not considered. As the area of Plot 24 and Plot 26 is the temporary yard of Phase I Project, it is necessary to implement topographic survey again. At Plot 22 and Plot 23, it is considered that there is no change excluding to the area near river side.

3.2 Port Facility Plan

[Phase II Project]

Terminal facility plan is addressed in this section based on the required terminal capacity indicated in section “2.3.2 Required Capacity” and operational conditions which are described in the following section “ 3.8. Terminal Operation Plan”.

3.2.1 Preconditions for the Facility Plan

(1) Container Handling Capacity

Targeted Terminal Capacity of Plot 24, 25 and 26 is 600,000 TEUs per annum in total.

(2) Container Handling Volume and its Breakdown

In the last several years, increase in the container volume at Yangon Port has been driven by import cargo, whereas export cargo has remained stagnant or slightly increased. Eventually, the proportion of empty containers foe export will become ridiculously high due to this imbalance. The proportions of container volume by type are shown in Table 3.2.1.

In future, export full container volume will increase and gradually match the level of import full containers as industrialization in Myanmar increases through an influx of foreign capital investment.

In the case that full terminal capacity of 600,000TEUs is required in the short term (ex., before 2030), the proportion of container volume by type will still remain as shown in the short-term proportions which is similar to current ones. On the other hand, when full terminal capacity is required in the long term (after 2030), the proportion of container volume by type will become as shown in the long-term proportions in Table 3.2.1. In this case, export full container will increase and achieve a balance with the import container volume.

For the Terminal Facility Planning in this Section, both the long-term proportions and the short-term proportions will be used.

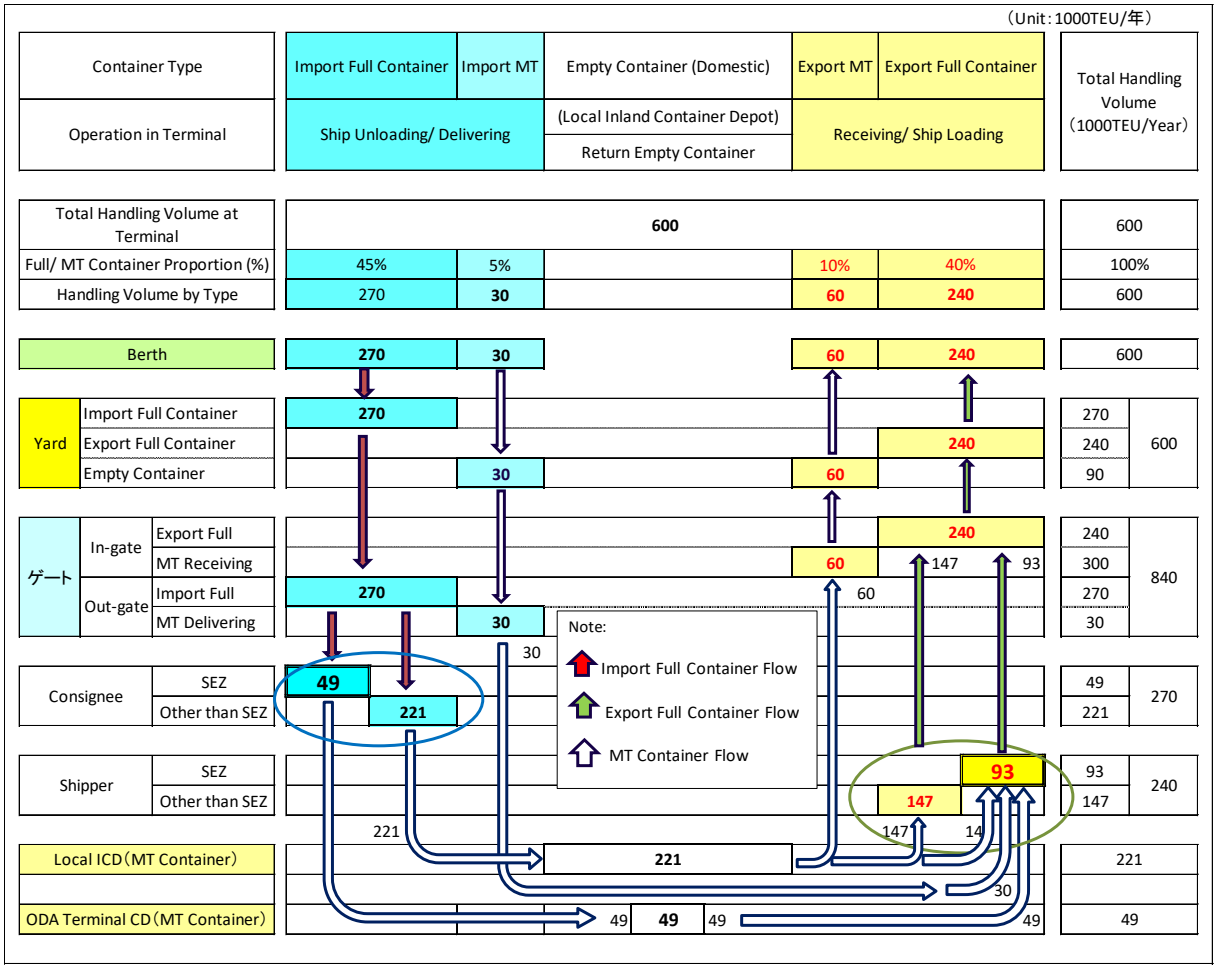
Table 3.2.1 Container Handling Volume by Type

Type of Container		Long-term Proportions		Short-term Proportions		Current Proportions
		Proportion (%)	Container Volume (TEU/Year)	Proportion (%)	Container Volume (TEU/Year)	Proportion (%)
Import	Full Container	90%	270,000	90%	270,000	95%
	Empty Container	10%	30,000	10%	30,000	5%
Export	Full Container	80%	240,000	60%	180,000	55%
	Empty Container	20%	60,000	40%	120,000	45%
Total	Full Container	85.0%	510,000	75.0%	450,000	75.0%
	Empty Container	15.0%	90,000	25.0%	150,000	25.0%
Grand Total		100.0%	600,000	100.0%	600,000	100.0%

Source :Study Team

(3) Material Flow related to the Terminal

Based on the cargo volume shown in Table 3.2.1 and SEZ related cargo volume indicated in Table 3.8.2, container flow models among related facilities inside the terminal (at the quay, yard and gate) and outside the terminal (shipper, consignee and local ICD (inland container depots)) are illustrated in Figure 3.2.1 and Figure 3.2.2. Figure 3.2.1 shows a model based on the container volume of long-term proportions in which SEZ related cargo is assumed as 142,000 TEUs in 2030 (refer to Table 3.8.2). Figure 3.2.2 is based on the short-term proportions in which SEZ related cargo is assumed as 78,000 TEUs in 2025.



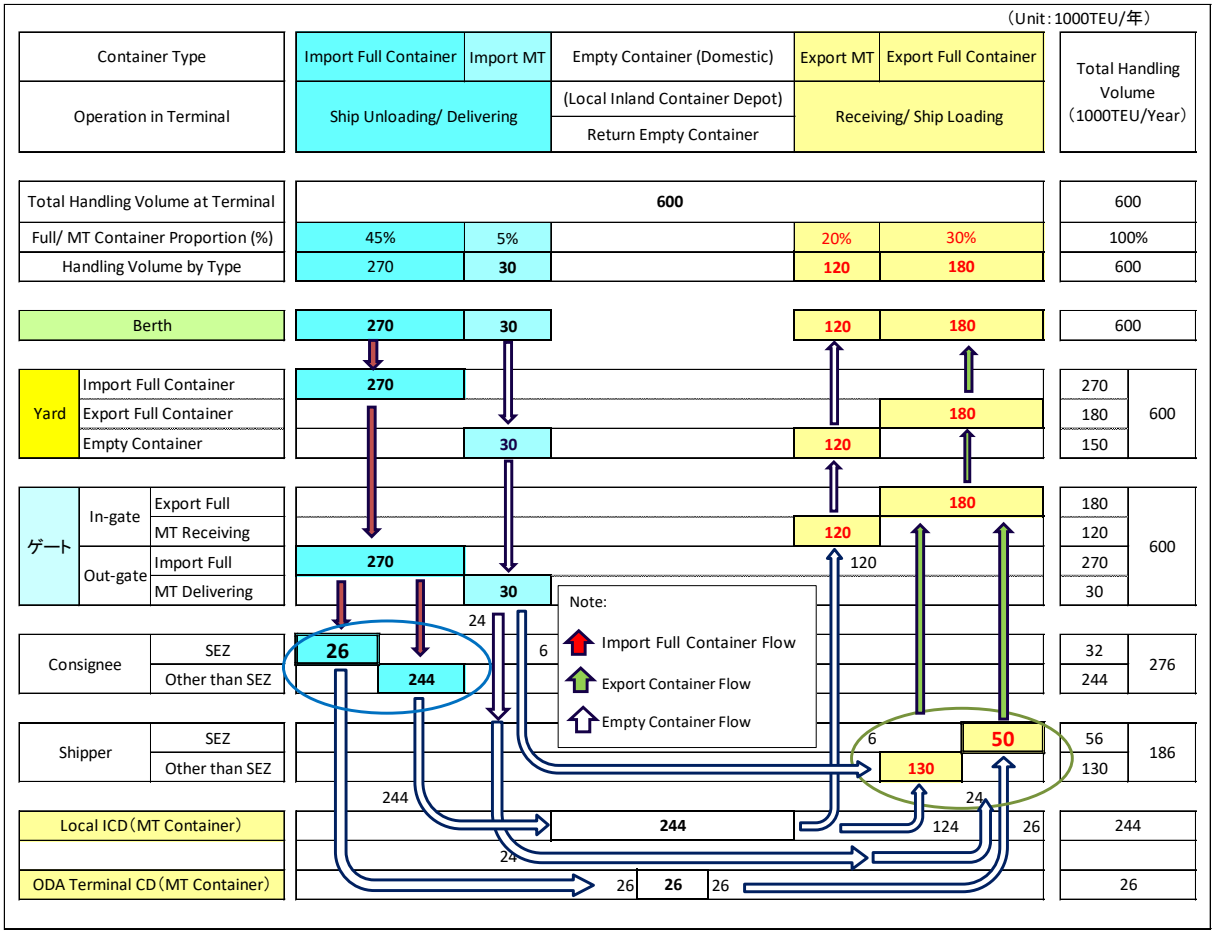
Source :Study Team

Figure 3.2.1 Material Flow Model based on the Long-term Proportions (2030)

1) Import containers

Full containers unloaded from vessel and delivered from the yard are de-vanned at the consignee's warehouse or factory. The empty containers are usually deposited to the inland container depots (ICD) or returned to the container depots in the terminal (TCD). These empty containers are washed or maintained and stored at the ICD or TCD.

The consignees for the Thilawa container terminal are mainly located at two sites; the Thilawa SEZ and another industrial zone behind Yangon city terminals (Northwest of Yangon City). In the former case, empty containers (de-stuffed at the consignees' site) are likely to return to the empty container yard/ depot in the Thilawa port container terminals. In the latter case, the empty containers are likely to return to the ICSs near the Yangon city terminals. (see Figures 3.2.1 and 3.2.2)



Source :Study Team

Figure 3.2.2 Material Flow Model based on the Short-term Proportions (2025)

2) Export containers

When shippers need empty containers for stuffing their export cargoes, there are two possibilities depending on their sites. Shippers in the SEZ will pick them up from the empty container yard/ depot near the Thilawa port container terminals or in the SEZ (this is expected to become an option in future). After they stuff their export cargoes, they will use Thilawa port for loading onto ships. On the other hand, shippers in the industrial zone northwest of Yangon City will likely pick up empty containers for stuffing from the ICDs near their site, i.e., the ICDs behind or surrounding the Yangon city terminals.

As described above, empty container depots are classified according to their clients' (consignee and shipper) locations. For clients other than those in the SEZ, existing ICDs behind or surrounding the Yangon city terminals will be used. On the other hand, for clients of the SEZ, a new empty container storage facility is necessary in the Thilawa area. To fulfil this requirement, an empty container storage facility (container depot) is planned in the Phase II Project. Because the containers once extracted from the terminal are deemed as domestic containers (except bonded transportation), the storage facility will be segregated from the empty container yard in the terminal (in the bonded area).

(4) Berthing Side of the Calling Vessels

Berthing side of the calling vessel is mainly starboard side for the following reasons.

Generally, berthing side depends on tidal stream. Considering the existing tugboat power of Yangon Port, calling vessels come alongside the pier against the tidal stream. As almost all container vessels calling this port have a deep draft, they come into the port on the flood tide. Accordingly, they come alongside the pier of Thilawa Terminal on starboard-side in response to the change in the direction of the current. If the current is still flowing in the same direction, they turn round and berth at the pier along the port-side of vessels. Therefore, calling vessels will berth both at starboard-side as well as port-side.

In terms of land transportation, vehicles are obliged to run on the right side of the road while trailers from the hinterland mainly come from the north of the terminal; therefore, the safest and most efficient traffic flow (less intersecting in the terminal traffic road) is for trailers to 1) come into the terminal from the north side, 2) go through the traffic road in the terminal anti-clockwise, 3) enter into the stacking yard from the north side of stacking blocks, and 4) exit from the south side of the terminal. In other words, trailers for vessel operation go round between the quayside and stacking yard in a clock-wise direction.

To enhance the safety and efficiency of the vessel operation, MPA is in the process of procuring more powerful tugboats. Accordingly, influence of tidal stream on deciding berthing side will be less in the near future. Considering the situation above, land transportation rule and traffic safety in the terminal are given priority over water side requirements, and berthing side of the calling vessel is designed at starboard side.

In the case that a calling vessel is moored on portside, trailers in seaside operation can easily turn round by using the trailer traffic road constructed between the stacking yard and revetment alongside the river.

(5) Cargo handling System in the Terminal

1) Cargo handling system at quay-side

QGC (Quay Gantry Crane) system is applied for the quay-side handling system in the Phase I Project. The same cargo handling system (QGC system as Phase I) is planned in the Phase II Project.

2) Cargo handling system in the yard

RTG (Rubber Tired Gantry Crane) system is applied for container handling in the yard (full container stacking yard) in the Phase I Project. The same cargo handling system (RTG system as Phase I) is planned in the Phase II Project, where the same maximum stacking height of RTG as the Phase I Project is planned to maintain safe yard operations in the whole terminal (Plot 24/25/26).

The new Thilawa terminal has a high possibility of being operated as a multi-purpose terminal for handling general cargoes (imported vehicles, steel products, construction materials, machinery and equipment, etc.) rather than a container-dedicated terminal in the early stage of its operation or even for a long period depending on the situation. Therefore, the whole terminal should be planned flexibly so that it can serve as a multipurpose terminal. Considering this requirement, the pavement structure of half the RTG yard is

designed to accommodate general cargoes using reach stackers or forklifts.

3.2.2 Yard Capacity and required Yard Blocks

(1) Preconditions for planning

1) Annual container handling volume; 600,000 TEU

2) Breakdown of each type of container: Refer to Table 3.2.1 (Container handling volume by type)

3) Container dwelling time in the yard: Refer to Table 3.2.2
Present container dwelling time of existing terminals in Yangon and Thilawa port is comparatively long compared to Japan. In AWPT (Asia World Port Terminal) in Yangon, average dwelling time of import containers is from 8 to 10 days, and that of export containers is 7 days. In MITT (Myanmar International Terminal Thilawa), average dwelling time is 11 days (import & export total). Considering this situation, targeted dwelling time as a precondition for the Phase II yard facility plan is listed in Table 3.2.2.

Table 3.2.2 Container Dwelling Time

Type of Container		Average Dwelling Time	
		Targeted Dwelling Time	Present Dwelling Time
Import	Full Container	8	8～10
	Empty Container	14	14～15
Export	Full Container	7	7～9
	Empty Container	14	14～15
Reefer Container		4	4～7

Source :Study Team

4) Yard Efficiency: Refer to Table 3.2.3

Yard efficiency represents what percentage of physical (maximum) stacking capacity is utilized in normal yard operation. The yard efficiency is mainly affected by “utilization ratio for efficient operation” (i.e., to preserve container shuffling space in the bay) and peak ratio for the yard operation. The yard efficiency as a precondition for the Phase II yard facility plan is 65% (for full containers) and 70% (for empty containers).

Table 3.2.3 Yard Efficiency

Type of Container	Stacking Height	Utilization Ratio for efficient operations			Peak Ratio (d)	Yard Efficiency (e) (%) (e)=(c)/(d)	Targeted Yard Efficiency (%)
		Dead space for shuffling (a) (TEU/Bay)	Physical Storage Capacity (b) (TEU/Bay)	Utilization Ratio (c) (%) (c)=((b)-(a))/(b)			
Full Container	1-over-5	4	30	87%	1.3	66.7%	65%
	1-over-4	3	24	88%	1.3	67.3%	
Reefer Container	1-over-3	2	18	89%	1.3	68.4%	
Empty Container	5 tiers						70%

Source :Study Team

1) Yard block size: Refer to Table 3.3.1

Block size of Plot 24/25/26 and physical capacity (maximum capacity) for full containers and reefer containers as well as ground slot capacity for empty containers are indicated in Table 3.3.1.

① Block size (dry container): 71.6 TEUs × 6 rows × 5 tiers

② Stacking capacity (dry container): 2,148 TEUs / Block

③ Effective stacking capacity (dry container): 1,396 TEUs/ Block (yard efficiency=65%)

2) Physical ground slot capacity for empty containers: 1,244 TEUs (Refer to Figure 3.3.2)

(2) Yard Capacity and Required Yard Blocks

Based on the above preconditions, annual yard capacity per block for import full containers is estimated to range from 51,000 TEUs to 63,700 TEUs with average dwelling times from 8 days to 10 days, and that for export full containers is estimated to range from 56,600 TEUs to 72,000 TEUs with average dwelling times from 7 days to 9 days. Assuming that average dwelling time is 8 to 10 days for imports and 7 to 9 days for exports, required yard blocks for import and export full containers are estimated at 8 to 10 blocks (See Table 3.2.4) in the case of long-term proportions. In the case of short-term proportions, the corresponding figures of required yard blocks for import and export full containers are estimated at 7 to 9 blocks (See Table 3.2.5). It is thus estimated that 8 blocks are required in the Phase II Project yard facility plan. This estimation is based on the assumption that the average dwelling time at the new terminal should be in line with the international standard of 8 days (for imports) and 7 days (for exports). Considering the present performance of existing terminals in Yangon and Thilawa, maximum effort will be required in order for the ODA terminal to achieve the targeted capacity.

Table 3.2.4 Container Yard Capacity and Required Yard Blocks (Long-term proportion)

Total Container Volume (TEU/Year)	600,000			(Reference)
Type of Container	**Import Full Container (Dry)**	**Export Full Container (Dry)**	**Empty Container**	**Reefer Container**
Percent to import or export container volume (%)	90%	80%	15%	
Container Volume (TEU/Year) (a)	270,000	240,000	90,000	
Container Dwelling Time (Day)	8 ～ 10	7 ～ 9	14 ～ 15	4 ～ 7
Turnover Rate (Times/Year) (b)	45.63 ～ 36.50	52.14 ～ 40.56	26.07 ～ 24.33	91.00 ～ 52.00
Stacking Capacity per Block				
Number of Bays (TEU)	**71.6**			54
Plot 24	25.6			
Plot 25	22			
Plot 26	24			
Rows in a Block (Row)	6			6
Number of Ground Slot (TEU)	430		1,244	324
Maximum Stacking Height (Tier)	5		5	3
Stacking Capacity per Block (TEU) (c1)	2,148		6,220	972
Yard Utilization Ratio (%) (d)	65%		70%	65%
Effective Stacking Capacity per Block (TEU)(c2)	1,396		4,354	632
Yard Capacity per Block (TEU/Year/Block) (e) (e) = (b) * (c2)	63,702 ～ 50,961	72,802 ～ 56,624	113,515 ～ 105,947	57,494 ～ 32,854
Required Number of Blocks (or Ground Slots) (f)*	63,702 ～ 50,961	72,802 ～ 56,624	(Required Ground Slots)	
Required Blocks by Type (f) = (a) / (e)	4.24 ～ 5.30	3.30 ～ 4.24	**986 ～ 1,057**	
Total Required Blocks (Calculated figures)	**Full Container:**	7.54 ～ 9.54	(Filling Ratio (%))	Reefer Container
Round up figures of Total Required Blocks	**Full Container:**	**8 ～ 10**	**126% ～ 118%**	**1**

Note: * This figure represent "Required Ground Slots" in the case of Empty Container

Source :Study Team

Table 3.2.5 Container Yard Capacity and Required Yard Blocks (Short-term proportion)

Total Container Volume (TEU/Year)	600,000			(Reference)
Type of Container	**Import Full Container (Dry)**	**Export Full Container (Dry)**	**Empty Container**	**Reefer Container**
Percent to import or export container volume (%)	90%	60%	25%	
Container Volume (TEU/Year) (a)	270,000	180,000	150,000	
Container Dwelling Time (Day)	8 ～ 10	7 ～ 9	14 ～ 15	4 ～ 7
Turnover Rate (Times/Year) (b)	45.63 ～ 36.50	52.14 ～ 40.56	26.07 ～ 24.33	91.00 ～ 52.00
Stacking Capacity per Block				
Number of Bays (TEU)	**72**			**54**
Plot 24	25.6			
Plot 25	22			
Plot 26	24			
Rows in a Block (Row)	6			6
Number of Ground Slot (TEU)	**430**		**1,244**	**324**
Maximum Stacking Height (Tier)	5		5	3
Stacking Capacity per Block (TEU) (c1)	**2148**		**6,220**	**972**
Yard Utilization Ratio (%) (d)	65%		70%	65%
Effective Stacking Capacity per Block (TEU)(c2)	1396		4,354	632
Yard Capacity per Block (TEU/Year/Block) (e) (e) = (b) * (c2)	63,702 ～ 50,961	72,802 ～ 56,624	113,515 ～ 105,947	57,494 ～ 32,854
Required Number of Blocks (or Ground Slots) (f)*	63,702 ～ 50,961	72,802 ～ 56,624	(Ground Slots)	
Required Blocks by Type (f) = (a) / (e)	4.24 ～ 5.30	2.47 ～ 3.18	**1,644 ～ 1,761**	
Total Required Blocks (Calculated figures)	**Full Container:**	6.71 ～ 8.48	(Filling Ratio (%))	Reefer Container:
Round up figures of Total Required Blocks	**Full Container:**	**7 ～ 9**	**76% ～ 71%**	**1**

Note: * This figure represents "Required Ground Slots" in the case of Empty Container

Source :Study Team

(3) Required Ground Slots for Empty Containers

Based on the above preconditions, number of required ground slots for empty container is estimated in Table 3.2.6.

In the case of long-term proportions, as the empty container volume is 90,000 TEUs (15% of the total container volume) per year, required ground slots for empty containers are 986. In this case, physical capacity of the ground slots in Plot 24/25/26 (1,244 GSs) can easily accommodate this volume.

In the case of short-term proportions, the empty container volume is 150,000 TEUs (25% of the total container volume) per year, and then required ground slots are 1,644. In this case, physical capacity of the ground slots is insufficient to accommodate this volume. However, considering that container volumes of full container and empty container have a trade-off relationship within the maximum terminal capacity, overflowing empty containers can be stacked in the full container stacking area.

In conclusion, physical stacking capacity for empty containers in Plot 24/25/26 (1,244 GSs) is sufficient to accommodate total capacity of 600,000 TEUs for any empty container volume proportion in the Phase II Project.

Table 3.2.6 Required Ground Slots for Empty Containers

Total Container Volume (TEU/Year)	**600,000**					
Empty Container Ratio (%)	10.0%	**15% *1**	**18.9%**	20.0%	**25% *2**	30.0%
Empty Container Volume (TEUs) (a2)	60,000	**90,000**	**113,520**	120,000	**150,000**	180,000
Preconditions						
Maximum Stacking Height (Tier) (g)	5					
Yard Utilization Ratio (%) (h)	70%					
Container Dwelling Time (Day) (i)	14					
Turnover Rate (Times/Year) (j)=365/(i)	26.1					
Required Ground Slots (TEU) (k)=(a2)/(j)/{(g)*(h)}	658	**986**	**1,244**	1,315	**1,644**	1,973

Note: *1 Long-term Proportions
*2 Short-term Proportions

Source :Study Team

3.2.3 Gate Capacity and Required Gate Lanes

Main functions of the gate in the standard international terminals are; 1) checking container and cargoes in and out from the terminal, 2) checking the authentication of container or cargo receiver (truck and driver), 3) checking the seal of the container, 4) checking container damage, and 5) instruction to the driver regarding destination in the yard. These functions are basically performed at the gates in the Thilawa ODA terminal. However, different to other standard terminals, Myanmar Customs executes cargo inspection for all the import and export containers inside the terminal. Therefore, work load at gate operation is less than other terminals (i.e., checking container and cargoes, checking the authentication of container or cargo receiver). In contrast, because trucks from outside are not able to enter the stacking yard directly, a second gate is necessary between customs area and stacking yard to indicate the designated location in the yard to the driver.

(1) Gate capacity and required gate lanes

Required gate capacity (number of lanes) largely depends on the container volume and expected empty container storage policy (i.e., whether or not an ICD function is included). As the storage capacity is limited in the terminal, the empty container yard is limited to temporary storage of imported and export empty containers for ship loading for the "positioning" of shipping lines' policy. Because the dwelling time of empty containers is extremely long, ICD functions are basically not expected in the terminal. In the Phase II Project, only the SEZ related empty container will be stored in the empty container depots in the terminal. Container flow among terminal, shippers, consignees and ICDs is illustrated in Figures 3.2.1 and 3.2.2.

1) Preconditions of Gate Planning（Refer to Table 3.2.7）

Preconditions of gate planning are listed below. Total number of containers handled at the terminal is 428,571 boxes per year, and based on this volume total number of containers to be handled at the gate is 642,875 boxes per year (refer to Table 3.2.7). As a result, number of containers at the gate is about 1.5 times larger than container throughput at the terminal based on the preconditions described above and listed below.

1) Annual container terminal capacity: 600,000 TEU
2) TEU Factor; 1.4
3) Gate operation days per year: 287 days
4) Gate operation hours per day: 12 hours
5) Peak Ratio: 1.2
6) Gate productivity per hour: 15 transactions/ hour
7) Gate productivity per day: 180 transactions/day

Table 3.2.7 Preconditions to Estimate Gate Lane Capacity

			Phase-2 Plan (Long-term proportions)		Phase-2 Plan (Short-term Proportions)	
Preconditions						
	Container Terminal Capacity （TEU/Year）		**600,000**		**600,000**	
	Proportions of each type of containers	Import Full Containers	45.0%	(90% of Import)	45.0%	(90% of Import)
		Import Empty Containers	5.0%	(10% of Import)	5.0%	(10% of Import)
		Export Full Containers	40.0%	(80% of Export)	30.0%	(60% of Export)
		Export Empty Containers	10.0%	(20% of Export)	20.0%	(40% of Export)
	TEU Factor		**1.40**		**1.40**	
	Gate operation days per year (days)*1		287		287	
	Gate operation hours per day (Hours)		12		12	
	Gate Productivity	(Transaction/Hr/Lane)	15		15	
		(Transaction/Day/Lane)	180		180	
		(Transaction/Year/Lane)	51,660		51,660	
	Peak Ratio	(Max handling volume per day/ Yearly average handling volume)	1.2		1.2	
Containers to be handled at Terminal (Box/Year)			**428,571**		**428,571**	
Containers to be handled at the Gate (Box/Year)			**642,857**		**642,857**	

Note *1 Gate Operation Days per Year＝365Days－52Weeks x1.5（Sunday and Saturday）＝287Days
*2 2nd Gate (available for 24 hour-basis operation) *3 Available for 24 hour-basis operation

Source :Study Team

2) Required Number of Lanes（Refer to Table 3.2.8）

Number of containers and trucks to be handled per year at the gate and required number of lanes are summarized in Table 3.2.8. As shown in the table, transactions at the gate are considered to become at least 1.5 times the total boxes to be handled at the berth. Required lanes at the gate of the terminal based on the above preconditions are estimated below.

① Regarding import full containers, ten (10) lanes are required for registration of import full container delivery (five (5) lanes) and for delivery of import full containers (five (5) lanes).

② Regarding export full containers, four (4) lanes are required for reception of export full containers.

③ Regarding empty containers, three (3) lanes are required for registration of empty containers pick-up (one (1) lane), for delivery of empty container (one (1) lane) and for receiving of export empty containers for loading (one (1) lane in long-term proportions, or two (2) lanes in short-term proportions).

Number of required lanes at the gate of the terminal is summarized in Table 3.2.8. Seventeen (17) lanes are required in total. Comparing the number of lanes in Phase I (200,000 TEU capacity), that of Phase II (600,000 TEU capacity) is about two times larger. This means the number of gates is not directly commensurate with the total handling volume.

(2) Gate Allocation Plan

There are two characteristics in gate allocation plans in the Phase II Project; 1) foundation of 2nd gate and 2) assembling each gate function into two large groups such as in-gate and out-gate.

1) 2nd gate

In the Phase I Project, the 2nd gate was planned to have a function to give instructions regarding the destination site of incoming trailers in the yard. In the Phase II Project, the following functions are added to remedy gate congestion;

① Registration for import empty container pick–up (24 hour basis: 1 lane is necessary)
② Receiving of export empty container for loading (24 hour basis: one (1) lane or two (2) lanes in the case of Short-term proportions).

By this allocation plan (above functions are allocated from the main gate to 2nd gate), number of gate lanes (main gate) can be reduced by two (2) lanes (from 17 lanes to 15 lanes)

2) Assembling gate function to in-gate and out-gate

Result of assembling gate function to in-gate and out-gate is shown in Table 3.2.8. As a result, by integrating out-gate functions such as 1) delivery of import full containers (5 lane is required) and 2) delivery of empty container (1 lane is required), out gate operation can be managed with five (5) lanes in total.

By the integration of out-gate functions, number of gate lanes (main gate) can be reduced by one (1) lane (from 15 lanes to 14 lanes)

Table 3.2.8 Required Number of Gate Lanes

Items			Phase-2 Plan			
			(Long-term proportions)		(Short-term Proportions)	
Containers to be handled at Terminal (Box/Year)			**428,571**		**428,571**	
Containers to be handled at the Gate (Box/Year)			**642,857**		**642,857**	
	Imported Containers (Discharged)	**Import related Gate Operations**	428,571		428,571	
		Registration of Import Full Container Delivery (In-gate)	192,857		192,857	
		Delivery of Import Full Containers (Out-gate)	192,857		192,857	
		Registration of Empty Container pick-up (In-gate)	21,429	(2nd Gate)*2	21,429	(2nd Gate)
		Delivery of Empty Container for Export Cargo Stuffing (Out-gate)	21,429	(24 H-base)*3	21,429	(24 H-base)
	Export Containers (Loading)	**Export related Gate Operations**	**214,286**		**214,286**	
		Reception of Export Full Containers (In-gate)	171,429		128,571	
		Leaving Empty Chassis after Releasing Export Full Containers (-)	-		-	
		Reception of Empty Containers for Loading (In-gate)	42,857	(2nd Gate)	85,714	(2nd Gate)
		Leaving Empty Chassis after Releasing Export Empty Containers (-)	-		-	
Containers to be handled by In/Out-gate (Box/Year or Hour) (c)			Box per Year	Box per Hour	Box per Year	Box per Hour
	Containers to be handled at the In-gate (Total)		**428,571**	**149**	**428,571**	**149**
	Empty Chassis	Registration of Import Full Container Delivery (In-gate)	192,857	67	192,857	67
	Empty Chassis	Registration of Empty Container pick-up (In-gate)	21,429	7	21,429	7
	Full Cont.	Reception of Export Full Containers (In-gate)	171,429	60	128,571	45
	Empty Cont.	Reception of Empty Containers for Loading (In-gate)	42,857	15	85,714	30
	Containers to be handled at the Out-gate (Total)		**214,286**	**75**	**214,286**	**75**
	Full Cont.	Delivery of Import Full Containers (Out-gate)	192,857	67	192,857	67
	Empty Cont.	Delivery of Empty Container for Export Cargo Stuffing (Out-gate)	21,429	7	21,429	7
	Total Containers to be handled at the Gate (In-gate + Out-gate)		**642,857**	**224**	**642,857**	**224**
Required Number of Gate Lanes (Related to the Containers)			**Required Lanes**		**Required Lanes**	
			Main Gate	**2nd Gate**	**Main Gate**	**2nd Gate**
	Total Number of Lanes (In-gate + Out-gate: (Round Value))		**14**	**2**	**13**	**3**
	In-gate Total	**(Round Value)**	**9**	**2**	**8**	**3**
		(Total)	8.46	1.49	7.47	2.49
	Empty Chassis	Registration of Import Full Container Delivery (In-gate)	4.48		4.48	
	Empty Chassis	Registration of Empty Container pick-up (In-gate) *2		0.50		0.50
	Full Cont.	Reception of Export Full Containers (In-gate)	3.98		2.99	
	Empty Cont.	Reception of Empty Containers for Loading (In-gate) *2		1.00		1.99
	Out-gate Total	**(Round Value)**	**5**	**0**	**5**	**0**
		(Total)	4.98		4.98	
	Full Cont.	Delivery of Import Full Containers (Out-gate)	4.48		4.48	
	Empty Cont.	Delivery of Empty Container for Export Cargo Stuffing (Out-gate)*3	0.50		0.50	

Note *1 Gate Operation Days per Year＝365Days－52Weeks x1.5（Sunday and Saturday）＝287Days

*2 2nd Gate (available for 24 hour-basis operation) *3 Available for 24 hour-basis operation

Source :Study Team

3.2.4 Customs Inspection facilities and CFS

According to the customs inspection procedures described in section **"**3.8 Terminal Operation Plan," required facilities for container cargo inspection and their capacity are estimated in this section, which include X-ray inspection and physical inspection.

(1) Preconditions for planning

Preconditions to estimate required facilities and equipment for import and export cargoes are described below. In the study, two types of the container volume breakdown are considered (refer to Table 3.2.1). Based on the preconditions above, average daily container volume (full container) to be handled in the terminal is estimated at 672 boxes per day for imports and 448 boxes per day for exports in the short-term proportions or 672 boxes (import) and 597 boxes (export) in the long-term proportions. In the short-term proportions, full container volume related to the Thilawa SEZ is assumed to be at 67 boxes (import) per day and 127 boxes (export) per day in the year of 2025 (refer to Table 3.2.9). On the other hand, in the long-term proportions, that of the Thilawa SEZ is assumed at 122 boxes (import) per day and 231 boxes (export) per day in the year of 2030 (refer to Table 3.2.10).

As described in section 3.8 Operation Plan, inspection rate is assumed at the same level of Phase I facility plan.

① Container Volume and daily container flow: 600,000 TEU/Year (Refer to Tables 3.2.9 and 3.2.10 「Daily Container Flow」)
② Customs operation days per year: 287 days/year
③ Customs operation hours per day: Normal days:7.5 hours/day (9:00-16:30), Peak days:10 hour/day （9:00-19:00）
④ TEU Factor: 1.4
⑤ Peak Ratio: 1.3
⑥ Daily container volume to be handled: Refer to Table 3.2.9 and 3.2.10 「Daily Container Flow」
⑦ Inspection Rate by each category：Refer to Table 3.2.11「Inspection Rate by Category」

Table 3.2.9 Daily Container Flow (Short-term Proportions)

		Preconditions	TEU/Year	Box/Year	Box/Day (average)
1. Terminal Capacity			600,000	428,571	1,493
2. TEU Factor		1.40			
3. Customs Operation Day (Days/Year)	Full Time Bases	287			
4. Customs Operation Hour (Hours/Day) (9:00-16:30 (7.5Hour))	Monday-Friday	7.5			
	Saturday	Half of Mon-Fri			
5. Peak Ratio		1.3			
6. Proportion	Import Full	45.0%	270,000	192,857	**672**
	Import Empty	5.0%	30,000	21,429	75
	Export Full	30%	180,000	128,571	**448**
	Export Empty	20%	120,000	85,714	299
	Total	100%	600,000	428,571	1,493
7. Thilawa SEZ Related Container	Import Full		27,000	19,286	**67**
	Export Full		51,000	36,429	**127**
	Total		78,000	55,714	194

Source :Study Team

Table 3.2.10 Daily Container Flow (Long-term Proportions)

		Preconditions	TEU/Year	Box/Year	Box/Day (average)
1. Terminal Capacity			600,000	428,571	1,493
2. TEU Factor		1.40			
3. Customs Operation Day (Days/Year)	Full Time Bases	287			
4. Customs Operation Hour (Hours/Day) (9:00-16:30 (7.5Hour))	Monday-Friday	7.5			
	Saturday	Half of Mon-Fri			
5. Peak Ratio		1.3			
6. Proportion	Import Full	45.0%	270,000	192,857	**672**
	Import Empty	5.0%	30,000	21,429	75
	Export Full	40%	240,000	171,429	**597**
	Export Empty	10%	60,000	42,857	149
	Total	100%	600,000	428,571	1,493
7. Thilawa SEZ Related Container	Import Full		49,000	35,000	**122**
	Export Full		93,000	66,429	**231**
	Total		142,000	101,429	353

Source :Study Team

Table 3.2.11 Inspection Rate by Category

Inspection Category	Import Container	Export Container
(1) Green : Document Check	70%	0%
(2) Yellow : X-Ray Inspection	20%	90%
(3) Red : Physical Examination	10%	10%

Source :Study Team

(2) Required Number of X-ray Inspection Machines

Required number of X-ray inspection machines is estimated based on the following inspection productivity (refer to Table 3.2.12 and 3.2.13). Figures in the item (1) Daily inspection volume in the tables are obtained by subtracting the Thilawa SEZ container volume (box/ day) from the daily container volume in Table 3.2.9 and 3.2.10. Number of total containers to be X-ray inspected is 410 boxes per day in the Short-term proportions, and 439 boxes per day in the long-term proportions. As a result, required number of X-ray machines is 4.6 sets in the short-term proportions, and 4.9 sets in the long-term proportions (on average).

Considering that the X-ray inspection ratio would be improved in the future, four (4) sets of X-ray machines are to be procured at the initial stage of the Phase II Project.

① Operating hours of X-ray inspection: 7.5 hours/day（10 hours/day at peak days）
② X-ray inspection efficiency (per hour): 12 Boxes/hour
③ X-ray inspection efficiency (per day): 90 Boxes/day（120 Boxes/day at peak days）

Table 3.2.12 Required Number of X-ray Machines [Short-term Proportions]

	Average Inspection Capacity		Inspection Capacity at peak time	
	Import	Export	Import	Export
(1) Daily Inspection Volume (Box/Day)	**605**	**321**	**786**	**417**
(2) Peak Ratio			1.3	1.3
(3) Inspection Ratio	20%	90%	20%	90%
(4) Number of Containers to be X-ray inspected (Box/Day)	121	289	157	376
	410		**533**	
(5) Operation Hour (Hours/Day) (9:00-16:30) (at peak: 9:00-19:00)	7.5		10.0	
(6) Hourly Inspection Capacity (Boxes/Hour)	12		12	
(7) Daily Inspection Capacity (Boxes/Day)	90		120	
(8) Required Inspection Machines	**4.6**		**4.4**	

Source :Study Team

Table 3.2.13 Required Number of X-ray Machines [Long-term Proportions]

	Average Inspection Capacity		Inspection Capacity at peak time	
	Import	Export	Import	Export
(1) Daily Inspection Volume (Box/Day)	**550**	**366**	**715**	**476**
(2) Peak Ratio			1.3	1.3
(3) Inspection Ratio	20%	90%	20%	90%
(4) Number of Containers to be X-ray inspected (Box/Day)	110	329	143	428
	439		**571**	
(5) Operation Hour (Hours/Day) (9:00-16:30) (at peak: 9:00-19:00)	7.5		10.0	
(6) Hourly Inspection Capacity (Boxes/Hour)	12		12	
(7) Daily Inspection Capacity (Boxes/Day)	90		120	
(8) Required Inspection Machines	**4.9**		**4.8**	

Source :Study Team

(3) Required Physical Examination Facilities

Required number of physical examination bays is estimated based on the following preconditions (refer to Table 3.2.14 and 3.2.15). Figures in the item (1) Daily inspection volume in the tables is the same as indicated in the previous section for X-ray machines. Number of total containers to be physically inspected is 93 boxes per day in the short-term proportions, and 92 boxes per day in the long-term proportions. As a result, the number of required physical inspection platforms for import containers is 33 bays (in the Short-term proportions) and 30 bays (in the Long-term proportions). For export containers, number of the required physical inspection platforms is 18 bays (in the Short-term proportions) and 20 bays (in the Long-term proportions).

① Operating hours of physical examination: Normal days:7.5hours/day, Peak days: 10 hours /day）
② Average Examination hour: 1 hour/ Box/ (Examination group)
③ Capacity of physical examination per day: Average:7.5 Boxes/ day/(Examination group)（Peak days:

10 Boxes/ day/(Examination group)

④ Required number of examination groups: 12 Groups (import: 8 group + export 4 group)

⑤ Bay occupation hours in physical examination: 4 hours/Box（1.9 cycles/bay/day）

In the facility plan for import containers, two kinds of platforms are required; the platforms for physical inspection (30 to 33 bays as shown above) and customs seal setting platforms for SEZ containers (which is assumed to be approximately 5 bays). In total, 35 to 38 bays are required. Hence, a CFS for import containers with a platform capacity of 40 bays (slightly higher than the calculated figure to be on the safe side) is to be constructed in the Phase II Project.

For the physical inspection export containers, a CFS facility with a platform capacity of at least 18 to 20 bays is necessary. This facility will be covered by the CFS planned in the Phase I Project.

Table 3.2.14 Required Number of Physical Examination Bays [Short-term Proportions]

	Average Inspection Capacity		Inspection Capacity at peak time	
	Import	Export	Import	Export
(1) Daily Inspection Volume (Box/Day)	**605**	**321**	**786**	**417**
(2) Peak Ratio	1.3	1.3	1.3	1.3
(3) Inspection Ratio	10%	10%	10%	10%
(4) Number of Containers to be Physically Inspected (Box/Day)	**60**	**32**	**79**	**42**
	93		**120**	
(5) Operation Hour (Hours/Day) (9:00-16:30) (at peak: 9:00-19:00)	7.5		10.0	
(6) Cycle Time of Platform (Hours/ Cycle)	4		4	
(7) Bay Utilization (Cycles /Day)	**1.9**		**2.5**	
(8) Required CFS Inspection Bays (Slots)	**33**	**18**	**32**	**17**
	51		**49**	

Source :Study Team

Table 3.2.15 Required Number of Physical Examination Bays [Long-term Proportions]

	Average Inspection Capacity		Inspection Capacity at peak time	
	Import	Export	Import	Export
(1) Daily Inspection Volume (Box/Day)	**550**	**366**	**715**	**476**
(2) Peak Ratio	1.3	1.3	1.3	1.3
(3) Inspection Ratio	10%	10%	10%	10%
(4) Number of Containers to be Physically Inspected (Box/Day)	**55**	**37**	**72**	**48**
	92		**119**	
(5) Operation Hour (Hours/Day) (9:00-16:30) (at peak: 9:00-19:00)	7.5		10.0	
(6) Cycle Time of Platform (Hours/ Cycle)	4		4	
(7) Bay Utilization (Cycles /Day)	**1.9**		**2.5**	
(8) Required CFS Inspection Bays (Slots)	**30**	**20**	**29**	**20**
	50		**49**	

Source :Study Team

(4) Required CFS Capacity

In the Phase II Project, CFS is planned to be the same type as designed in the Phase I Project. Size of the CFS is planned at 50 m in depth including the platform for customs inspection. Floor level of the truck side of the CFS is assumed to be the same height as the truck passing area.

1) Preconditions of the Plan

① LCL cargo volume: 12,150 TEUs per year (5% of import container cargoes excluding Thilawa SEZ related cargo)

② Block size of the cargo storage area: 30 m (L) x 2.5 m (D) x 6 m (H) (comprised of 96 pallet racks (Refer to the pp 80-82 of the Final Report 2 of "The preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area (JICA June 2014)"

③ Length of the CFS Area : 6 m x (number of blocks) + 3 m (Refer to Table 3.2.16)

2) Required Length of CFS

Length of CFS comprises three parts; CFS area, Customs bonded area and Office area. Considering that 9.66 blocks are required for the CFS area to accommodate 4,500 TEUs in the Phase I Project, 26 blocks will be required to accommodate 12,150 TEUs in the Phase II Project. Hence, 16 blocks of the CFS area are to be additionally constructed in the Phase II Project (refer to Table 3.2.16).

As a result, CFS (used for import LCL cargo) with a total length of 168 m is planned in the Phase II Project, which comprises the CFS area (99 m), LCL customs bonded area (53 m) and Office area (16 m).

Table 3.2.16 Required Capacity of CFS

Item		Unit	Phase-II Plan	(Reference) Phase-I Plan	Remarks
LCL Cargo Volume *1		(TEU/Year)	12,150	4,500	
Required Blocks		(Blocks)*2	26.08	9.66	
Planned Block Distribution	CFS in Plot 25	(Blocks)*2	10	10	
	CFS in Plot 26	(Blocks)*2	16	-	
	Total	(Blocks)*2	**26**	**10**	
Length of CFS (Warehouse)	CFS Area *3	(m)	99	64	Width of Warehouse =50m which is including platform.
	LCL Customs Bonded Area	(m)	53	32	
	Office Area	(m)	16	8	
	Total	(m)	168	104	
Note:	*1 LCL cargo volume = 5% of Import container cargo excluding SEZ related cargo *2 Block is comprised of 96 modules of pallet racks (Block size: 30m (L) x 2.5 m (D) x 6m (H)) *3 Length of CFS = 6m x (Number of Blocks) + 3m				

Source :Study Team

3.2.5 Equipment Maintenance Shops

Maintenance shop for the equipment planned in the Phase II Project is examined in this Section. The equipment to be covered is detailed in section "3.8.6 Cargo Handling Equipment Plan" (refer to Table 3.8.8).

In general, when the quantity of equipment is tripled, the capacity of maintenance shops must also triple. However, such an approach would result in overinvestment. Accordingly, a different approach has been adopted in this study. First, we will examine how to manage maintenance of the planned equipment using the existing (Phase I) maintenance shop. Second, we will identify any shortages in maintenance space and

then prepare an investment plan to provide adequate space for maintenance.

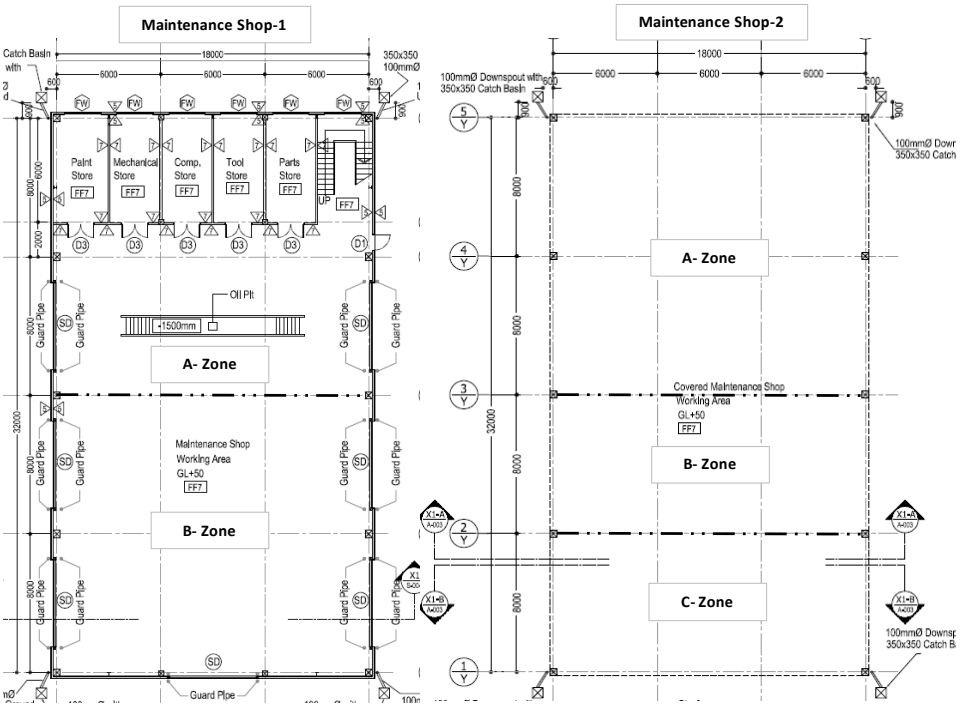
(1) Space of Maintenance Shop

Considering the building structure, maintenance shops were sectioned into two (maintenance shop-1(S1)) and three (maintenance shop-2(S2)) work spaces as indicated in Figure 3.2.3.

Maintenance shop-1 (S1) was divided into zone-A and zone-B. Zone-A is assigned for the maintenance of tractor heads, whereas zone-B is assigned for chassis and other vehicles.

Maintenance shop-2 (S2) was divided into zone-A, zone-B and zone-C. Zone-A is assigned for the maintenance of heavy-duty equipment such as reach stackers and fork lifts. Zone-B and zone-C are assigned for the QGC spreaders and relatively small size fork lift which is used in the CFS.

Maintenance and repairing of other equipment are conducted outside the shop building; 1) maintenance of QGCs is conducted at the site (quay side), 2) maintenance of RTGs is conducted at the RTG depot which is specially designed for RTG maintenance, and 3) maintenance of MT container lifter is conducted in the space outside the shops (beside the maintenance shop).



Source :Study Team

Figure 3.2.3 Working Space in Maintenance Shop

(2) Frequency and Maintenance Time

There are two types of maintenance activities for equipment; periodical maintenance and repairing work upon breakdown trouble. Frequency and maintenance days for periodical maintenance are described in Table 3.2.17. Maintenance period of monthly maintenance is assumed as one (1) day while that of yearly

maintenance is assumed as three (3) days. Periodical maintenance is basically performed during weekdays (from Monday to Friday). Hence, available days of maintenance facilities for the periodical maintenance are assumed at 260 days per year (365 days - 52 weeks x 2 days/ week).

Frequency of equipment breakdown and repairing time are unforeseeable. In this study, the residual time frame of year up to 102 days (360 days – 260 days) is allocated for repairing work of unforeseeable equipment trouble. However, in the event of catastrophic failures or equipment troubles, priority is given to restoration, and at that time ordinary periodic maintenance may be shifted to the weekend. Based on this assumption, required capacity of the maintenance building is estimated in the following section.

(3) Utilization Ratio of Maintenance Shop and Required Number of Shops

Utilization ratio of the maintenance shop estimated by the frequency and days for periodical maintenance is shown in Table 3.2.17. Utilization ratio and required number of shops is summarized as follows;

1) RTG Depots; Utilization ratio of one RTG depots is 52%. From these figures, two (2) RTG depots seem to be sufficient for 18 TRGs. Considering that long maintenance period is required for RTGs once broken, one more RTG depot is planned for back-up use.

2) Maintenance Shop 1 (S1); Utilization ratio of S1 shop exceeds 200%. Hence, two more S1 shop will be necessary theoretically in the Phase-II Project. However, S1 shop is planned to set up one more building considering to the back-up from S2 shop’s residual capacity.

3) Maintenance Shop 2 (S2); Utilization ratio of S2shop slightly exceeds 100%. Therefore, one more S2 shop is to be set up concurrently with the back-up for S1 shop.

The above results are summarized in Table 3.3.4 (Quantity and Dimensions of Equipment Maintenance & Repair Shop).

Table 3.2.17 Utilization Ratio of Maintenance Shops

	Type of Equipment and Quantity		Maintenance Days (Periodical maintenance)								Distribution of Maintenance Days (Days/Year)							
	Name of Equipment	Quantity	Maintenance Area	Maintenance Cycle		Maintenance Days *1		Total Maintenance Days			Field Area			Maintenance Shop *5				
														1st Shop (24m)		2nd Shop (32m)		
				Monthly	Yearly	Monthly	Yearly	Monthly	Yearly	Total	Quayside	RTG Depot	Shop Outside	A-Zone	B-Zone	A-Zone	B-Zone	C-Zone
		(Sets)		(Times/Year)		(Days)		(Days/Year)						8m	16m	16m	8m	8m
1	QGC	**6**	Quayside	12	1	1	3	72	18	90	90							
	QGC Spreader *2	**8**	Shop	12	0	1		96	0	96								96
2	RTG	**18**	RTG Depot	12	1	1	3	216	54	270		270						
3	Reach Stacker	**3**	Shop	12	1	1	3	36	9	45						45		
4	MT Container Lifter	**6**	Shop Outside *3	12	1	1	3	72	18	90			90					
5	Tractor Head	**36**	Shop	12	1	1	3	432	108	540				540				
6	Trailer Chassis	**36**	Shop	12	0	1		432	0	432					432			
7	Fork Lift	**1**	Shop	12	1	1	3	12	3	15						15		
8	Engine Fork Lift	**2**	Shop	12	1	1	3	24	6	30						30		
9	Engine Fork Lift	**4**	Shop	12	1	1	3	48	12	60						60		
11	CFS Battery Fork Lift	**12**	Shop	12	1	1	3	144	36	180								180
12	CFS Battery Lifter	**12**	Shop	12	1	1	3	144	36	180							180	
13	Fuel Supplying Vehicle	**1**	Shop	12	0	1		12	0	12					12			
14	Pick-up Car	**2**	Shop	12	0	1		24	0	24					24			
15	Company Vehicle	**4**	Shop	12	0	1		48	0	48					48			
16	Commuting Bus	**6**	Shop	12	0	1		72	0	72					72			
Total of Periodical Maintenance Days (a)								1,884	300	**2,184**	90	270	90	540	588	150	180	276
Utilization Ratio with Phase-I Maintenance Shop			Capacity of each Zone (Days/Year)*4 (b)									520	260	260	260	260	260	260
			Utilization Ratio (%) (c)=(a)/(b)*100									**52%**	**35%**	**208%**	**226%**	**58%**	**69%**	**106%**
			Redundancy (Days/Year) (d)=(b)-(a)									250	170	-280	-328	110	80	-16
Utilization Ratio with 2 set of Phase-I Maintenance Shop			Capacity of each Zone (Days/Year)*4 (b)									780	260	520	520	520	520	520
			Utilization Ratio (%) (c)=(a)/(b)*100									**35%**	**35%**	**104%**	**113%**	**29%**	**35%**	**53%**
			Redundancy (Days/Year) (d)=(b)-(a)									510	170	-20	-68	370	340	244

*1 Maintenance days: Monthly Inspection & maintenance : 1 Day/ Time
Yearly Inspection & Maintenance : 3 Days/ Time

*2 QGC Spreader is maintained periodically in off-line basis by rotation maintenance system (once a month).

*3 Utilization Ratio (UR) of the maintenance shop is only for periodical maintenance, not including breakdown maintenance time.

*4 Capacity of each Zone (Days /Year) is assumed that maintenance work is done in weekdays (365 days-52 weeks x 2=260 days per year)

Source :Study Team

3.2.6 Administration Building and Marine Lounges

(1) Administration Building

Based on the workforce plan described in section "3.8 Terminal Operation Plan" of this report, management and company staff of the private operator who will work in the administration building (hereinafter called "the inhabitants") is summarized in Table 3.2.18. This table does not include Customs Officers (approximately 30 persons in the Phase I Project) and Shipping Company's/ Agents' staff (approximately 16 persons) who will also work in the administration building.

Total number of inhabitants in the tentative plan of Phase II is assumed at 122 persons (refer to the Tentative Plan (2018) in Table 3.2.18). This is about 1.7 times larger than the inhabitants planned in the Phase-1 Project (73 persons; refer to the Original Plan (2014) in Table 3.2.18). As the administration building planned in the Phase I Project is based on the inhabitants of the Original Plan (2014), it will be difficult to accommodate the inhabitants of the Phase II Project.

Accordingly, some staff members will be shifted to a different building as follows;

1) Anteroom for gate booth clerk and gate checkers is to be shifted from the administration building to the CFS Office in Plot 26 (36 personnel will be shifted)
2) Office room for CFS document manager and staff is to be shifted from the administration building to the CFS Office in Plot 26 (16 personnel will be shifted).

By these measures the total inhabitants in the Phase II will reach the level of Phase I (122-36-16=70 personnel).

Recently, the private Operator’s idea of workforce allocation was revealed (refer to the Operator’s Idea (2018) in the Table 3.2.18 as a reference). The number of inhabitants based on this idea (94 personnel in the Phase I stage) is larger than the Original Plan (73 personnel). The difference between the Original Plan and Operator’s idea is to be adjusted in the implementation stage of the Phase I Project.

Table 3.2.18 Number of Company Staff in Administration Building

Job Area & Positions			Working Room/ Anteroom	Phase-1 Plan (Plot 25) Capacity: 200,000 TEU			Phase-2 Plan (Plot 24-26) Capacity: 600,000 TEU		
				Original Plan (2014)	Operator's Idea (2018)	Remarks	Tentative Plan (2018)	Operator's Idea (2018)	Remarks
Management			**Administration Building (3F)**						
	President			1	1		1	1	
	Vice President				1		1	1	
	General manager				1		1	1	
	Manager				1		1	1	
	Sub Total			**1**	**4**		**4**	**4**	
Administration Department									
	Marketing & Sales			2	2		2	2	
	Accounting			4	4		5	6	
	General Affairs			4	4		5	6	
	IT			2	3		3	3	
	Sub Total			**12**	**13**	(R.D.P.C:12)*	**15**	**17**	
Operation Department									
	Senior Manager		**Administration Building (4F)**	12	1		15	1	
	Container Operation Section								
		Manager			1			1	
		Assistant Manager						1	
		Superintendent			6			10	
		Controller			6			8	
		Sub Total		**12**	**14**	(R.D.P.C:12)*	**15**	**21**	
Documentation Department									
	Manager		**Administration Center (2F)**	**1**	1		1	1	
	Container	CY Import		5	5		7	9	
		CY Export		3	3		7	7	
		Vanpool(MT Container)		3	3		5	5	
		CY Document Sub Total		**12**	**12**	(R.D.P.C:15)*	**20**	**22**	
		Gate Booth Clerk **	**Administration Center (1F)**	10	16		16	40	**To be shifted to CFS Office (Plot26)
		Gate Checker **		10	16		20	40	
		**Gate Booth Sub Total **		**20**	**32**	(R.D.P.C:20)*	**36**	**80**	
	Warehouse , Bulk Cargo, Ro/Ro	CFS Document Manager, Import	**Administration Center (2F)**	4	6		8	10	**To be shifted to CFS Office (Plot26)
		FS Export		4	3		8	7	
		CFS Checker **		8	10		16	30	
		CFS Sub Total		**16**	**19**	(R.D.P.C:16)*	**32**	**47**	
Total Number of Operator's Management & Staff to be accommodated in Administration Center Building * **				**73**	**94**		**122**	**191**	

Note: * (R.D.P.C. 12) means Room Design Pre-condition in Phase-1 is at the capacity of 12 persons.

**** This number is excluding Customs Officer and Shipping Company/ Agents' Staff.**

Source :Study Team

(2) Marine Workers' Lounge

Based om the workforce plan described in section " 3.8 Terminal Operation Plan" of this report, site superintendent and equipment operators/ drivers of the private Operator who will use the marine lounge (hereinafter called " the marine workers") is summarized in Table 3.2.19**.**

Total number of the marine workers in the tentative plan of Phase II is assumed at 149 persons (refer to the

Tentative Plan (2018) in Table 3.2.19). This is about 3 times larger than that of the Phase-1 Project (51 persons; refer to the Original Plan (2014) in Table 3.2.19). As the marine lounge planned in the Phase I project is for 60 marine workers, it will be difficult to accommodate the marine workers of the Phase II Project.

Therefore, one more marine lounge has to be built to accommodate the additional marine workers. Details of the building structure are to be designed at the DD stage of the Phase II Project.

Table 3.2.19 Workers to be accommodated in the Marine Lounge

Job Area & Positions	Working Room/ Anteroom	Phase-1 Plan Capacity: 200,000 TEU		Phase-2 Plan Capacity: 600,000 TEU	
		Original Plan (2014)	Operator's Idea (2018)	Tentative Plan (2018)	Operator's Idea (2018)
Operation Department					
Senior Manager	**Administration Building (4F)**	12	1	15	1
Container Operation Section					
Manager			1		1
Assistant Manager					1
Superintendent			6		10
Controller			6		8
Sub Total		**12**	**14**	**15**	**21**
Site Superintendent	**Marine Lounge ***	2	3	3	3
QGC Operator		8	8	24	24
RTG Operator		18	22	54	66
Tractor Head Driver		18	22	54	66
MT Container Lifter		5	8	13.5	24
Reach Stacker					
Sub Total		**51**	**63**	**149**	**183**
Note: Room Design Precondition of Marine Lounge in Phase-1 : 60 persons					

Source :Study Team

3.2.7 Electric Power Stations and Water Supply Facilities

(1) Electric Power Stations

Load Capacity Plan of the Phase-2 Power Supply Facility is shown in Table 3.2.20. Electrical Power is supplied to each facility and equipment through three Substations; electric facility substation (Main Station), jetty substations and reefer container substations. According to the Phase I power facility design, total capacity is 5,000 KVA, and main power consuming facilities are two sets of QGCs (42%) and reefer containers (33%).

Based on the facility and equipment plan of Phase II, additional power supply capacity of 8,200 KVA is required. Main item of the additional facility/ equipment is 1) QGC (4 sets), 2) Reefer container facility (2 times bigger than Phase I capacity) and other facilities located in Plot 24 and Plot 26.

In total, design based load capacity of 13,200 KVA is required (for Plot 24/25/26) which requires a total of seven (7) substations (refer to Table 3.2.20).

Table 3.2.20 Load Capacity Plan of Phase-2 Power Supply Facilities

No.	Load Capacity Plan of Phase-1						Load Item	Load Capacity Plan of Phase-2				Thilawa ODA Terminal Total	
	Substation (S.S.)*1	Capacity by S.S.		Capacity by Load Item		Number of S.S.		Quantity (Times of Phase-1 Capacity)*2	Capacity by Load Item. (KVA)	Capacity by S.S. (KVA)	Number of S.S.	Capacity KVA	Number of S.S.
		(KVA)	(%)	(KVA)	(%)								
1	Jetty Substation	2,127	43%	2,037	42%	1	QGCx2sets(Phase-1)	2	4,074	4,164	1	6,291	2
				55	1%		Marine Lounge (1 Bld.)	1	55				
				35	1%		Port Security	1	35				
2	Ref Con Substation	1,755	36%	1,619	33%	1	Ref Con	2	3,238	3,374	2	5,129	3
				90	2%		Maintenance Shop	1	90				
				11	0%		2nd Gate	1	11				
				35	1%		Port Security	1	35				
3	Electric Facility Substation (Main Station)	1,011	21%	492	10%	1	Administration Building	0	0	699	1	1,710	2
				214	4%		CFS	1	214				
				25	1%		Main Gate	1	25				
				80	2%		X Ray Machine x2 sets	1	80				
				11	0%		Fuel Station	1	11				
				120	2%		Water Facility	2	240				
				60	1%		Electrical Facility	2	120				
				9	0%		Security Post	1	9				
4	Yard Lighting	n.a.		n.a.									
	Total	**4,893**	100%	**4,893**	100%	**3**			**8,237**	**8,237**	**4**	**13,130**	**7**
	Round Figure	**5,000**		**5,000**					**8,200**	**8,200**		**13,200**	

Note: *1 S.S.=Substation *2 Times of load item quantity by the quantity of Phase-1

Source :Study Team

(2) Water Supply Facilities

Water demand of each water consuming facility and water supply capacity are shown in Table 3.2.21.

Phase I Water Supply Facilities were designed to have a capacity of 480 ㎥/day including 1) building water supply of 68 ㎥/day, 2) ship water supply of 400 ㎥/day, 3) and water supply for container washing of 3 ㎥/day. The requirement for ship water service has been decreasing in the port since MPA started water supply services using its Water Supply Boat. Therefore, as water supply needs in the Phase II Project can be covered by the Phase I facilities, additional water supply facility is not planned.

Table 3.2.21 Water Supply Capacity planned in the Phase-1 Project

No.	Water Consuming Facility	Water Demand		Capacity planned in Phase-1
		㎥/Day	(%)	㎥/Day
1	Building Occupants and Sanitary Use	68	14%	480
2	Ship Supply Water	400	85%	
3	Container Wash	3	1%	
	Total	471	100%	

Source :Study Team

3.2.8 Main Features of Cargo Handling Equipment

Based on the section "3.8.6 Cargo Handling Equipment Plan", required quantity and main features of cargo handling equipment are summarized in Table 3.2.22.

Table 3.2.22 Required Capacity and Main Features of Equipment

No.	Equipment	Required number of Equipment (Plot 24/25/26)			Main Use	Capacity and Main Features
		ODA Loan	Private Invest.	Total		
1	QGC	6		6	Containers	・Earthquake resistance gantry crane with seismic isolation system ・Capacity: 40.6 Ton, ・Rail span: 16 m ・Outreach: 14 rows on deck (Phase-2)
2	RTG	18		18	Containers	・Capacity: 40.6 Ton, ・Gantry Span: 23.5m ・Stacking height: 1-ober-5, ・Span:23.5m
3	Reach Stacker	3		3	Containers General Cargoes	・Capacity: 40.6 Ton, ・Stacking height: 5 tier
4	MT Container Lifter	3	3	6	Containers	・Capacity: 10 Ton (for Empty Container Handling) ・Stacking height: 5 tier
5	Tractor Head	30	6	36	Containers	・20 feet x2, 40 feet x1
6	Trailer Chassis					
7	Engine Fork Lift	1		1	General Cargoes (Heavy Duty)	・Capacity: 24 Ton
8	Engine Fork Lift	1	1	2	General Cargoes	・Capacity: 10 Ton-12 Ton
9	Engine Fork Lift	4		4	General Cargoes	・3 Ton-4 Ton
10	CFS Battery Fork Lift	6	6	12	General Cargoes	・3 Ton (General Cargo handling in CFS)
11	CFS Battery Lifter	6	6	12	General Cargoes	・3 Ton (General Cargo handling in CFS)
12	Fuel Supplying Vehicle		1	1	Fuel Supply	・Fuel Supply for Yard Equipment (RTG, Reach Stacker, MT Container Lifter, Fork Lift, etc.)
13	Pick-up Car		2	2	General Use	
14	Company Vehicle		4	4	General Use	
15	Commuting Bus		6	6	Commuting Workers	(29-Passanger)

Source :Study Team

[Phase III Project]

Prerequisites for planning are almost the same as those in Phase II, and different parts are noted below.

3.2.9 Preconditions for the Facility Plan（Phase III）

(1) Container handling Capacity

Targeted Terminal Capacity of Plot 22 and 23 is at 400,000 TEUs per annum.

(2) Container Handling Volume and its Breakdown

The proportions of each type of container and the handling volume as a precondition for this plan is summarized in Table 3.2.23. The composition ratio adopts the long-term assumed proportions in the Phase II plan (see Table 3.2.1).

Table 3.2.23 Container Handling Volume by Type (Phase III)

Type of Container		Long-term Proportions	
		Proportions (%)	Container Volume (TEUs/Year)
Import	Full Container	90%	180,000
	Empty Container	10%	20,000
Export	Full Container	80%	160,000
	Empty Container	20%	40,000
Total	Full Container	85%	340,000
	Empty Container	15%	60,000
Grand Total		100.0%	400,000

Source :Study Team

(3) Thilawa SEZ Related cargo Volume

Cargo Volume related to the Thilawa SEZ (Phase III) at Plot 22/23 is listed in Table 3.2.24. The ratio of SEZ-related cargo volume to the total cargo volume adopts the same premise as in the Phase II plan for both import and export (see Table 3.8.3).

Table 3.2.24 Cargo Volume related to the Thilawa SEZ (Phase III)

Category		Long-term Proportions	
		Proportions (%)	Container Volume (TEUs/Year)
Import Full Container	SEZ Cargo	18%	32,400
	Other than SEZ	82%	147,600
	Import (Full) Total	100%	180,000
Export Full Container	SEZ Cargo	39%	62,400
	Other than SEZ	61%	97,600
	Export (Full) Total	100%	160,000
Full Container Total	SEZ Cargo	28%	94,800
	Other than SEZ	72%	245,200
	Full Container Grand Total	100%	340,000

Source :Study Team

Other preconditions for facility planning are the same as those of the Phase II Project (see 3.2.1 (3) Material Flow related to the Terminal, (4) Berthing Side of the Calling Vessels, (5) Cargo Handling System in the Terminal).

3.2.10 Required Capacity for each Component (Phase III)

Required capacity of each component in the Phase III terminal (total capacity: 400,000 TEUs) and the basis of estimation are summarized in Table 3.2.25. The basic method to obtain the required quantity (capacity) of each component of the Phase III terminal is as follows; In order to achieve the targeted cargo handling capacity of Phase III terminal, required quantity of each component of the terminal is estimated by multiplying 67% (400,000 TEU/ 600,000 TEU) by the quantity of corresponding component of Phase II terminal (Plot 24/25/26).

Required capacity of components is described in Table 3.2.25. Additional explanation is given for the following components; 1) Stacking yard blocks, 2) Physical inspection facilities and CFS, 3) Maintenance shops, 4) Administration building and marine house.

Table 3.2.25 Required Capacity of the Terminal Facilities (Phase III: Plot 22/23)

Facility		Required Capacity	Requirements	Remarks
Stacking Yard	Dry Container Yard (Full)	8 blocks x 48 bays in TEUs	67% of Phase-I & II stacking capacity	Refer to 3.2.10 (1)
	Empty Container Yard	1,244 ground slots in TEUs	78% capacity of Phase-I & II stacking capacity	
	Reefer Container Yard	1 block x 39 bays in (TEUs)	72% capacity of Phase-I & II stacking capacity	
Terminal Gates	Main Gate	10 lanes	67% of Phase-I & II gate lanes	
	2nd Gate	3~4 lanes	Same numbers as Phase-I & II gate lanes	
Customs Inspection Facilities	X-Ray Inspection Facilities	3 sets	67% of Phase-I & II X-ray machines	
	Physical Inspection Facilities & CFS	34 Inspection Bays and 16 CFS storage blocks	67% of Phase-I & II inspection platforms	Refer to 3.2.10 (2)
Maintenance Shops	Maintenance Shop (S1)	1 building	Examined based on the Phase-III cargo handling equipment plan	Refer to 3.2.10 (3)
	Maintenance Shop (S2)	1 building		
	Container Repair Shop	1 building	Same numbers as Phase-I repair shop	
	RTG Maintenance Depot	2 depots	Same number as Phase-I RTG depots	
Administration Building		1 building	Examined based on the Phase-III workforce plan	Refer to 3.2.10 (4)
Marine Workers' Lounge		1 building		
Power Supply Facilities	EF Substation	1 set	200% of Phase-I capacity	
	Jetty Substation	1 set	200% of Phase-I capacity (4 QGCs)	
	Ref Container Substation	1 set	200% of Phase-I capacity	
Water Supply Facilities	Water Supply Facility	1 building	Same capacity as Phase-I Facility	
	Water Supply Tower	1 Tower	Same capacity as Phase-I Facility	

Source :Study Team

(1) Yard Capacity and Required Yard Blocks

Yard specifications and stacking capacities of both Phase I & II plan (Plot 24/25/26) and Phase III plan (Plot 22/23) are listed in Table 3.2.26. Regarding the most fundamental yard blocks, dry-full container blocks, block length of 48 TEUs is set for the blocks of plot 22/23 (Phase III), which is 67% of the total block length of Plot 24/25/26 (72 TEUs). For empty container and reefer containers, the block size is determined according to the yard layout space.

In conclusion, yard stacking blocks of Plot 22/23 are planned to have a capacity of 17,000 TEUs: 11,520 TEUs for dry-full containers, 4,849 TEUs for empty containers and 702 TEUs for reefer containers (see

Table 3.2.26).

Table 3.2.26 Required Stacking Capacity and Yard Blocks (Phase III)

Phase	Phase-I & II (Plot 24/25/26): (a)	Phase-III (Plot 22/23): (b)	(b) / (a)
Required Capacity (TEUs /Year)			
Total	**600,000**	**400,000**	**67%**
Number of Bays (TEUs)			
Dry/ Full	**72**	**48**	**67%**
Empty	-	-	-
Reefer	**54**	**39**	**72%**
Block Size (Bays (TEUs) x Rows x Blocks)			
Dry/ Full	72 TEUs x 6 Rows x 8 Blocks	48 TEUs x 6 Rows x 8 Blocks	-
Empty	(18~23) TEUs x (6~10) Rows x (2~4) Blocks	44 TEUs x (6~10) Rows x 3 Blocks	-
Reefer	54 TEUs x 6 Rows x 1 Block	39 TEUs x 6 Rows x 1 Block	-
Number of Ground Slots (TEUs)			
Dry/ Full	**3,440**	**2,304**	**67%**
Empty	**1,244**	**968**	**78%**
Reefer	**324**	**234**	**72%**
Stacking Height (Tiers)			
Dry/ Full	5	5	-
Empty	5	5	-
Reefer	3	3	-
Stacking Capacity (TEUs)			
Dry/ Full	**17,200**	**11,520**	**67%**
Empty	**6,220**	**4,840**	**78%**
Reefer	**972**	**702**	**72%**
Total	**24,392**	**17,062**	**70%**

Source :Study Team

(2) Physical Inspection Facilities and CFS

Required number of slots on the platform for the physical inspection facility at the Phase III terminal is summarized in Table 3.2.27. Assuming that the preconditions for determining required platform capacity, i.e. composition of handling cargo volume, ratio of SEZ-related cargo volume, physical inspection rate and inspection efficiency, and customs official working hours, is the same as that of the Phase II terminal, the size of the required platform (number of slots) in Phase III terminal is proportional to the container handling at the terminal. As a result, the required number of slots in Phase III plan is about 34 Bytes. Based on the size of the platform, the required length of CFS is estimated to be at least 136 m (width of platform 4 m/ Bay x 34 Bays =136 m).

Table 3.2.27 Required Physical Inspection Slots (Phase III)

Phase	Units	Phase-I & II (Plot 24/25/26): (a)	Phase-III (Plot 22/23): (b)	(b) / (a)
Total Container Throughput	TEU	**600,000**	**400,000**	67%
Number of containers to be physically inspected per day (average)	Box/ Day	**92 *1**	**61.3**	67%
Required CFS inspection platform (import + export)	Slots	**50 *1**	**34**	67%
Remarks		Including customs seal setting platform	Not including customs seal setting platform	
Note: *1 Refer to Tables 3.2.10, 3.2.11 and 3.2.15				

Source :Study Team

The amount of LCL cargo in Phase III plan is estimated to be 7,380 TEUs per year which is 5% of import container excluding SEZ cargo (147,600 TEUs per year x 5% = 7,380 TEUs per year (see Table 3.2.24)). Applying the design criteria adopted in the Phase I Project (in the case of CFS handling volume of 4,500 TEUs per year, storage capacity was required at 9.66 blocks), required CFS storage capacity for Phase III plan is estimated at 16 blocks. This is equivalent to a CFS length of 99 m and width of 50 m. In the stage of FS for the Phase III Project, the required customs bonded area inside the CFS will be examined in the future. However, a length of 136m is considered to be sufficient for carrying out the physical inspection works and for LCL cargo storage.

In conclusion, the dimensions of the CFS in the Phase III plan are provisionally set as 50 m in width and 136 m in length.

(3) Equipment Maintenance Shop

The utilization ratio of the equipment maintenance shop in the Phase III Project is described in Table 3.2.28.

The composition of the maintenance shop is the same as that of the Phase I plan, mainly including the1st maintenance shop (S1) which is used for maintenance of the vehicles such as the tractor head, the trailer chassis, etc. and the 2nd maintenance shop (S2) which is used for the maintenance of QGC spreaders and heavy duty handling equipment such as reach stackers and forklifts. In order to carry out the maintenance and repairing work for the equipment planned in the Phase III terminal (refer to Table 3.8.9 "Required Quantity of Cargo handling Equipment (Plot 22/23)), two maintenance shops (one S1 and one S2) are to be constructed in Plot 22/23.

The utilization ratio in Table 3.2.28 is estimated based on the same conditions as that of the Phase II plan, which include I) zone allocation of each shop and 2) maintenance standards (frequency of periodical inspection and maintenance, maintenance days, etc.) of each type of cargo handling equipment.

Because the container handling capacity of the Phase III Project is planned at 400,000 TEUs per year, which is double that of the Phase I project, the quantity of cargo handling equipment of Phase III will also be about twice that of the Phase I plan. Therefore, the utilization ratio of each zone of the 1st and 2nd shop is also higher than Phase I. In particular, the utilization rate of the 1st shop will exceed 100%, even if it is only used for periodic inspection and maintenance work. Hence, a larger maintenance building than that constructed in the Phase I project will be necessary. Further examination is necessary in the FS stage of Phase III Project in the future.

Table 3.2.28 Utilization Ratio of Maintenance Shops (Phase III)

	Type of Equipment and Quantity		Maintenance Days (Periodical maintenance)								Distribution of Maintenance Days (Days/Year)							
	Name of Equipment	Quantity	Maintenance Area	Maintenance Cycle		Maintenance Days *1		Total Maintenance Days			Field Area			Maintenance Shop *5				
														1st Shop (24m)		2nd Shop (32m)		
				Monthly	Yearly	Monthly	Yearly	Monthly	Yearly	Total	Quayside	RTG Depot	Shop Outside	A-Zone	B-Zone	A-Zone	B-Zone	C-Zone
		(Sets)		(Times/Year)		(Days)		(Days/Year)						8m	16m	16m	8m	8m
1	QGC	**4**	Quayside	12	1	1	3	48	12	60	60							
	QGC Spreader *2	**5**	Shop	12	0	1		60	0	60								60
2	RTG	**12**	RTG Depot	12	1	1	3	144	36	180		180						
3	Reach Stacker	**2**	Shop	12	1	1	3	24	6	30						30		
4	MT Container Lifter	**4**	Shop Outside *3	12	1	1	3	48	12	60			60					
5	Tractor Head	**24**	Shop	12	1	1	3	288	72	360				360				
6	Trailer Chassis	**24**	Shop	12	0	1		288	0	288					288			
7	Fork Lift	**1**	Shop	12	1	1	3	12	3	15						15		
8	Engine Fork Lift	**1**	Shop	12	1	1	3	12	3	15						15		
9	Engine Fork Lift	**2**	Shop	12	1	1	3	24	6	30						30		
11	CFS Battery Fork Lift	**6**	Shop	12	1	1	3	72	18	90								90
12	CFS Battery Lifter	**6**	Shop	12	1	1	3	72	18	90							90	
13	Fuel Supplying Vehicle	**1**	Shop	12	0	1		12	0	12								12
14	Pick-up Car	**2**	Shop	12	0	1		24	0	24								24
15	Company Vehicle	**4**	Shop	12	0	1		48	0	48							48	
16	Commuting Bus	**6**	Shop	12	0	1		72	0	72								72
Total of Periodical Maintenance Days (a)								1,248	186	**1,434**	60	180	60	360	288	90	138	258
Utilization Ratio with Phase-III Maintenance Shop				Capacity of each Zone (Days/Year)*4 (b)								520	260	260	260	260	260	260
				Utilization Ratio (%) (c)=(a)/(b)*100								**35%**	**23%**	**138%**	**111%**	**35%**	**53%**	**99%**
				Redundancy (Days/Year) (d)=(b)-(a)								340	200	-100	-28	170	122	2

*1 Maintenance days: Monthly Inspection & maintenance : 1 Day/ Time
Yearly Inspection & Maintenance : 3 Days/ Time

*2 QGC Spreader is maintained periodically in off-line basis by rotation maintenance system (once a month).

*3 Utilization Ratio (UR) of the maintenance shop is only for periodical maintenance, not including breakdown maintenance time.

*4 Capacity of each Zone (Days /Year) is assumed that maintenance work is done in weekdays (365 days-52 weeks x 2 days =260 days per year)

Source :Study Team

(4) Administration Building and Marine Workers' Lounge

Considering the fact that the administration building planned in the Phase I Project (Plot 25) is diverted to the Phase II Project (Plot 24/25/26) , the administration building of the same scale will be sufficient to

accommodate the relevant staff in the Phase III Project (Plot 22/23).

Considering that the number of habitants in the Phase III Project for the marine workers' lounge is twice that of the Phase I project, or in other words 67% of the Phase II Project, construction of one marine house at the quayside is necessary to accommodate the relevant workers. Number of workers in Phase III Project is shown in Table 3.8.6. (Refer to the [Reference] column in the Table 3.8.6)

3.3 Facility Layout Plan

[Phase II Project]

The layout planning for the Expansion Project of Yangon Port in Thilawa Area (Phase II) and preconditions for the planning such as the basic policy and quantity and dimensions of each component are described in this section.

3.3.1 Basic Policy for Layout Planning

(1) Terminal Unit

Plots 24‐26 (quay length 600m) are deemed as one business unit from the viewpoint of efficient terminal operation. The reason is described in detail in Section 3.8.1 **"**Basic Policy for Layout Planning".

(2) Targeted Terminal Capacity

Targeted terminal capacity is 600,000 TEUs per annum.

(3) Unified Layout

Phase II terminal layout is planned under a unified concept with Phase I layout to enable effective operation among three yard Plots (24/25/26). For example, a QGC system is adopted as the cargo handling system at the quay side while an RTG System is adopted at the yard side as in the Phase I System. In addition, stacking blocks in the yard are arranged in a straight line alongside to the quay line.

(4) Truck Flowline in the terminal

Berthing side of ships on the quay is mainly starboard side. Hence, seaside trailers run clockwise in the terminal, whereas landside trailers run counter-clockwise. The reason that this traffic flow has been adopted is described in Section 3.2.1"Basic Policy of the Facility Plan".

3.3.2 Quantity and Dimensions of each Component

(1) Yard Blocks

Quantity and dimensions of yard blocks are shown in Table 3.3.1. In order to shorten the travel distance of seaside trailers during loading and unloading operations, yard blocks are allocated for dry container, reefer container and empty container from seaside to landside.

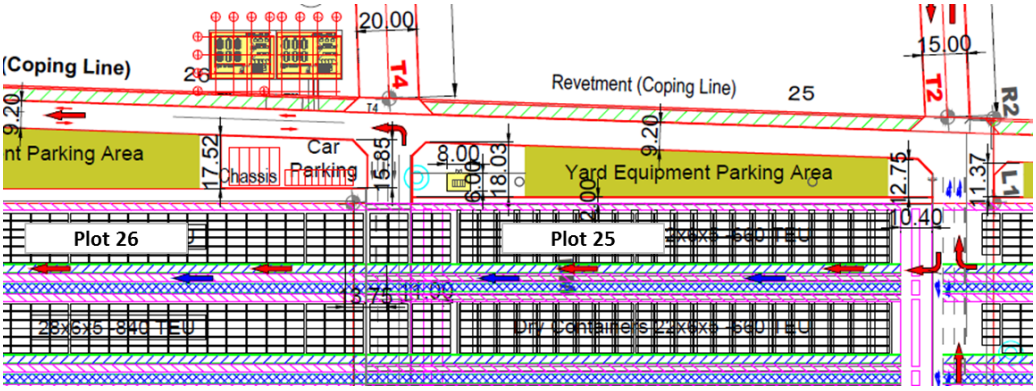
In order for RTG operators to observe quayside operations from their cabin, truck lane in the RTG gantry is allocated at landside. One passing lane is allocated at landside of each dry container block for smooth passing of outside trailers and avoiding mutual interference of outside and inside (quayside) trailers in the yard blocks. This allocation type is called “6-0-0”. This allocation type is applicable only for terminals with sufficient yard space to have a passing lane.

In order to simplify the traffic line of outside trailers and minimize crossing points between outside and inside (quayside) trailers, outside trailers are to pass from the north block end of Plot 24 to the south block end of Plot 26 in a counter clock-wise movement.

Stacking blocks in Plot 26 are allocated at an appropriate point to allow the passing road between Plot 25 and Plot 26 (running east-west) to be used as a container stacking yard (see Figure 3.3.1).

Table 3.3.1 Quantity and Dimensions of Stacking Blocks

	Plot 24	Plot 25	Plot 26	Total
	Block Size			
	(Bays (TEUs) x Rows x Blocks)			
Dry	26 TEUs x 6 x 8	22 TEUs x 6 x 8	24 TEUs x 6 x 8	72 TEUs x 6 x 8
Empty	20 TEUs x (6/10) x 2	(18/22) TEUs x (6/10) x 2	(21/23) TEUs x (6/10) x 4	(18/23) TEUs x (6/10) x (2/4)
Reefer	20 TEUs x 6 x 1	17 TEUs x 6 x 1	17 TEUs x 6 x 1	54 TEUs x 6 x 1
	Number of Ground Slots			
	(TEUs)			
Dry	1,232	1,056	1,152	**3,440**
Empty	320	312	612	**1,244**
Reefer	120	102	102	**324**
	Stacking Height			
	(Tiers)			
Dry	1 over 5	1 over 5	1 over 5	1 over 5
Empty	5	5	5	5
Reefer	3	3	3	3
	Stacking Capacity			
	(TEUs)			
Dry	6,160	5,280	5,760	**17,200**
Empty	1,600	1,560	3,060	**6,200**
Reefer	360	306	306	**900**
Total	8,120	7,146	9,126	**24,300**



Source :Study Team

Figure 3.3.1 Container stacking image at the passing road between Plot 25 and Plot 26

(2) Terminal Gate

Number of lanes and dimensions of the gate facilities are shown in Table 3.3.2.

Table 3.3.2 Quantity and Dimensions of Gate Lanes

Gate Location		Quantity of Lanes		Approximate Building Dimension	Remarks
		Phase-2 *1	Phase-1 *2		
Main Gate	In-gate	9 lanes	5 lanes	14 lanes: 28m(L) x103m(W)	(4 weighing bridge)
	Out-gate	5 lanes	3 lanes		
	Total	14 lanes	8 lanes		
2nd Gate	In-gate	-	3~4 lanes	23m(L) x 27m(W)	
Note: *1 Corresponding to Plot 24 to 26 *2 Corresponding to Plot 25					

Source :Study Team

Terminal land area is segregated into two parts. One is the west part of the 2nd gate line, which represents the container stacking area (ISPS security area), and the other is the east part of the 2nd gate line, which represents the customs and administration area. The former includes standard international container terminal facilities such as container stacking blocks, maintenance shops, marine lounge building and special container (DG container) storage area. The latter includes customs inspection facilities (X-ray inspection machines, physical inspection platforms, and parking area), CFS, main gate, administration building and electric and water supply stations.

In contrast to other terminals in Yangon Port, this terminal has two gates. In the Phase I Project, the 2nd gate was used to give instructions regarding the destination site of incoming trailers in the yard. In the Phase II Project, the 2nd gate is expected to have the following functions;

① Instructions on the destination site of incoming trailers in the yard
② Registration for import empty container pick-up (24 hour basis)
③ Receiving of export empty container (24 hour basis)

(3) Customs Inspection Facilities & CFS

Quantity and dimensions of customs inspection facilities are shown in Table 3.3.3.

Inspection facilities are located on the truck flowline in the terminal. Export container inspection facilities are located on the truck flowline between the main gate and 2nd gate (Plot 25), whereas import container inspection facilities are located between the stacking yard and the main gate (Plot 26).

Container cargoes related to the Thilawa SEZ are assumed to be inspected and cleared at the SEZ Customs, and are to be transported between Thilawa Port and the SEZ in bond.

Table 3.3.3 Quantity and Dimensions of Customs Inspection Facilities

Facility	Quantity of Facilities		Building Size	Physical Inspection Platform	CFS Truck Lane
X-Ray Inspection Facilities	Import Cargo Inspection	2 sets	35m (L) x 13m (W)	-	-
	Export Cargo Inspection	2 sets		-	-
Physical Inspection Facilities & CFS	Import Cargo Inspection	1 building	104m (L) x 50m (W)	40 Bays	40 Bays
	Export Cargo Inspection	1 building	170m (L) x 50m (W)	36 Bays	12 Bays

Source :Study Team

(4) Equipment Maintenance & Repair Facilities

Quantity and dimensions of maintenance facilities are shown in Table 3.3.4.

Quantity of facilities (S1 & S2) is estimated based on the types & quantities of the equipment. Maintenance & repair facilities are concentrated in the same area.

Table 3.3.4 Quantity and Dimensions of Equipment Maintenance & Repair Shops

Maintenance Facility	Building Size	Quantity		Remarks
		Phase-2 *1	Phase-1 *2	
Maintenance Shop (S1)	18 m x 32 m	2 buildings	1 building	Cargo Handling Equipment Maintenance
Maintenance Shop (S2)	18 m x 32 m	2 buildings	1 building	
Container Repair Shop	15 m x 42 m	1 building	1 building	Container Repairing
RTG Maintenance Depot	-	3 depots	2 depots	RTG Maintenance
Note: *1 Corresponding to three Plots (Plot 24, 25 and 26) *2 Corresponding to Plot 25				

Source :Study Team

(5) Administration Building/Marine Workers' Lounge

Quantity and dimensions of the administration building and marine workers' lounge is shown in Table 3.3.5.

The layout of the administration building is planned based on the assumption that the building under construction (for Phase I) will accommodate Management, Administration Department, Control Room and Documentation Department staff of the Operating Company as well as Customs Officer and Shipping Line/ Agent's staff in the Phase II stage. Other staff of the Operating Company (i.e. Site Managers of Operation Department, Checkers (gate booth clerk, gate checker, CFS checker, etc.), who were accommodated in the Administration Building in the Phase I stage, would be shifted to the other office to be built in CFS in Plot 26. Detailed allocation plan is to be studied in the DD stage of the project.

Marine workers' lounge building for the Phase II Project is to be built due to the increase of workers. Size of the additional building will be designed based on the number of workers in the DD Stage. The buildings for Phase I and Phase II will be located in the same area.

Table 3.3.5 Quantity and Dimensions of Administration Building and Marine Workers' Lounge

Building	Building Size	Quantity	
		Phase-2 *1	Phase-1 *2
Administration Building	40m x 21 m (5 stories, Total Floor Space 3,400 ㎡)	1 Building	
Marine Workers' Lounge	18 m x 12 m *3 (2 stories, Total Floor Space 684 ㎡)	2 buildings	1 building
Note: *1 Corresponding to three Plots (Plot 24 to 26) *2 Corresponding to Plot 25 *3 Size of the Building for Phase-2 is tentative in the Feasibility Study.			

Source :Study Team

(6) Electrical Power Supply Facility Building

Electrical power is supplied to the terminal facility and equipment through three types of Substations; electric facility substations (Main Stations), jetty substations and reefer container substations. Dimensions and quantity of the substation buildings are shown in Table 3.3.6.

Two buildings of the main stations are to be concentrated in the same area as Phase I. Regarding jetty substations, additional station is located at the north side of Plot 24. It will cover QGCs on the Jetty of Plot 24 and Plot 23 in the future. Each substation for reefer containers is located in the reefer block area of Plot 24-26.

Table 3.3.6 Quantity and Dimensions of Power Supply Facilities

Substations	Building Size	Quantity	
		Phase-2 *1	Phase-1 *2
EF Substation (Main Station)	23 m x 33 m (760 ㎡)	2 buildings	1 building
Jetty Substation	8.8 m x 7.4 m (65 ㎡)	2 buildings	1 building
Reefer Container Substation	4.1 m x 7.9 m (12 ㎡)	3 buildings	1 building
Note: *1 Corresponding to three Plots (Plot 24 to 26) *2 Corresponding to Plot 25 *3 Size of the Building for Phase-2 is tentative in the Feasibility Study.			

Source :Study Team

(7) Water Supply Facilities

Quantity and dimensions of water supply facilities are shown in Table 3.3.7.

Phase I Water Supply Facilities were designed to have a capacity of 480 ㎥/day including 1) building water supply of 68 ㎥/day, 2) ship water supply of 400 ㎥/day, 3) and water supply for container washing of 3 ㎥/day. Considering that the need for ship water supplying service has lessened since MPA started the service by water boat, water supply needs for Phase II terminals can be covered by the Phase I facilities. Hence, additional water supply facility is not planned.

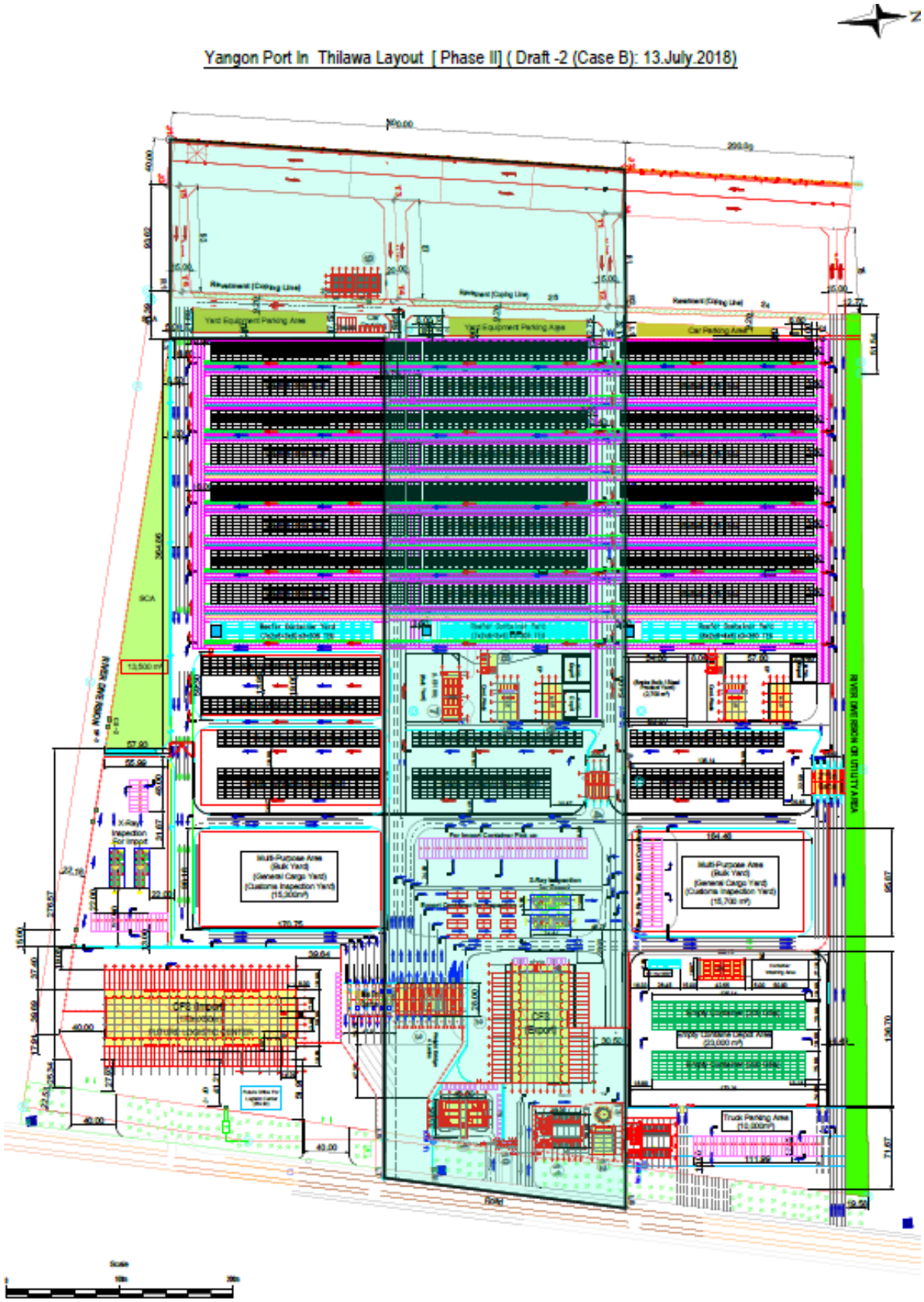
Table 3.3.7 Quantity and Dimensions of Water Supply Facilities

Substations	Building Size	Quantity	
		Phase-2 *1	Phase-1 *2
Water Supply Facility	23 m x 33 m (760 ㎥)	1 building	
Water Supple Tower	35 m high, Tank Capacity:40㎥	1 tower	
Note: *1 Corresponding to three Plots (Plot 24 to 26) *2 Corresponding to Plot 25			

Source :Study Team

3.3.3 Layout Drawing of Phase II Project (Plot 24 & Plot 26)

A Layout Drawing corresponding to the basic policy of the planning and quantity and dimensions of each component described above is attached in Figure 3.3.2.



Source :Study Team

Figure 3.3.2 Layout Drawing of Phase I (shadowed) and Phase II

[Phase III Project]

3.3.4 Basic Policy for Layout Planning（Phase-Ⅲ）

Four main points to be considered for the Phase III layout planning are described as follows;

(1) Targeted Terminal Capacity

Targeted terminal capacity is 400,000 TEUs per annum (Plot 22/23).

(2) Terminal Business Units

1) As described in the Phase II layout planning, quay-lines of Plot 22/23 (400m length) and Plot 24/25/26 (600m length) are not in a straight line (inflective at 8-degrees). Therefore, a calling vessel cannot be berthed at the area where the jetties are joined; accordingly, each jetty has no choice but to be operated independently.

2) As Plot 22/23 has two berths (total length of 400 m), two vessels can be accommodated at the same time. Therefore, Plot 22/23 can be operated as an independent terminal.

3) A Japanese terminal operator, who was awarded Plot 25/26 concession, has a strong interest to operate Plot 24/25/26 as a business unit in the Phase II Project. However, the operator does not show any interest in the project at Plot 22/23 at present stage, because Phase I (Plot 25/26) terminal is still in construction and has not yet started its operation.

Due to the above, when considering the facility plan in the Phase III Project, it is too risky to make the layout plan based on the assumption that Plot 22-26 will have a quay length of 1,000m and be operated as one integrated business unit. Therefore, in this survey, Plots 22/23 will be planned to be operated as an independent business unit. Integrated operation unit of five plots (Plot 22-26) will be discussed in the case that the rail terminal is incorporated in the Plots (refer to [for reference] " Draft of Facility Layout Plan with Railway Terminal in Plot 23").

(3) Defining the outer edge of plot 22

In examining the facility layout plan of the Phase III Project, the basic boundary conditions, i.e. how much dead space is to be secured for the river diversion, drainage and other detour route at the outer edge on the north side of the Plot 22, have not been clearly defined because the survey on natural conditions has not yet been completed. Therefore, in this survey, dead space (rainwater drainage route, utility area) of 15 m to 22 m width is tentatively preset on the north side of plot 22, and terminal facilities are laid out inside thereof.

Regarding the outer edge of the south side of plot 23, dead space of about 30 m in width is secured including the utility area on the north side of plot 24 (width 12 to 20 m) and the terminal facilities are arranged inside the dead space. Therefore, detailed examination (FS or development preparation survey) of the outer edge of the terminal is necessary in the next stage survey.

(4) Inclusion of Railway Terminal in the Plot

The inclusion of the railway terminal to the ODA terminal was proposed in the survey previously conducted by the Ministry of Economy, Trade and Industry (METI) (March 30, 2016 "Survey on infrastructure development surrounding Myanmar-Thirawa SEZ"). However, this proposal was not shared with the officials of the Myanmar Port Authority (MPA). Therefore, this proposal is still at the conceptual stage. When planning the railway terminal in the future, the site of the terminal, i.e., whether to develop it in the plot of the ODA terminal (dedicated rail terminal) or to develop it in the SEZ in parallel with the quay wall and the road (common rail terminal) needs to be carefully examined.

The location of the railway terminal will determine whether one or two business units are adopted for management of the ODA terminal as indicated in Table 3.3.8. As is apparent from this table, when the railway terminal is developed in the ODA terminal (Plot 23), the yard area of plot 22/23 becomes insufficient. Therefore, in order to overcome this problem, plots 22-26 need to be operated as one business entity.

Table 3.3.8 Railway terminal construction site and business unit of the ODA terminal

Construction Cite of Railway Terminal	Business Unit of ODA Terminal	
	One Unit *1	Two Units *2
SEZ Premises	○	○
ODA Terminal (Plot 23)	○	×

Note: *1 One Business Unit : Plot 22-26 is operated by one operator/ consortium.

*2 Two Business Units : Plot22/23 and Plot 24/25/26 is operated by different operator/ consortium.

Source :Study Team

3.3.5 Quantity and Dimensions of each Component (Phase III)

Quantity and approximate dimensions of each component that form the basis of the facility layout plan (Phase III) are summarized in Table 3.3.9. The dimensions are estimated based on 3.2.10 "Required capacity of each facility (Phase III)" in the previous section (refer to Table 3.2.25)

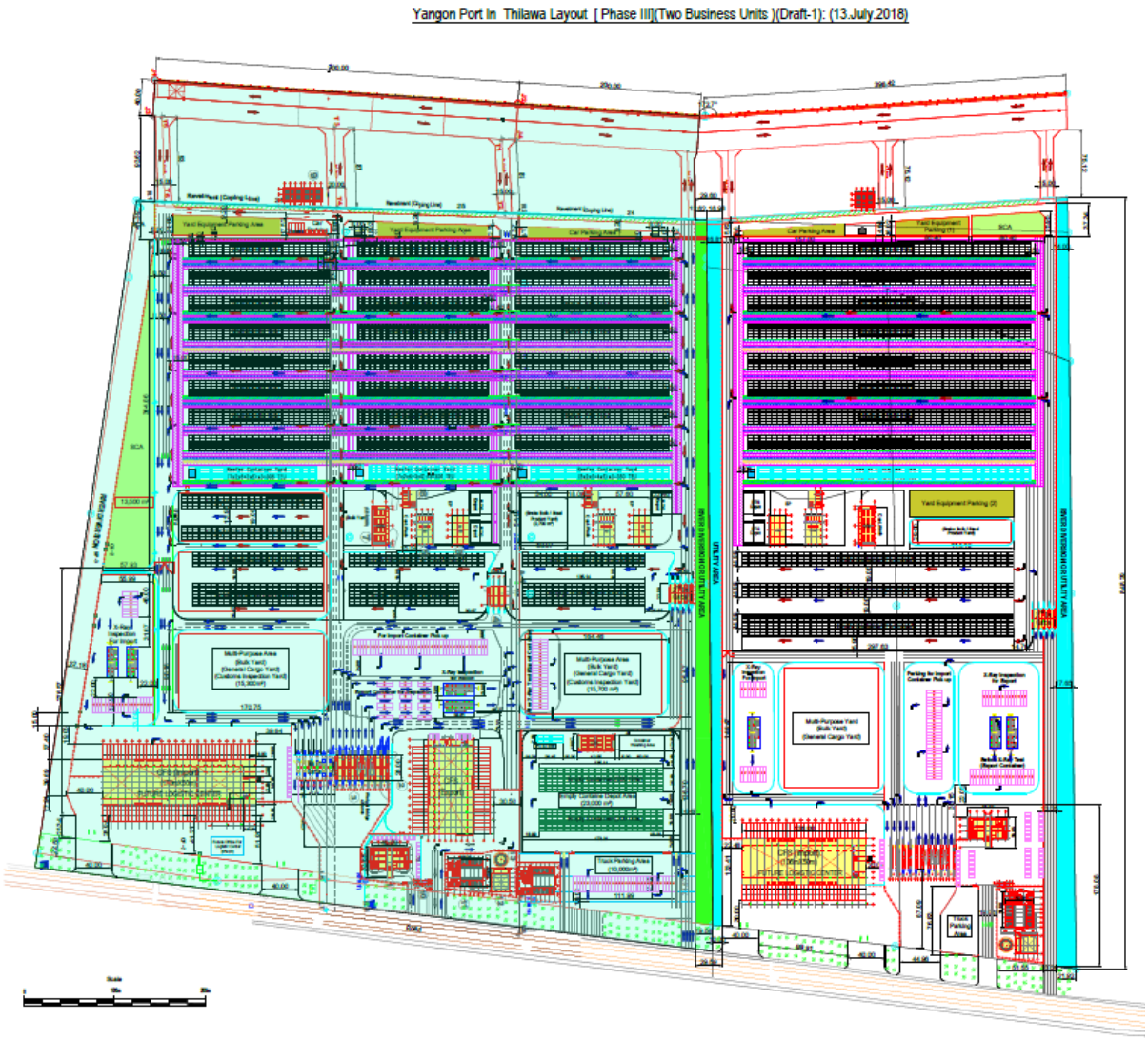
Table 3.3.9 Quantity and Dimensions of Terminal Facilities (Plot 22/23)

Facility		Required Capacity	Approximate Size of the Facility/ Building*1	Remarks
Stacking Yard	Dry Container Yard (Full)	8 blocks x 48 bays in TEUs	Block size: 342 m (L) x 26m	Stacking area : 48 TEUs x 6.5 m = 312 m RTG traverse lane: 14m (N) + 16 m (S)
	Empty Container Yard	1,244 ground slots in TEUs	Block size: 286 m (L) x 15 m, 286 m x 25 m	Block length : 44 TEUs x 6.5 m = 286 m
	Reefer Container Yard	1 block x 39 bays in (TEUs)	Block size: 300 m (L) x 26m	Excluding RTD traverse lane
Terminal Gates	Main Gate	10 lanes	28m(L) x73m(W)	with 3～4 weighing bridges
	2nd Gate	3~4 lanes	23m(L) x 27m(W)	
Customs Inspection Facilities	X-Ray Inspection Facilities	3 sets	35m (L) x 13m (W) per machine	
	Physical Inspection Facilities & CFS	34 Inspection platforms	136m(L) x 50m(W)	Size of CFS will be reexamined.
Maintenance Shops	Maintenance Shop (S1)	1 building	18 m (W) x 40 m (L)	Size of S1 shop will be reexamined.
	Maintenance Shop (S2)	1 building	18 m (W) x 32 m (L)	Same size as Phase-I repair shop
	Container Repair Shop	1 building	15 m (W) x 42 m (L)	Same size as Phase-I repair shop
	RTG Maintenance Depot	2 depots	-	Same size as Phase-I RTG depots
Administration Building		1 building	44m x 33 m	Same size as Phase-I admi. building
Marine Workers' Lounge		1 building	28(L) x 15m(W)	Examined based on the Phase-III workforce plan
Power Supply Facilities	EF Substation	1 set	23 m x 33 m (760 ㎡)	200% of Phase-I capacity
	Jetty Substation	1 set	8.8 m x 7.4 m (65 ㎡)	200% of Phase-I capacity (4 QGCs)
	Ref Container Substation	1 set	-	200% of Phase-I capacity
Water Supply Facilities	Water Supply Facility	1 building	23 m x 33 m (760 ㎥)	Same capacity as Phase-I Facility
	Water Supply Tower	1 Tower	35 m high, Tank Capacity:40 ㎥	Same capacity as Phase-I Facility
Note: *1 Approximate Size of the Building is tentative for Pre-feasibility Study, and to be examined in the Feasibility Study.				

Source :Study Team

3.3.6 Draft of Facility Layout Plan of Phase III Project (Plot 22/23)

The original draft of the facility layout plan (Plot 22/23) formulated based on the above preconditions is illustrated in Figure 3.3.3. As described above, this layout plan is drawn assuming that plot 22/23 is operated by an entity independent of Phase II terminal. However, even when Plot 22/23 is integrally operated with Plot 24/25/26, the layout will be almost the same since 1) the required facilities are estimated based on the handling capacity of 400,000 TEUs, and as a result 2) the quantity and size of each component will be the same as in the independent case.



Source :Study Team

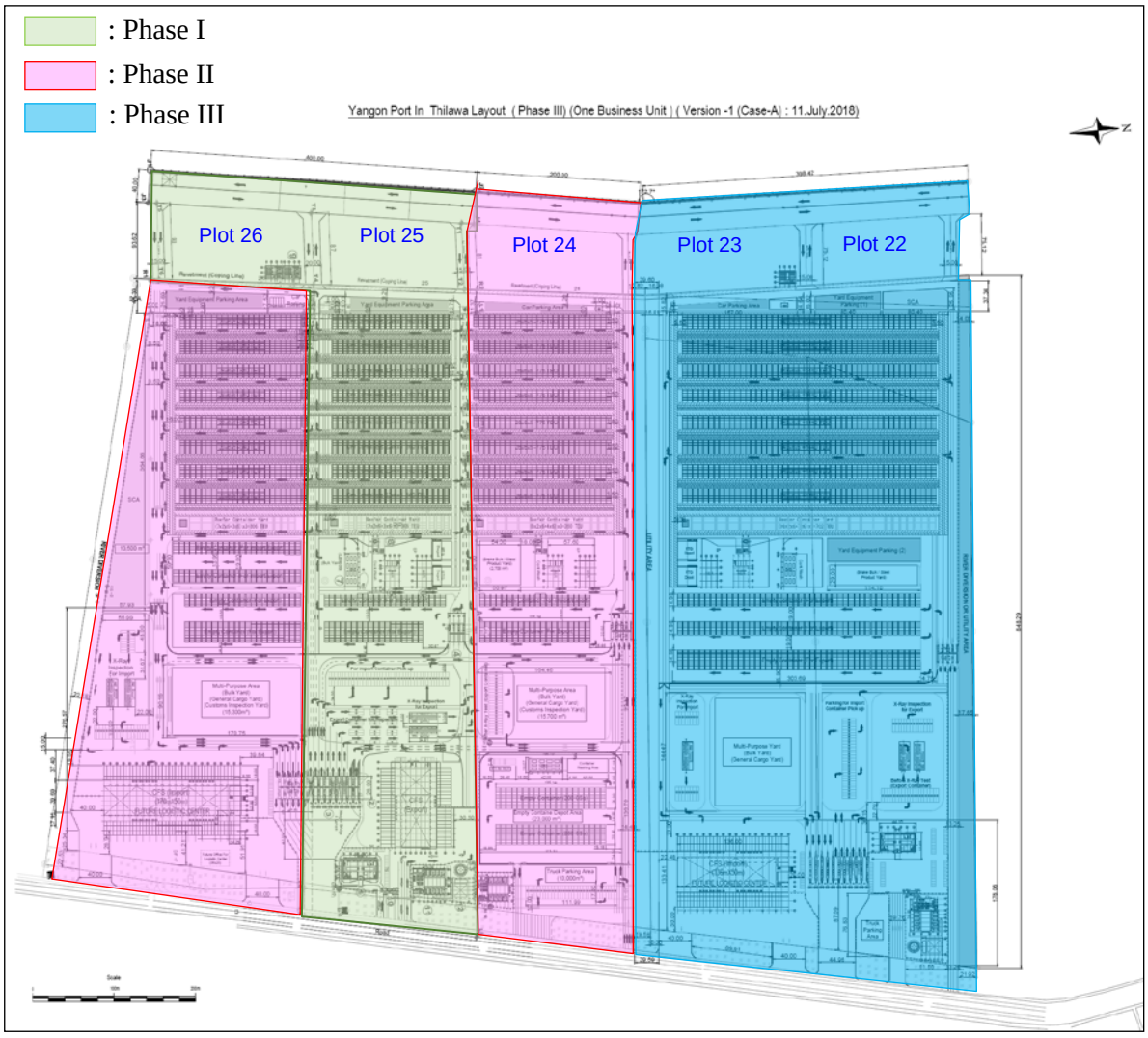
Figure 3.3.3 Layout Drawing of Phase I/ Phase II (shadowed) and Phase III (Case-A)

3.4 Preliminary Design of Major Port Facilities

3.4.1 Civil Facility

(1) Design Condition

The phase-wise layout plan of Plots in Thilawa area of Yangon Port and their operation policy are summarized in Figure 3.4.1 and Table 3.4.1.



Source: Study Team

Figure 3.4.1 Phase-wise Layout Plan for Plots

Table 3.4.1 Operation Policy for Plots

Plot No.	Phase	Operation Policy
Plot 26	Phase I (jetty, trestle, revetment) and Phase II (yard)	・ Three Plots (Plots 24, 25 and 26) will be utilized as a unified business unit.
Plot 25	Phase I	
Plot 24	Phase II	
Plots 23 and 22	Phase III	・ Two Plots (Plots 22 and 23) will be utilized as a unified business unit. ・ This unit will be operated independently from the other business unit (i.e. Plots 24, 25 and 26)

Source: Study Team

Preliminary design was conducted for civil facilities of the port, which are 1) jetty, 2) trestle, 3) revetment and 4) soil improvement of Plots 24, 23 and 22 in Phase II and III. Since this study is in the preliminary design stage, design procedures were simplified with following policy.

<Preliminary design policy>

1. The preliminary design of civil facilities will be conducted for those of Plot 24 because this Plot has highest possibilities to be developed in future.
   (Possibilities of development for Plot 23 and 22 are less than that of Plot 24 because they will be more affected by future uncertainties on cargo demand and development policy in future)
2. Once facilities' design for Plot 24 were finalized then it will be evaluated whether the same type of design is applicable to Plot 23 and 22 or not. If it was evaluated as being not applicable, then alternative design will be evaluated and proposed.

Principal design conditions are summarized in Table 3.4.2. These conditions are same as those of Phase 1 unless no comments were noted in the table.

Table 3.4.2 Principal Design Condition

Category	Item		Detail	
Natural condition	Hydrographic condition	Tide level	H.H.W.L.	+7.10 m
			H.W.L.	+6.24 m
			M.W.L.	+3.28 m
			L.W.L.	+0.33 m
			C.D.L.	+0.00 m
		Current	Velocity	3.1 m/s
		Wave	Significant wave height	$H_{1/3}$=1.7 m
			Significant wave period	$T_{1/3}$=3.5 s
			Direction	SW/NW
	Meteorological condition	Wind	Max. velocity	59.2 m/s
			Max. instantons velocity	72.0 m/s
	Earthquake	Seismic condition	Horizontal seismic condition	Kh=0.15
			Vertical seismic condition	Not considered
	Soil condition		(Refer to Tables 3.4.3-3.4.5)	
Design vessel and berth condition	Design vessel		DWT: 30,000 DWT (20,000 DWT*) LOA: 192 m (177 m*) B (breadth): 35 m (27 m*) d (maximum draft): -9 m	
	Berth		Berth length: L=200 m Berth depth: -10 m	
Quay gantry crane			Total weight Wheel load(operating) Wheel load(stormy) Wheel load(seismic)	7,000 kN Pv=387 kN/wheel ** Pv=630 kN/wheel ** Pv=491 kN/wheel **
Surcharge load			Jetty	W=20 kN/m2
			Container yard	W=50 kN/m2

*Design values of Phase 1. These values were updated based on recent vessel size.
** Specifications of gantry crane was updated based on design vessel size

Source: Study Team

Table 3.4.3 Soil Conditions for Jetty Design

EL (CDL)	Soil Layer	N-Value (Mean)	Cohesion C (kN/m2)	Friction angle ϕ (Deg.)	Unit Weight (kN/m3)		Modulus of Elasticty (kN/m2)
					Wet	Saturated	
GL -15.65	CLAY	2	C=1.79Z+25.81 (Z=0 at ±0.0)	-	17	17	1,300
-15.65 -20.65	CLAY with silt	10	C=1.79Z+25.81 (Z=0 at ±0.0)	-	19	19	6,600
-20.65 -23.15	Sandy CLAY	16	50	-	19	19	10,600
-23.15 -35.15	Silty Sandy	30	-	39	19	19	21,000
-35.15	SAND	40	-	43	18	20	28,000

Source: Study Team

Table 3.4.4 Soil Conditions for Trestle Design

EL (CDL)	Soil Layer	N-Value (Mean)	Cohesion C (kN/m2)	Friction angle ϕ (Deg.)	Unit Weight (kN/m3)		Modulus of Elasticty (kN/m2)
					Wet	Saturated	
GL -13.40	CLAY	2	C=1.79Z+25.81 (Z=0 at ±0.0)	-	17	17	1,300
-13.40 -17.50	CLAY with silt	10	C=1.79Z+25.81 (Z=0 at ±0.0)	-	19	19	6,600
-17.50 -19.60	Sandy CLAY	16	50	-	19	19	10,600
-19.60 -26.70	Silty SAND	30	-	39	19	19	21,000
-26.70 -30.70	Sandy CCLAY	16	50	-	19	19	10,600
-30.70	Silty SAND	40	-	43	18	20	28,000

Source: Study Team

Table 3.4.5 Soil Conditions for Revetment Design

EL (CDL)	Soil Layer	N-Value (Mean)	Cohesion C (kN/m2)	Friction angle ϕ (Deg.)	Unit Weight (kN/m3)		Modulus of Elasticty (kN/m2)
					Wet	Saturated	
GL -15.05	CLAY	2	C=1.79Z+25.81 (Z=0 at ±0.0)	-	17	17	1,300
-15.05 -18.75	CLAY with silt	10	C=1.79Z+25.81 (Z=0 at ±0.0)	-	19	19	6,600
-18.75 -30.25	Sandy CLAY (interbed)	17	50	-	19	19	10,600
-30.25 -34.05	Silty SAND	30	-	39	19	19	21,000
-34.05	SAND	40	-	43	18	20	28,000

Source: Study Team

(2) Jetty (L=200m)

Structures of jetty were evaluated using criteria listed below for candidate structures; 1) Batter pile type (PHC), 2) Batter pile type (SPP), 3) Strut (SPP), and 4) Jacket (SPP). The evaluation results are summarized in Table 3.4.6 while its details are shown in Table 3.4.7. Typical cross section of jacket type jetty, which was finally recommended as the study result, is shown in the Figure 3.4.2.

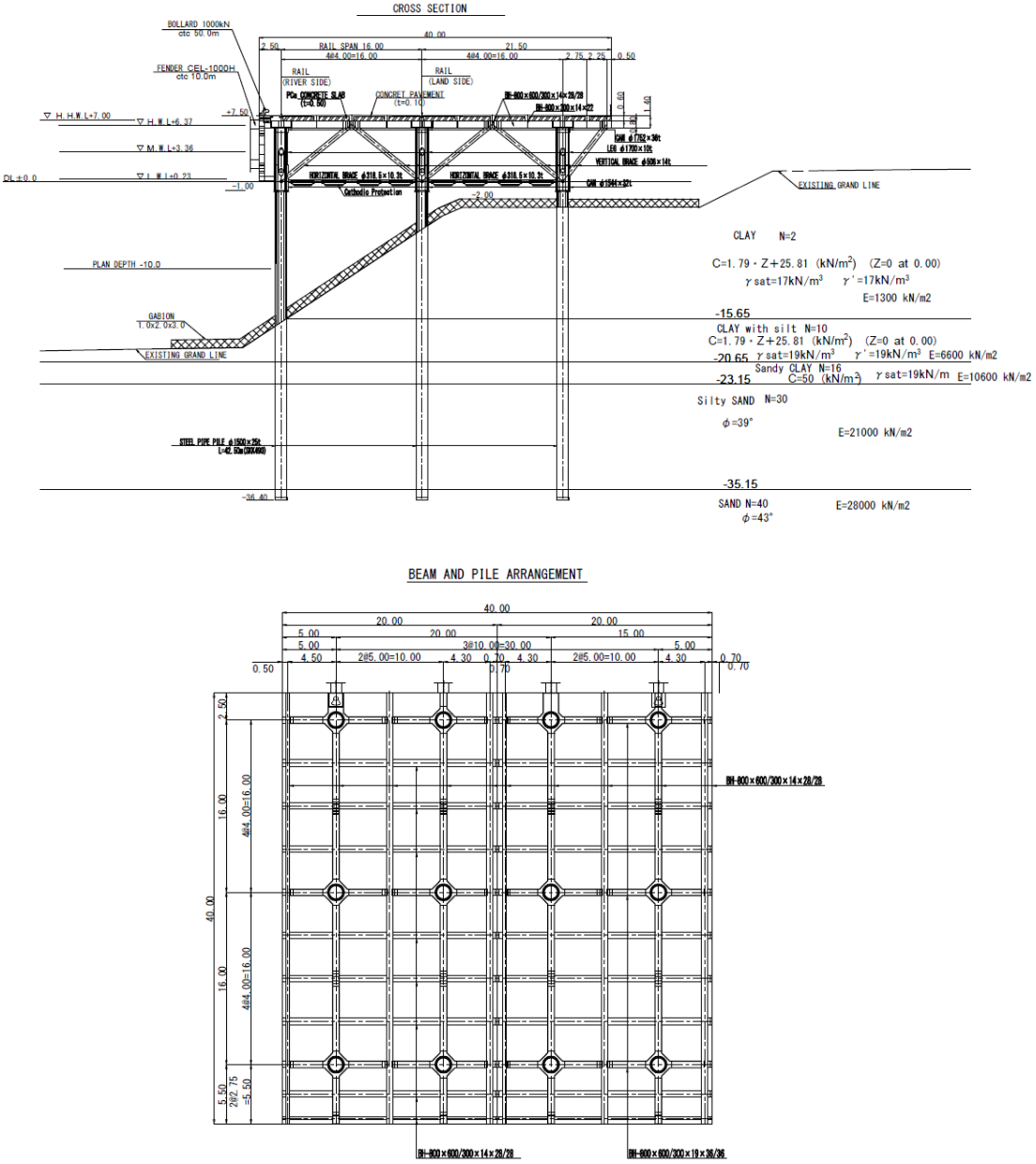
<Evaluation criteria for Jetty>

1. Technical aspect
   - 1-1. Difficulty level in construction
   - 1-2. Risk in delay of construction due to natural conditions
   - 1-3. Degree of technology transfer
2. Utilization and environment
   - 2.1 Structural risk for continuous use of jetties
   - 2.2 Environment impact on river
3. Economic efficiency
   - 3.1 Approximate construction cost
   - 3.2 Period of cargo handling disturbance at Plot 25 during construction

Table 3.4.6 Summary of Evaluation Results for Jetty Structures

Criteria \ Type of structure	Batter pile (PHC)	Batter pile (SPP)	Strut type	Jacket type
1.Technical aspect	B	B	C	A
2. Utilization and environment	C	C	B	A
3. Economic efficiency	A	B	B	B
Overall evaluation	**B**	**B-**	**B-**	**A- (Recommended)**

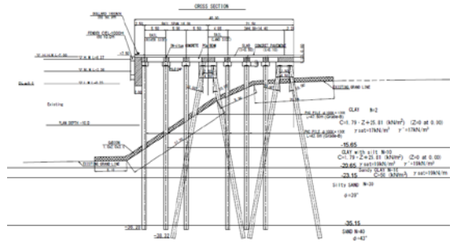
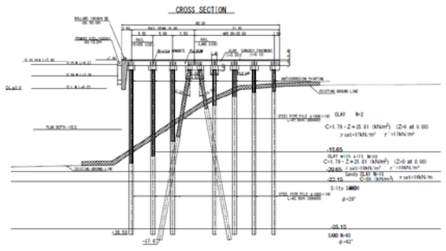
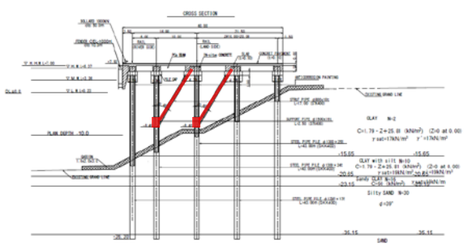
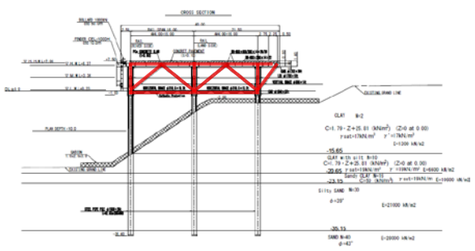
A: Superior, B: Fair, C: Inferior
Source: Study Team



Source: Study Team

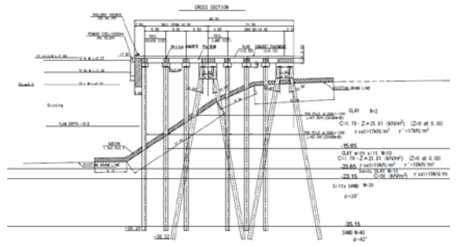
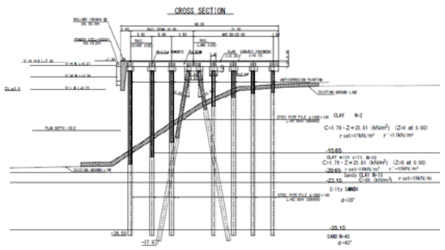
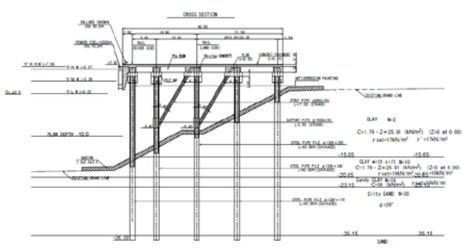
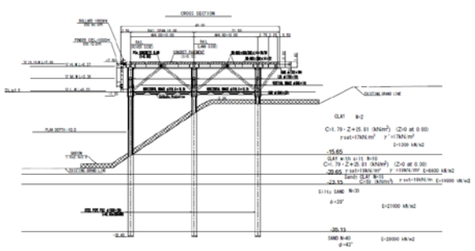
Figure 3.4.2 Typical Cross Section and Plie Arrangement of Jacket Type Jetty

Table 3.4.7 (1/2) Comparison of Jetty Structure

	Batter Pile(PHC)		Batter Pile(SPP)		Strut Type		Jacket Type	
Structural drawing and characteristics								
	・ No. of piles(PHC)：400 piles/ berth ・ Batter piles applied to increase resistance to horizontal(seismic) force ・ With less stiffness than SPP, largest No. of piles required.		・ No. of piles(SPP): 360 piles/ berth ・ Batter piles applied to increase resistance horizontal(seismic) force ・ With more stiffness than PHC, less No. of piles required. (10% reduced compared to PHC)		・ No. of piles(SPP)：200 piles/berth ・ Strut members (red-colored) are attached to SPP to increase resistance to horizontal(seismic) force ・ With more stiffness than batter pile types, less No. of piles required. (50% reduced compared to PHC)		・ No. of piles(SPP)：60 piles/berth ・ Jacket, a rigid frame shown in red-colored, covered on SPP to increase resistance to horizontal(seismic) force ・ With most stiffness, No. of piles substantially reduced. (85% reduced compared to PHC)	
1. Technical aspect	**Rating：B**		**Rating：B**		**Rating：C**		**Rating：A**	
1-1. Difficulty level in construction (Technical and experiences)	**Normal** ・ Bit difficult for piling of batter piles but fair for vertical ones. ・ Plenty experiences of construction in Yangon and Thalia.	**A**	**Normal** ・ (same as left column) ・ Not so many cases for using SPP in Myanmar	**A**	**High** ・ Though double high accuracy required for piling (±5cm), less No. of piles required. ・ Underwater execution by divers required for welding of strut member at about -9m (see Figure above). This work will be very difficult to conduct under no-visibility condition at Project site, Yangon river. ・ No experiences in Myanmar	**C**	**Bit high** ・ Though double high accuracy required for piling (±5cm), least No. of piles required. ・ No underwater execution required for Jacket type. ・ Having experiences at Plot 25 and 26.	**B**
1-2. Risk in delay of construction due to natural conditions *1	**Bit high** ・ Longest construction period at river due to largest No. of piles. ・ No underwater work required.	**B**	**Bit high** ・ Longer construction period at river due to large No. of piles ・ No underwater work required if heavy-duty coating was applied for SPP	**B**	**High** ・ Shorter construction period at river due to less No. of piles. ・ High risk for delay due to necessity of underwater work.	**C**	**Low** ・ Shortest construction period at river due to least No. of piles. ・ No underwater work required	**A**
1-3. Degree of technology transfer	**Low** ・ No special technology involved	**B**	**Low** ・ (same as left)	**B**	**High** ・ Advanced technology involved in piling and welding	**A**	**High** ・ Advanced technology involved in piling, setup of truss structure and welding	**A**

Source: Study Team

Table 3.4.7 (2/2) Comparison of Jetty Structure

	Batter Pile(PHC)		Batter Pile(SPP)		Strut Type		Jacket Type	
Structural drawing								
2. Utilization and Environment	**Rating : C**		**Rating : C**		**Rating : B**		**Rating : A**	
2-1. Structural risk for continuous use of jetties *2	**High** ・ Characteristics against horizontal(seismic) force is much different from adjacent jetty (i.e. Plot 25) due to difference in structure ・ This might trigger unexpected overload especially at connection points and cause structure failure such as breakage of rail.	**C**	**High** ・ (same as left column)	**C**	**High** ・ (same as left column)	**C**	**Low** ・ Characteristics against horizontal(seismic) force will be same as adjacent jetty at Plot 25 because the same type of structure (i.e. jacket) will be applied. ・ Therefore, no excessive force beyond design force is expected.	**A**
2-2. Environment impact on river *3	**Fair** ・ Erosion is anticipated due to disturbance of flow created by large No. of piles	**B**	**Fair** ・ (same as left column)	**B**	**Small** ・ Less impact on erosion is expected due to small influence on river flow. (due to small No. piles in river)	**A**	**Minimal** ・ Least impact on erosion expected due to smallest influence on river flow. (due to smallest No. piles in river)	**A**
3. Economic efficiency	**Rating : A**		**Rating : B**		**Rating : B**		**Rating : B**	
3-1. Approximate construction cost in ratio *4	**Lowest** 1.00	**A**	**2nd lowest** 1.16	**B**	**3rd lowest** 1.20	**B**	**4th lowest** 1.22	**B**
3-2. Period of cargo handling disturbance at Plot 25 during construction *5	**Long** ・ Estimated disturbance period: 83 days		**Long** ・ Estimated disturbance period: 75 days		**Long** ・ Estimated disturbance period: 83 days		**Short** ・ Estimated disturbance period: 25 days	
Overall Evaluation (Items 1～3)	B		B-		B-		A- (Recommended)	

Source: Study Team

<Supplementary notes for the comparison of structure type in Table 3.4.7>

***1 Risk in delay of construction due to natural conditions**

Construction work at the Yangon River has some risks in delay due to severe natural conditions as follows. In other words, the longer the work period at river is required the more risks will be involved in construction schedule.

- Large tidal difference : 6 m
- High current velocity : 3 m/s
- No visibility at underwater due to high turbidity
- Impact by tropical cyclone and flood

Table 3.4.8 shows a comparison of required piling period at river for each structure of jetty and the pilling period of Jacket type will be much shorter than others. In addition, piling work in Phase I for Jacket type jetty was implemented smoothly and completed earlier than planned while high accuracy was required for it. Therefore, it is concluded that the risk in delay of construction can be minimized by applying Jacket type jetty.

Table 3.4.8 Comparison of Required Piling Period at River for Each Structure of Jetty

	Batter pile (PHC)	Batter pile (SPP)	Strut	Jacket
(1) No. of piles for entire berth	400	360	200	60
(2) Piling rate	2 piles/day	2 piles/day	1 pile/day	1 pile/day
(3) Operation ratio	0.6	0.6	0.6	0.6
(4) Piling period at river ((1)/(2)/(3))	11 months	10 months	11 months	3 months (shortest)

Source: Study Team

***2 Structural risk for continuous use of jetties**

The structural risk can be explained as follows.

(1) Necessity for continuous use of Jetty (Plot 24-26)

In the port planning, cargo handling capacity of 600,000 TEU/ year is estimated based on continuous use of 3 Plots (i.e. Plot 24 to 26). This plan requires following characteristics for berth:

- Continuous rail for gantry crane (see Figure 3.4.3 a))
- Continuous jetty so that a large vessel can berth (vessel with LOA=190m requires 225m > 1 berth(200m))

(2) Necessity for rigid connection

Rigid connection of each block is required to realize continuous use of jetty and secure safety for operation. Figure 3.4.3 b) shows the rigid connection by welding for each block, 40m by 20m, of the jetty. The same method will be required for the connection part between Plots 25 and 24.

a) Rail trench at Plot 25 to be extended continuously to Plot 24

b) Rigid connection between blocks by welding (11 locations in cross-section direction)

Source: Study Team

Figure 3.4.3 Construction Method for Phase I (crane rail and connection of blocks)

(3) Structural risk when different type of structures were applied for continuous plots under rigid connection

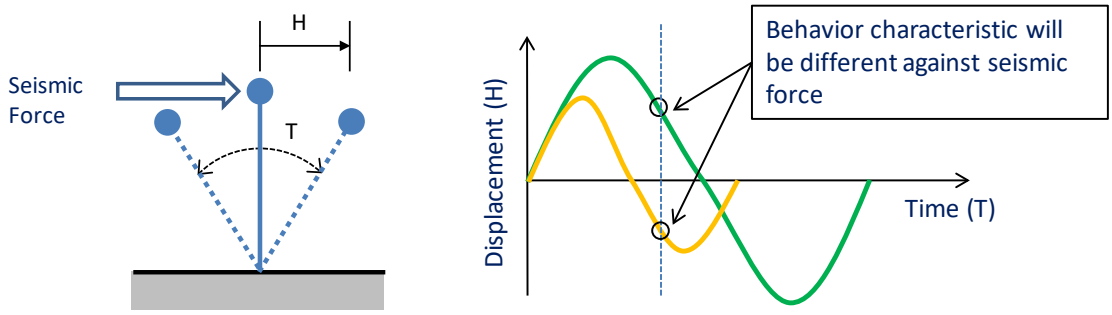
There are some concerns for applying different type of structures for continuous plots under ridged connection as follows. Therefore, structural risk when applying different type of structures (i.e. different from that of Plot 25, jacket type) is evaluated as high.

- There are very few cases of application
- Might trigger unexpected overload, especially at connection points that are shown in Table 3.4.9 and Figure 3.4.4, and cause structure failure such as breaking of rail.
- Technically difficult to apply rigid connection for different type of beam

Table 3.4.9 Behavior Characteristics against Horizontal(seismic) Force for Each Structure

	Jacket	Batter pile (PHC)	Batter pile(SPP)	Strut
Horizontal displacement between Plots 25 and 26 structures and rail	(Base)	6 cm	6 cm	4 cm
Natural oscillation period	1.7 s	0.9 s	0.8 s	1.1 s

Source: Study Team

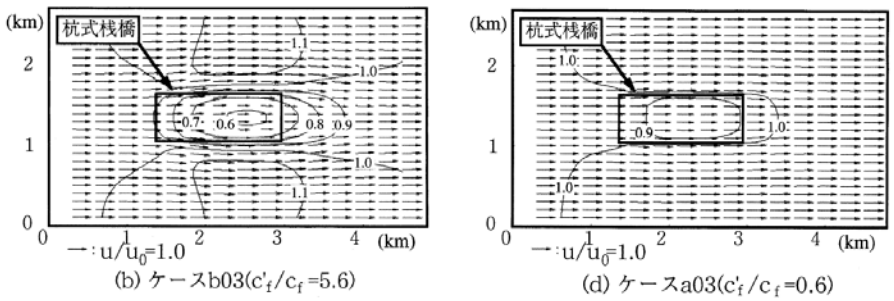


Source: Study Team

Figure 3.4.4 Schematic Figure for Behavior Difference against Seismic Force

***3 Environment impact on the river**

Figure 3.4.5 shows the changes in flow velocity ratio due to existence of Jetty and Case 1 shows jetty with larger number of piles and Case 2 for less number of piles. It is shown from these figures that with larger number of piles, flow velocity increases at lateral side of jetty. This phenomenon could cause or enhance erosion at river-bank and river-channel at site. In this point of view, Jacket type was evaluated to have least impact on river because it has least number of piles on river.



(b) ケースb03(c'_f/c_f=5.6) (d) ケースa03(c'_f/c_f=0.6)

Case 1: Large No. of piles Case 2: Small No. of piles

Note : Jetty location
U : flow velocity with jetty
U_0: flow velocity without jetty

Source: Ueno et al.: Proceedings of Coastal Engineering, JSCE, PP.1171-1175, 1998-36

Figure 3.4.5 Velocity Field around Jetty with Different No. of Pile

***4 Approximate cost in ratio for construction**

The construction cost of jetty and the total construction cost for package 1 are shown in Table 3.4.10.

Table 3.4.10 Comparison of Construction Cost in Ratio for Jetty and Package 1

	Batter pile (PHC)	Batter plie (SPP)	Sturt	Jacket
Approx. construction cost in ratio for jetty	1.00	1.16	1.20	1.22
Total construction cost for Package 1	1.00	1.02	1.02	1.02

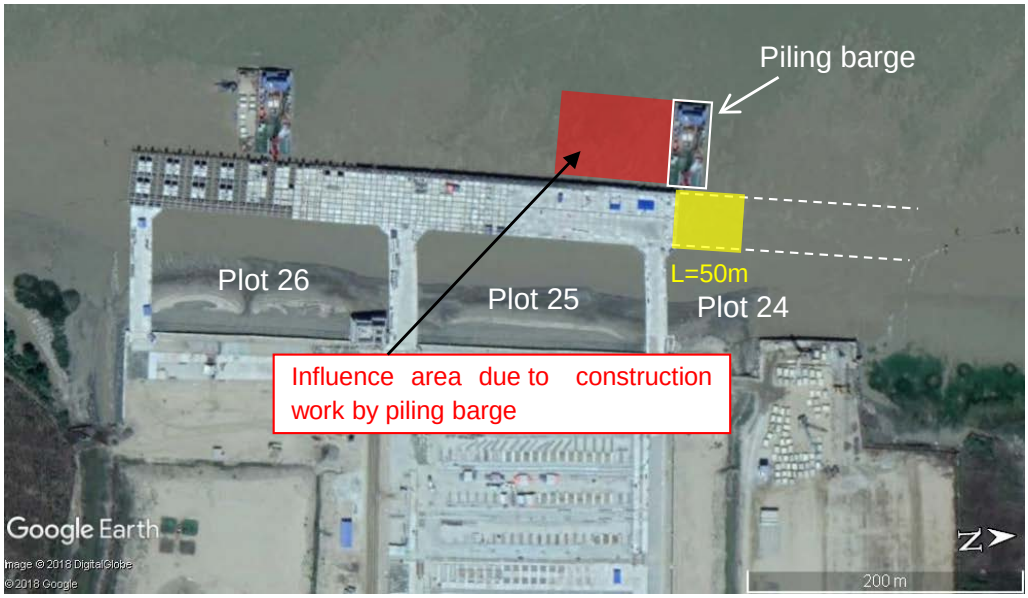
Source: Study Team

***5 Period of cargo handling disturbance at Plot 25 during construction**

The constriction of the Jetty for Plot 24 is scheduled to start from 2022 and Plot 25 (and 26) will be in operation at this period. Therefore, it is concerned that piling work at Plot 24 especially adjacent to Plot 25 will affect berthing and cargo handling operation at Plot 25. Here, it is assumed that piling work for 50 m length from the boundary of Plots 25 and 24 (yellow highlighted in Figure 3.4.6) will affect berthing at Plot 25 and cargo handling cannot be done during this period. Table 3.4.11 shows piling period at this area with 50 m length.

Assumption: Piling barge need to extend anchors about 100 m for piling work. And it is assumed that if the anchoring area was overlapped more than 50 m in front of Plot 25 then cargo operation cannot be done at

Plot 25. This is equivalent to piling area of 50 m at Plot 24



Source: Study Team (Google Earth)

Figure 3.4.6 Influence Area due to Construction Work by Piling Barge

Table 3.4.11 Piling Period at Plot 24 for 50m length

	Batter pile (PHC)	Batter plie (SPP)	Sturt	Jacket
(1) No. of piles (in 50m area)	100	90	50	15
(2) Piling rate	2 piles/day	2 piles/day	1 pile/day	1 pile/day
(3) Operation ratio	0.6	0.6	0.6	0.6
(4) Piling period ((1)/(2)/(3))	83 days	75 days	83 days	25 days

Source: Study Team

<Consideration on Jetty structure for Plots 22 and 23>

Bathymetric and soil conditions of Plots 22 and 23 are almost same as that of Plot 24. However, structure of Plots 22 and 23 does not necessarily have to be the same type of Plot 24 (i.e. Jacket type) in terms of the structural risk as they will be developed as an independent business unit. Therefore, the criteria in Table 3.4.7, "2-1. Structural risk for continuous use of jetties" will not be included in the evaluation of structure type for Plots 22 and 23 while the other criteria are evaluated as same manner as that of Plot 24.

Table 3.4.12 shows the evaluation result for Plots 22 and 23, and the Jacket type was recommended as structure type of jetty for Plots 22 and 23, which is the same conclusion on that of Plot 24.

Table 3.4.12 Comparison of Structure Type of Jetty for Plots 22 and 23

Item \ Structure	Batter pile (PHC)	Batter pile (SPP)	Strut	Jacket
1. Technical aspect	B	B	C	A
2. Environment*	B	B	A	A
3. Economic aspect	A	B	B	B
Overall evaluation	**B+**	**B**	**B**	**A- (Recommended)**

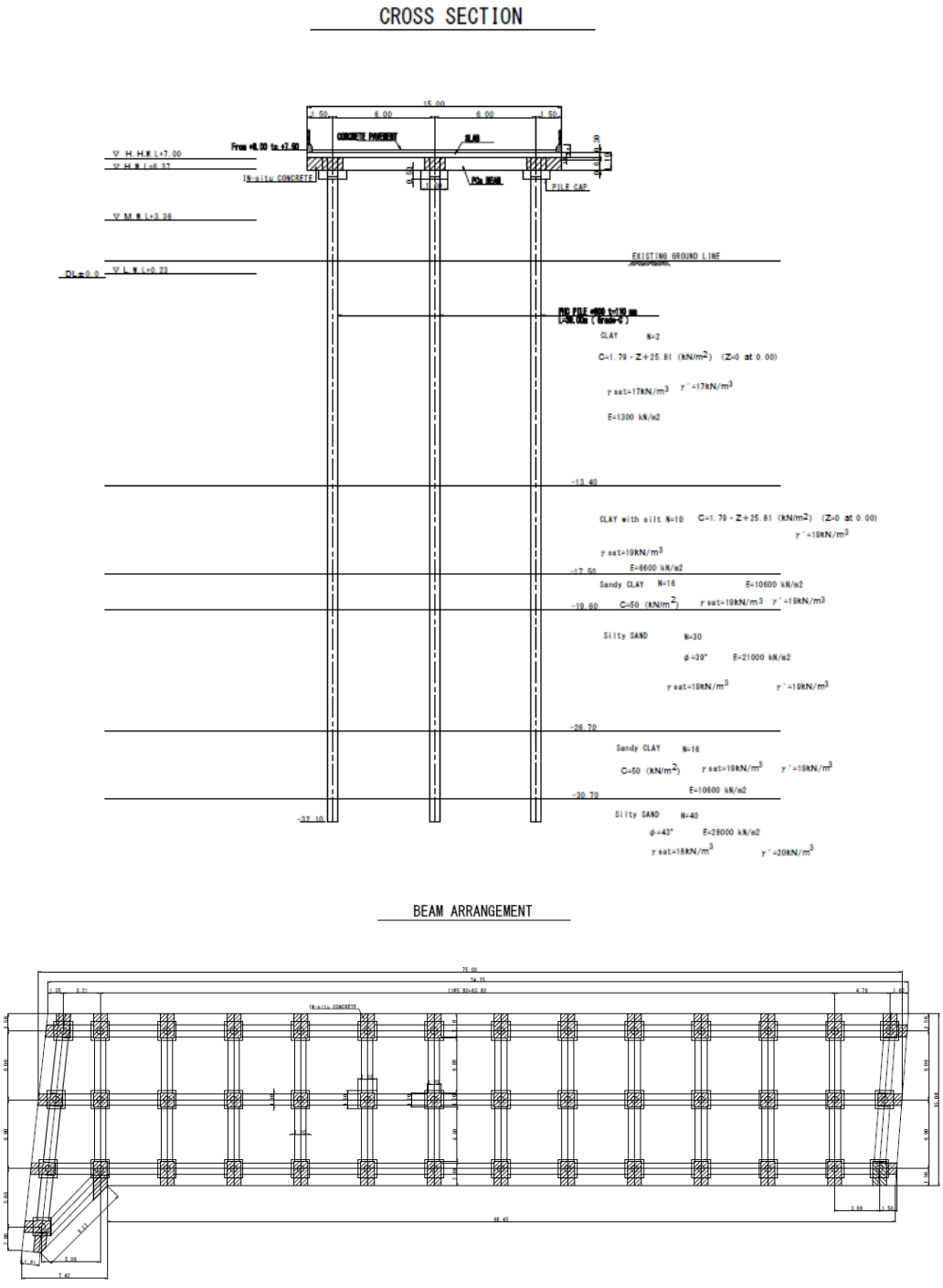
*Criteria 「2-2 Environment impact on river」 (refer to Table 3.4.7) was only evaluated.

Source: Study Team

(3) Trestle

Vertical pile type (PHC) shown in Figure 3.4.7 is selected for recommended structure of trestle for Plot 24 with following procedures. And the same type of structure is also recommended for Plots 22 and 23 as bathymetric and soil conditions are quite uniform in this area.

1. Jetty type is recommended to achieve required bearing force on the soft ground.
2. Vertical pile type is recommended as horizontal force is not so significant compared to that of quay wall (same as Phase I).
3. Finally, PHC pile is recommended as it is most inexpensive.
   Note: Though PHC pile is a bit inferior to SPP in workability as it is heavier, this will not make much differences in construction as the facility scale is relatively small.



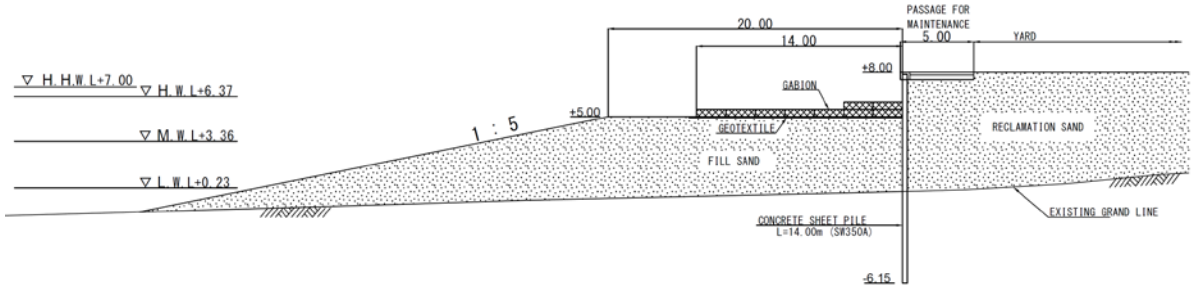
Source: Study Team

Figure 3.4.7 Typical Cross Section and Pile Arrangement of Trestle

(4) Revetment

Concrete sheet pile type shown in Figure 3.4.8 is selected as recommended structure of revetment with following procedures. And the same type of structure is also recommended for Plots 22 and 23 as soil conditions is quite uniform in this area.

1. Sheet pile type is recommended to achieve required bearing force on the soft ground (same as Phase I).
2. Concrete sheet pile type is recommended as it is most inexpensive and there are plenty cases in construction in Myanmar.
   Note: Though PHC pile is a bit inferior to SPP in workability as it is heavier, this will not make much difference in construction as the facility scale is relatively small.



Source: Study Team

Figure 3.4.8 Typical Cross Section of Revetment

(5) Soil improvement

The PVD (prefabricated vertical drain) with embankment surcharge was adopted for soil improvement of Phase I (Plot 25) because it was evaluated as the most superior method in terms of construction period, cost, difficulty of implementation and work experiences in Myanmar compared with other methods, the sand drain (SD) method and deep mixing method (DMM). The soil condition required for soil improvement of Phase II (Plot 24) was confirmed to be almost same as shown in Table 3.4.13, therefore, the same method of Phase I (Plot 25), PVD with embankment surcharge, can be applied for soil improvement of Plot 24. Figure 3.4.9 shows schematic figure of PVD method with embankment surcharge.

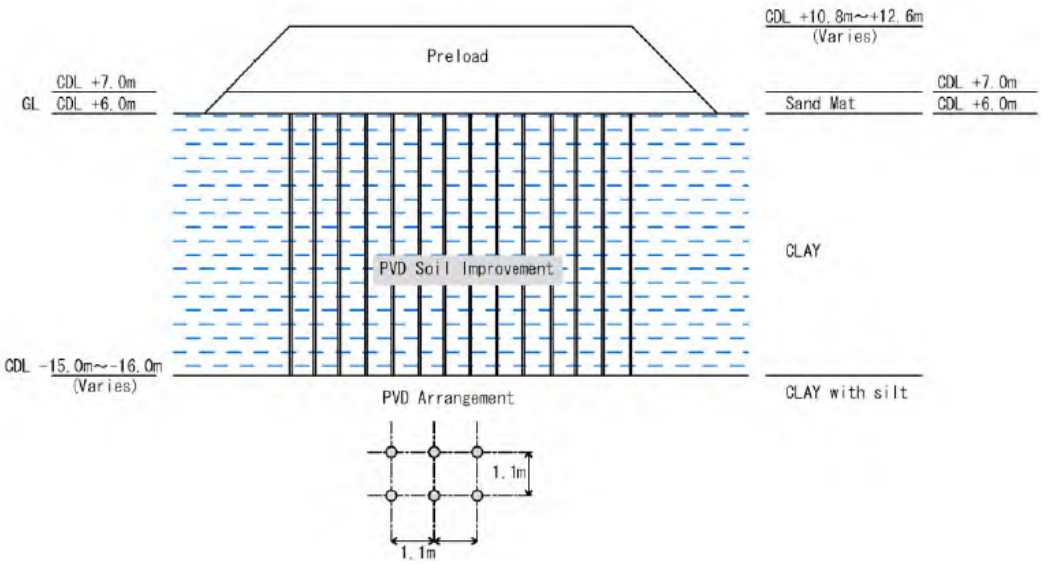
Furthermore, since soil conditions, especially for upper layer of clay with N-value less than 10, are almost uniform along Plots as shown in Figure 3.4.10 the same soil improvement method (i.e. PVD) is recommended for Plots 22 and 23 as well.

Table 3.4.13 Soil Condition Required for the Improvement (Plots 24 and 25)

Yard Area	Elevation (m, +C.D.L)	Thickness of CLAY layer with N- Value less than 10	Coefficient of Consolidation (cm^2/day)
Phase II (Plot 24, average*)	+6.3 m	21.0 m	42 cm^2/day
Phase I (Plot 25, average)	+6.0 m	23.0 m	50 cm^2/day

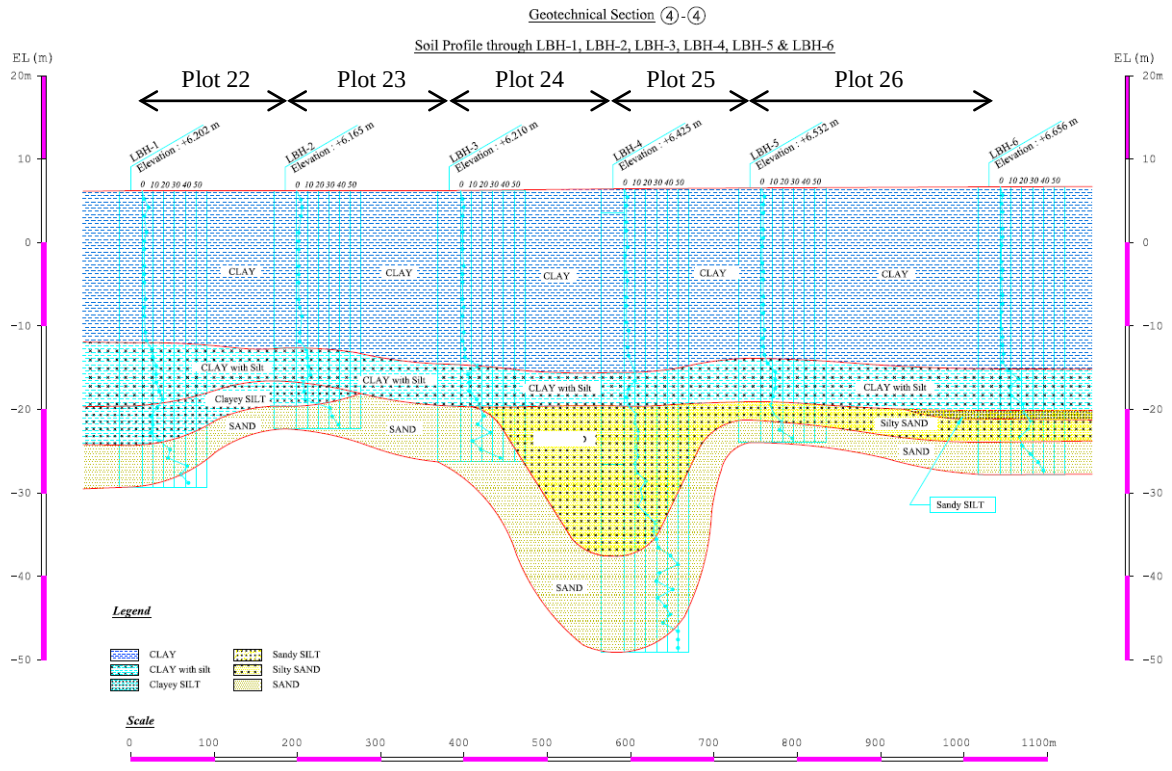
*Elevation and the thickness were derived from survey data of Phase I (seven boreholes, LBH-3,4,7,8,10,11,15) while coefficient of consolidation was derived from the investigation of this study.

Source: Study Team



Source: Study Team

Figure 3.4.9 Schematic Figure of Soil Improvement by PVD and Surcharge



Source: Study Team

Figure 3.4.10 Soil Profile (Plot 22-26)

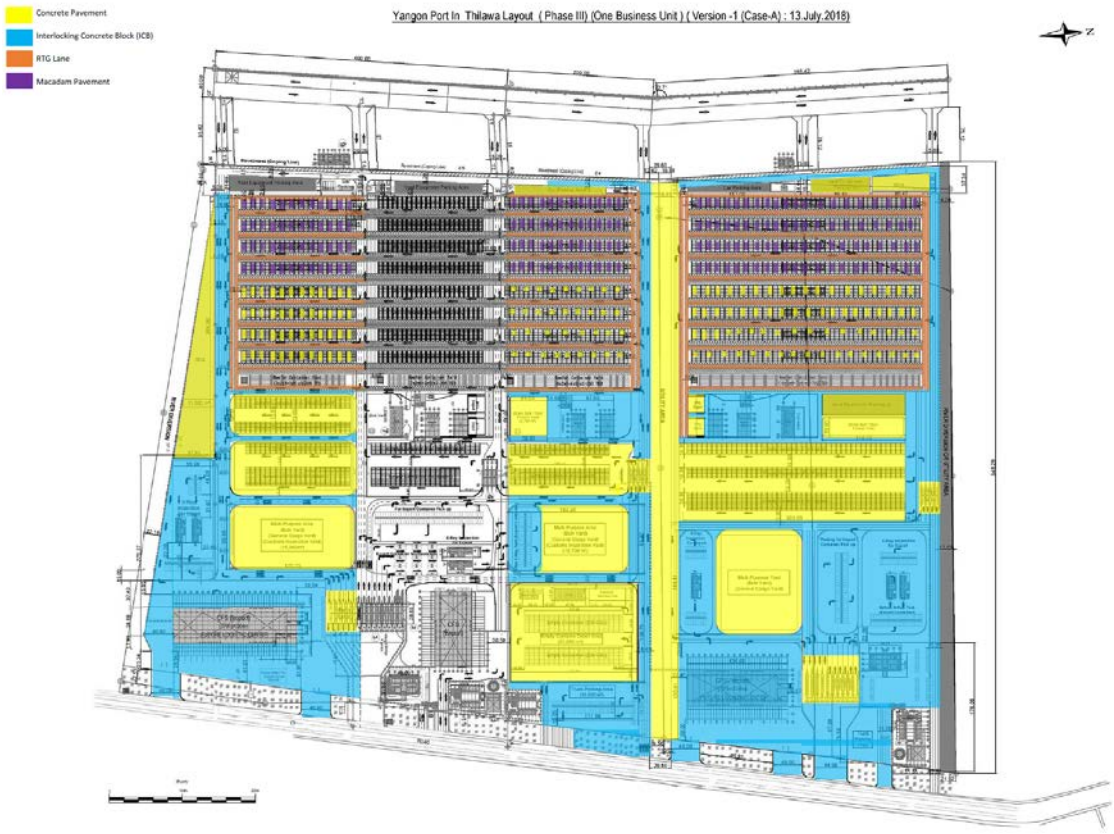
(6) Pavement

The same pavement classification of Plot 25(Phase I) will be applied for Plots 24 and 26 (Phase II) and Plots 22 and 23 (Phase III) (See Table 3.4.14 and Figure 3.4.11).

Table 3.4.14 Pavement Type to be Applied for Plots 24 and 26

Pavement type	Target area
ICB (Interlocking concrete block)	Traffic area for heavy vehicle(such as trailers) and sidewalk
Concrete pavement	Traffic area for reach stackers and empty container area
Macadam pavement	No traffic area
RTG lane	Traffic area for RTG

Source: Study Team



Source: Study Team

Figure 3.4.11 Pavement Classification for Plots 22- 26

3.4.2 Buildings and Utilities

(1) Design condition for building work

1) Codes and Standards

Applicable codes, regulations and standards for architectural works are as follows;

- Myanmar National Building Code 2016: MNBC 2016
- Building Code of Japan
- Japanese Industrial Standards (JIS)

2) Design Concepts

About design concepts of building, the followings were taken into consideration for building design.

i) Simple plan of the buildings

All the building plans were studied by considering functionality and operationality in a simple manner. The plan of buildings reflects the required function, number of workers to utilize, adequate and appropriate space, and so on.

ii) Simple shape of the buildings

All the buildings have a simple shape of modern design. Derived from simple plan of the buildings, elevation and section of the buildings show the simple shape of the buildings, and it results in cost efficiency of initial cost and running cost.

iii) Simple structure of the buildings

All the buildings have a simple structure system. Since almost all buildings require long span framing and wide range of opening, steel superstructure system which is suitable for such requirement is adopted. Derived from the simple shape of the buildings, each building is designed with a strong and safe structure.

iv) Short construction period

For the large scaled buildings, steel superstructure system was adopted instead of reinforced concrete superstructure in order to shorten the construction period. Since the construction period for building works is limited to a year and a few months, it is necessary to select the construction method to fit such a short period. Thus, prefabricated steel structure system was adopted to lessen on-site works and to shorten the construction period.

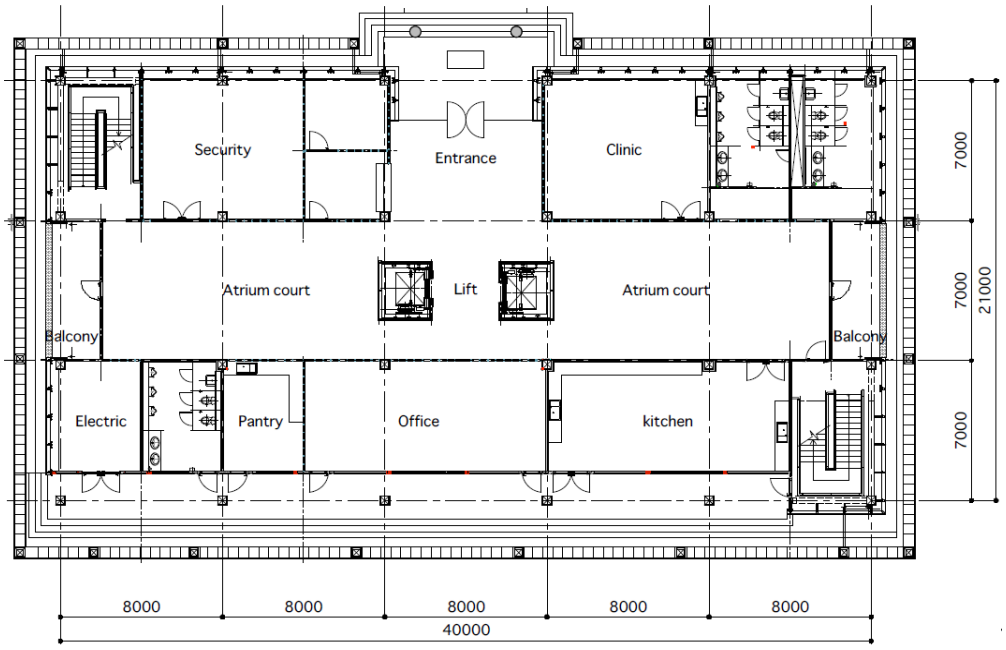
v) Intake of natural day-light and natural ventilation for energy saving

It is proposed for almost all buildings to utilize natural day-light intake through sun light from the windows and natural ventilation through ventilation monitor on roof top to save energy.

(2) ADM (Administration Building)

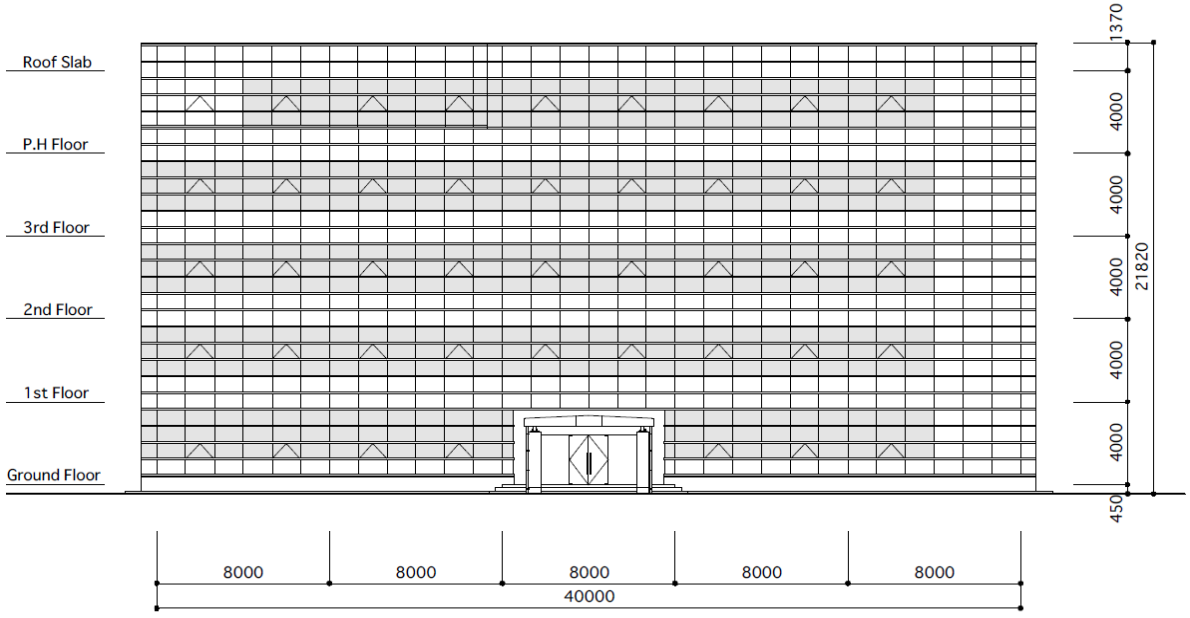
The administrative staff required for Phase II can be accommodated in ADM (Administration Building)

constructed in Phase I by shifting some part of staff to CFS (see 3.2 Terminal Facility Plan for the details). Therefore, ADM is not included in Phase II project considering its capacity. For Phase III project, new ADM of the same scale as the Phase I facility will be built near the terminal gate.



Source: Study Team

Figure 3.4.12 ADM Plan (Ground Floor Plan)



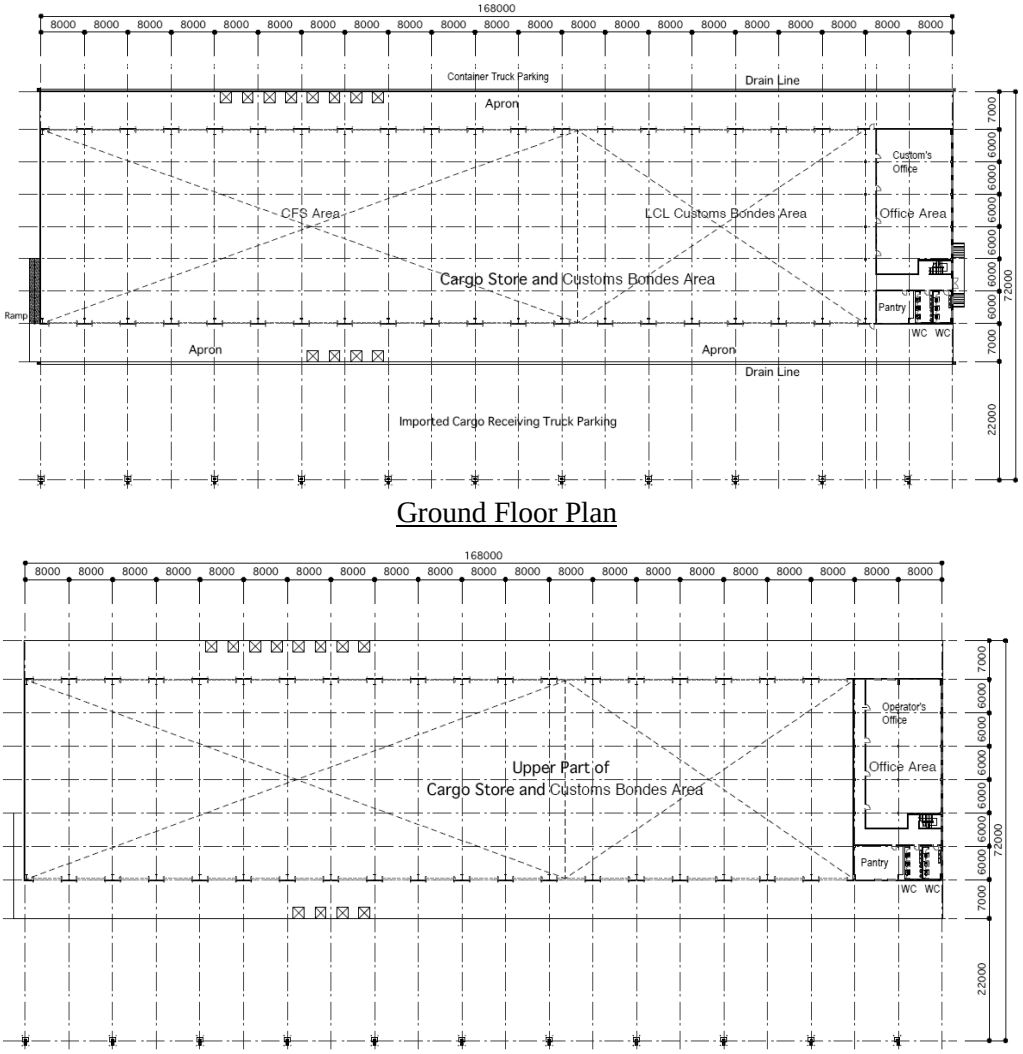
Source: Study Team

Figure 3.4.13 ADM Elevation

(3) CFS (Container Freight Station)

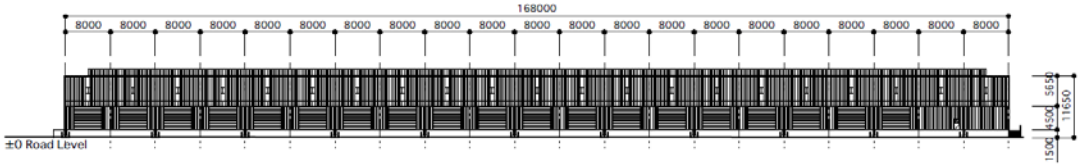
Since the annual handling volume will increase to 600,000 TEUs by the implementation of Phase II project,

CFS (104 m x 50 m) which is constructed during Phase I project will be utilized for the export only and new CFS (170 m x 50 m) for the import is planned to build for Phase II project. In the future, this new CFS will also be used for the logistic center. The platform for the physical examination (40 Bay) and the truck lane for CFS (GL type) will be constructed for the physical examination of import containers (see Figure 3.4.14 and Figure 3.4.15). CFS (136 m x 50 m) will be built for Phase III project since the annual handling volume will increase by 400 thousand TEU furthermore.



Source: Study Team

Figure 3.4.14 CFS Plan (Phase II)

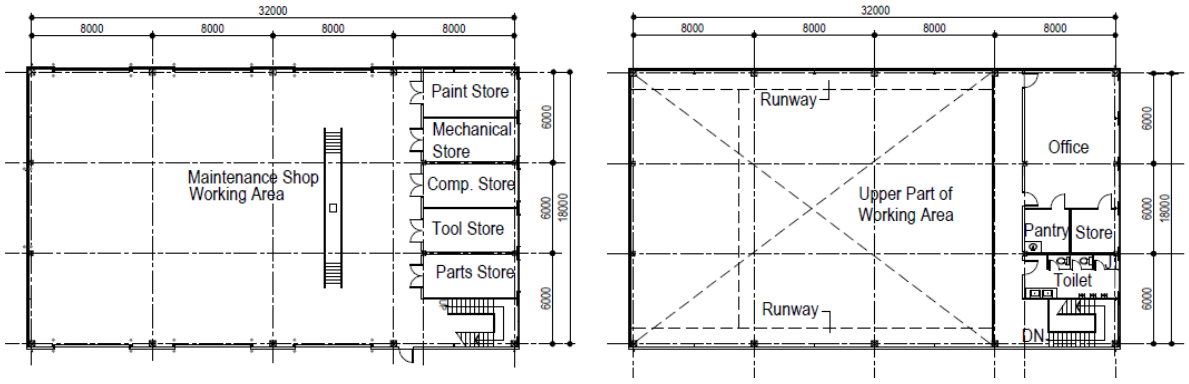


Source: Study Team

Figure 3.4.15 CFS Elevation (Phase II)

(4) Maintenance Shop

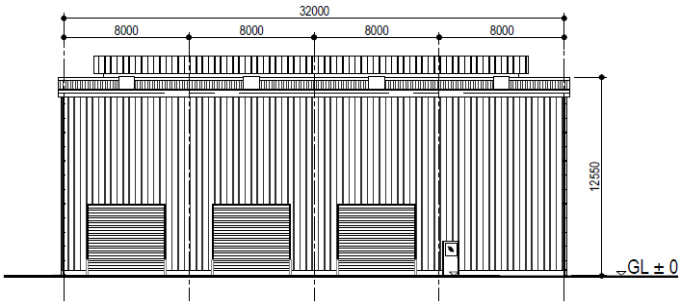
Maintenance and repair work for cargo handling equipment shall be carried out at the site and the maintenance shop. Maintenance shop of Phase I project was planned to consist of two (2) buildings, one is indoor type and another is covered with roof only. Two (2) maintenance shops will be built respectively for the Phase II and Phase III project, since the cargo handling equipment will be procured approximately equivalent to Phase I. (see Figure 3.4.16 to Figure 3.4.19)



Ground Floor Plan　　Mezzanine Floor Plan

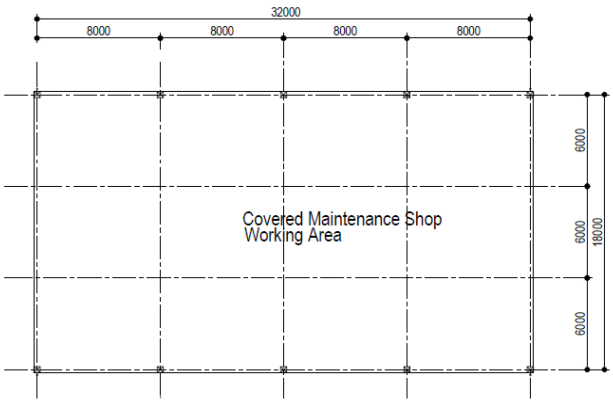
Source: Study Team

Figure 3.4.16　Maintenance Shop-1 Plan



Source: Study Team

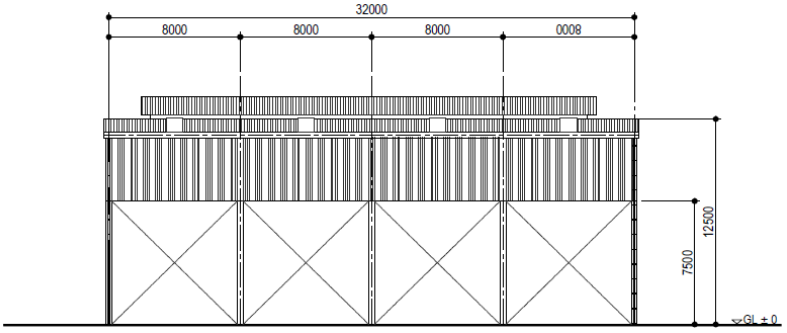
Figure 3.4.17　Maintenance Shop-1 Elevation



Source: Study Team

GROUND FLOOR PLAN

Figure 3.4.18　Maintenance Shop-2 Plan



Source: Study Team

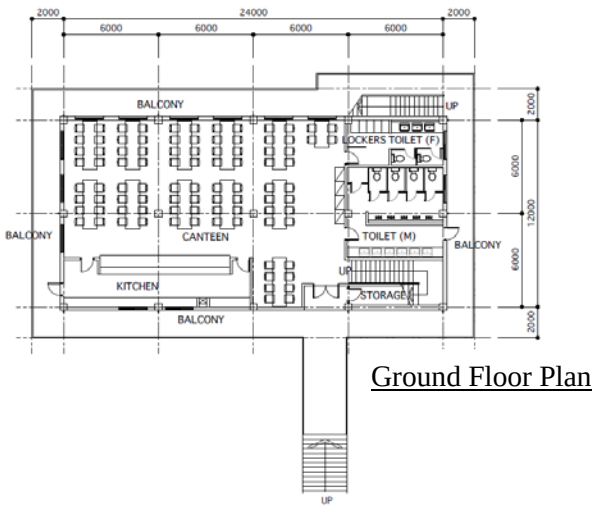
Figure 3.4.19 Maintenance Shop-2 Elevation

(5) Container Box Repair Shop

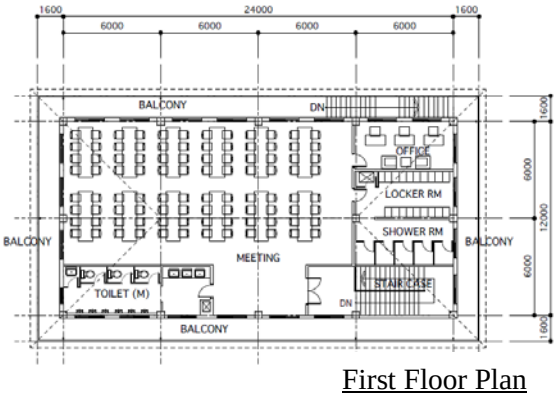
Twelve 20 ft. container boxes can be placed as single layer simultaneously. Container box will be placed as single layer and shifted by forklift. Repair shop needs roof and wall for welding work and painting work. One (1) container box repair shop will be constructed respectively for Phase II and Phase III project assuming that number of staff and workers for each phase ten.

(6) Marine Workers' Lounge

Marine Workers' Lounge is planned to be located near the cargo handling wharf. Function of Marine Workers' Lounge is to provide work meeting space, changing-room, dining, shower-room and so-on. For Phase I project, about fifty of stationed workers and sixty ship crew member in-charge of cargo loading from/to ship are planned to use the Lounge. Marine Workers' Lounge with same scale and specification as Phase I will be built for Phase II and Phase III project, since it is expected that same number of workers and ship crews need to use the lounge (see Figure 3.4.20 and Figure 3.4.21). Ship crew members are expected to use only the lavatory and kiosk.



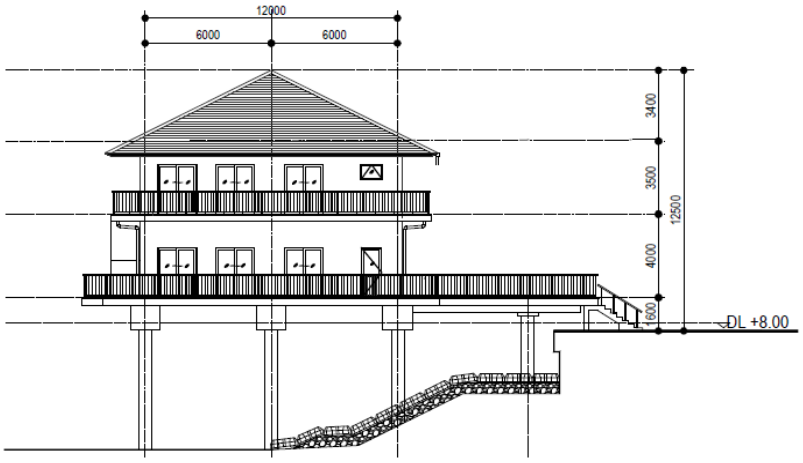
Ground Floor Plan



First Floor Plan

Source: Study Team

Figure 3.4.20 Marine Worker's Lounge Plan



Source: Study Team

Figure 3.4.21 Marine Worker's Lounge Elevation

(7) Summary of Buildings and Utilities

The summary of main buildings and utilities for Phase II and Phase III project is shown in Table 3.4.15.

Table 3.4.15 List of Buildings and Utilities for Phase II and Phase III Project

No	Buildings	Quantity (Story)		Remarks
		Phase II	Phase III	
1	Administration Building (ADM)	-	3,400 m^2 (5)	-
2	Container Freight Station (CFS)	8,500 m^2 (1+M)	6,800 m^2 (1+M)	For import use (it will be used for logistic center in the future)
3	Terminal Gate	6 lane (1)	11 lane (1)	-
4	2nd Gate	4 lane (1)	5 lane (1)	Entrance of bonded area
5	Maintenance Shop (1)	580 m^2 (1+M)	580 m^2 (1+M)	With the wall
	Maintenance Shop (2)	580 m^2 (1)	580 m^2 (1)	Without the wall
6	Container Repair Shop	770 m^2 (1)	770 m^2 (1)	-
7	Fuel Station	160 m^2 (1)	160 m^2 (1)	-
8	Marine Workers' Lounge	670 m^2 (2)	670 m^2 (2)	-
9	Security Post	-	70 m^2	Beside a terminal gate
10	Power Supply Facility	6,600 kVA (1)	8,800 kVA (1)	2,200 kVA per one (1) Gantry Crane
11	Water Supply facility	-	500 m^2 (1)	Phase III: including water supply tower (H=35 m)
12	Reefer Sub-station	1 set (-)	1 set (-)	Beside a reefer container
13	Jetty Sub-station	1 set (-)	1 set (-)	For Gantry Crane
*	X-ray Inspection Facility	2 unit (1)	3 unit (1)	-

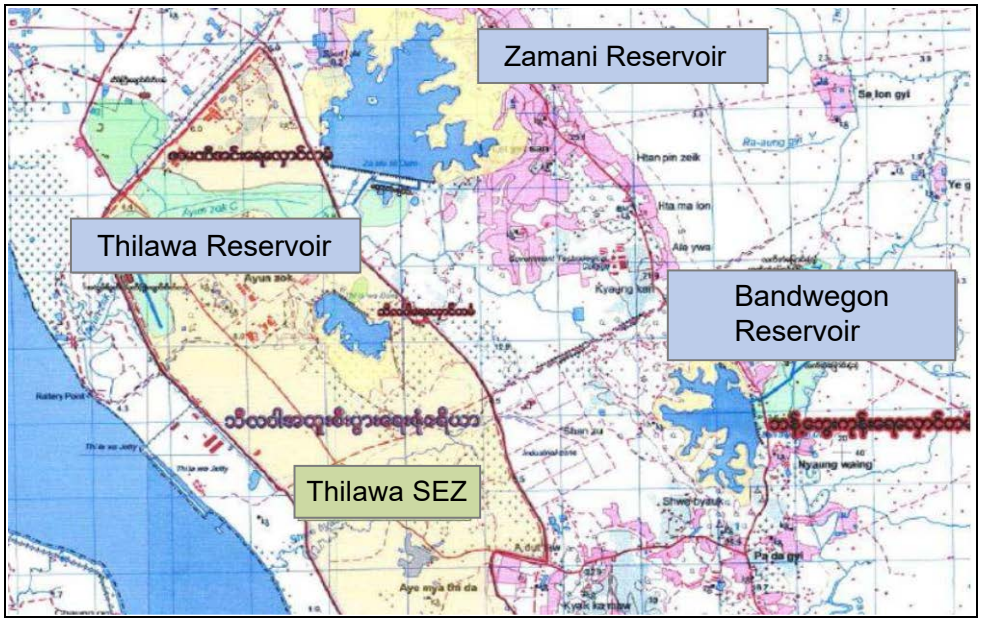
Note M : Mezzanine,
Source : Study Team

(8) Water Supply System

1) Water Resources

There are three relatively large water reservoirs around the Thilawa area, these are Banbwegon, Zamani and Thilawa reservoirs with a storage capacity of 1.89 million m^3, 6.63 million m^3 and 1.34 million m^3 respectively, and mainly used for irrigation, industry and domestic purposes (see Figure 3.4.22). Two water treatment plants in Thilawa reservoir are currently operated by Ministry of Construction (MOC) and Ministry of Industry (MOI). The water treatment plant operated by the MOC is supplies water to the five business establishments including MITT and MIPL. However, it is unable to supply potable water to the Plot 24, 25 and 26 due to lack of the storage capacity.

Therefore, it is planned to use the tube well and rain water for securing the required water amount during Phase I project. Also, some amount may be purchased from the water trailer as necessary. Currently the water supply works from Lagunbyin is on-going under the support of JICA and it is planned to be 10,000 m^3 in 2019 and 40,000 m^3 in 2020 to Thilawa area. Then it is assumed that this water resource can be used after completion of Phase II project.



Source: Study Team

Figure 3.4.22 Water Reservoirs around Project Site

2) Outline of the Water Supply System

The ground water tank (500 m^3) and elevated water tank (40 m^3) are under construction for Phase I project.

3) Water Demand

Water demand for the terminal facilities to be used is categorized into a) building occupants and sanitary use, b) ships, and c) container washing. Including the Phase II project, water demand for the building occupants and sanitary use is assumed to be about 100 m^3/day and water demand for the container washing

is assumed to be 3 m^3/day. Water demand for the ships is assumed to be 400 m^3/day at maximum although it depends on the frequency of ships call. The water supply for Phase II operation is to be covered by the facilities constructed during Phase I, thus, no facility for water supply will be constructed for Phase II project.

For Phase III project, the water supply facility including the grounded tank and elevated tank of the same scale as the Phase I facility will be built.

(9) Fuel Supply System

For Phase I project, the fuel station is planned to be located at the middle of Plot No. 25 for the diesel which to be used by the cargo handling equipment. Selling to the outside trailers is not considered. STS Gantry is operated by electronic power. Container track, fork lift and Tank lorry will come to the fuel station. RTG and Reach Stacker will not come to the fuel station but they take from tank lorry or others.

Fuel supply system with same capacity (8,000 L) as Phase I will be built for Phase II and Phase III project, since the number of cargo handling equipment will be procured approximately equivalent to Phase I.

(10) Electrical Works

1) Code and Standard

This design basically follows the JIS Standard as reference ones.

2) Environmental Condition

The works are designed based on the following condition.

- Temperature: up to 45 ºC
- Relative Humidity: up to 90 %
- Elevation: up to 50 m
- Salt Laden Air: negligible

3) Electrical System

The words are designed based on the following electrical system.

- Incoming: 33 KV, 3 phases 3 wire, 50 Hz
- Medium Voltage: 6.6 KV, 3 phases 3 wire, 50 Hz
- Low voltage: 400/230 V, 3 phases 4 wire, 50 Hz

4) Design Concept

The Electrical Works including Building Electrical Works will be designed based on the following concepts to secure required necessary reliability, durability, functionality and the like within minimum cost under the local circumstances.

i) **Redundancy**

The works shall be secured against possible power failure by means of dual incoming and stand-by generator and UPS with Battery.

ii) **Reliability**

The works shall be reliable in operation with applying appropriate protection schemes and highly specified materials even if there is any accident or human error.

iii) **Durability**

The works shall be maintained in performance for whole its lifetime with applying appropriate protection schemes and highly specified materials under the given circumstances.

iv) **Cost**

Both of initial and running cost shall be minimized with applying profound engineering materials, method of works and related specification.

v) **Energy Saving**

Energy consumption shall be reduced through proper monitoring system with control scheme and employing high efficiency and energy saving devices.

vi) **Safety**

Whole the system shall be designed to prevent accident resulting in injury or death including damage to the facility whatever may happen.

vii) **Maintenance**

Whole the system shall be able to be renewed and /or repair easily and economical as the need arises with keeping necessary space.

(11) **Lighting and Security related System**

According to ISPS (International Ship and Port Facility Security), following security related facility will be installed in restricted area to ensure the terminal security.

- Fence and Gate
- Area Lighting
- CCTV Camera
- Public Address (PA) system

3.5 Construction Method and Schedule

3.5.1 Construction Method

(1) Temporary Yard

Main temporary facilities are as below. It is assumed that Plot 23 can be used as a temporary construction yard for Phase II project.

- Temporary site office (Contractor, Engineer and Employer)
- Storage and fabrication yard for reinforcement, formwork, other construction materials
- Fabrication yard for precast concrete such as slab, beam, curb, etc.
- Concrete Batcher Plant (option by Contractor)
- Temporary Jetty for loading and unloading for Jacket, steel pipe pile, PC slab, stone, etc.
- Yard for extension of Steel Pipe Pile

Source: Study Team

Figure 3.5.1 Temporary Yard (Phase

(2) Civil Work

1) Jetty Construction

Dredging work will be started before piling work. Steel pipe pile will be driven by piling barge with hydraulic hammer and vibrio hammer. PC slabs are manufactured at the temporary yard and installed by crane barge from the river side. Jacket will be fabricated at a factory and assembled at the temporary yard, then installed by floating crane. One span of jetty will be 20 m and a total number of span will be 10.

Splicing of steel pipe piles will be made at temporary yard before carrying to the piling site. In-situ concrete works of upper structure will be casted by concrete pump truck. Gabion works under the jetty for slope protection will be installed by crane barge.

Source: Study Team

Figure 3.5.2 Jetty (Phase I)

2) Trestle construction

PHC pipe pile will be driven mainly by piling barge at the river, and it will be done by three points crawler piling machines from land side in shallow area. The precast beam and slab will be applied as super-structure type, and it will be casted by concrete

Source: Study Team

Figure 3.5.3 Trestle (Phase I)

pump truck from the land side.

3) **Revetment construction**

After the completion of soil improvement work in the area adjacent to the revetment, sheet piling work will be started. Slope protection by installation of filling sand and armor stone can be started after completion of sheet piling work. Coping concrete will be casted by concrete pump truck. The construction will be started from South side.

Source: Study Team

Figure 3.5.4 Revetment (Phase I)

4) **Soil Improvement Construction (PVD)**

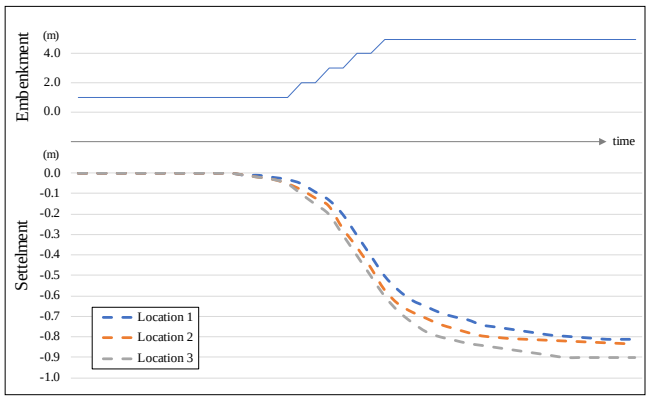
In Phase II (Plot 24), soft ground is assumed as well as Phase I (Plot 25-26), thus the soil improvement work (PVD method) will be implemented. Under the Phase I project, some works were added such as additional filling, extension of surcharge period, etc. because the consolidation has not proceed as planned. Based on these experiences, points to be noted in construction are summarized below:

Source: Study Team

Figure 3.5.5 Soil Improvement

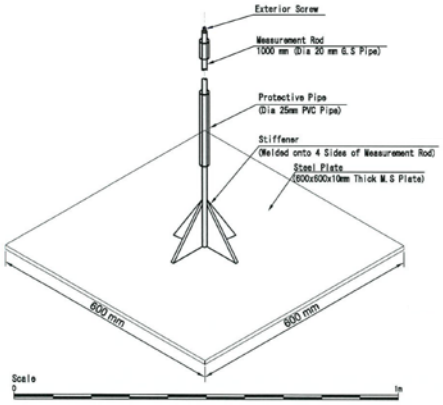
- It is important to confirm the effect of soil improvement by periodic monitoring.
- Targeted consolidation degree shall be 90 % or more and the following construction will be carried out after confirming that the residual settlement is 10 % or less of the final settelement.
- In managing consolidation settlement, the management of groundwater level is important because it is necessary to drain by pumping the soil water (targeted residual water level shall be less than C.D.L. +7.5 m).

Based on the results of such monitoring, it is necessary to implement adaptive measures. For reference, image of the changes in embankment height and settlement (Figure 3.5.6) and image of the settlement plate which is used for mesureing the settelement (Figure 3.5.7) are shown below.



Source: Study Team

Figure 3.5.6 Changes in Embankment and Settlement



Source: Study Team

Figure 3.5.7 Image of Settlement Plate

Firstly, sand filling will be installed for sand mat. The sand will be obtained from Yangon river by local pumping boat. Soil improvement work with PVD driving machines will be started from behind the revetment toward the land side. Surcharge sand will be removed to temporary yard by dump trucks after the completion of surcharge.

5) **Pavement work**

Pavement work is a series of construction work, such as interlocking concrete block, concrete pavement and crushed stone. Concrete drainage ducts and pits will be casted in place before the pavement works then concrete curb will be constructed.

Source: Study Team

Figure3.5.8 Pavement (Phase I)

(3) **Cargo Handling Equipment**

Cargo handling equipment such as Gantry Crane, RTG, Reach Stacker, Forklift, Truck and Chassis, etc. will be procured from foreign countries and then transported to Myanmar. Fabricated Gantry Crane will be placed on jetty by a floating crane.

- Period of Supply and Assembly for:
  Gantry Crane: 20 months
  RTG: 15 months
  Reach Stacker: 15 months
- Period of Transport: 2.0 months
- Period of Installation and Inspection: 2.0 months

Source: Study Team

Figure 3.5.9 Gantry Crane (Phase I)

Source: Study Team

Figure 3.5.10 Piling Work (Phase I)

(4) Buildings and Miscellaneous Facilities

1) Piling Work

PHC pile will be procured from neighboring countries. Steel pipe pile will be procured from Japan. Construction machinery will be employed locally.

2) Earth Work

Construction machinery will be employed locally. Appropriate operating space will be secured by over break simultaneously with checking the level of excavation bottom. Proper slope angle is required considering the soil condition. The rolling compaction to the predetermined height of the backfill shall be repeated in order to prevent subsidence at the completion of work.

Source: Study Team

Figure 3.5.11 Earth Work (Phase I)

3) Concrete Work

Concrete and concrete pump cars will be employed locally. When pouring concrete, the tip of concrete pump pipe shall not go down the specified height to prevent honeycombing. It is noted to pay attention when pouring concrete to the narrow space, such as wall, by using vibrator.

Source: Study Team

Figure 3.5.12 Concrete Work (Phase I)

4) Form Work

Materials for shuttering form will be procured locally. At the time of shuttering form installation, it is required to place separator properly and tight the form tie closely to prevent swelling. When using a donut for the spacer to secure the depth of protective concrete cover, it is needed to pay attention to the position and direction of installation and to pour concrete properly.

Source: Study Team

Figure 3.5.13 Form Work (Phase I)

5) Steel Reinforcement Work

Materials will be purchased from neighboring countries. The storage location of materials shall be determined in consideration of the humidity and dirt. When bring materials into the project site, each mill sheets shall be checked. During the construction, the splice of main reinforcement bars will be installed to specified positions. If the interval of the main reinforcement bar is narrow, the number of stages shall be increased in order to make the coarse aggregate of concrete can pass through space between bars.

Source: Study Team

Figure 3.5.14 Reinforcement Work

6) **Structural Steel Work**

Materials will be purchased from neighboring countries and construction machinery will be procured locally. The ultrasonic testing shall be conducted in order to check the accuracy of factory processing and welding. Equipment and engineer for full-scale inspection and ultrasonic testing will be arranged from neighboring countries. If constructing the internal diaphragm due to the use of the different column size, the accuracy of welding of internal diaphragm shall be checked before welding external diaphragm as necessary.

Source: Study Team

Figure 3.5.15 Structural Steel Work (Phase I)

7) **Steel Roofing Work**

Steel roof and wall materials will be shipped from neighboring countries. It is noted to pay careful attention to humidity of the products storage to avoid corrosion of the products. Also the storage method will be planned in order to prevent the distortion of tight frame and damage of accessories such as spacer.

Source: Study Team

Figure 3.5.16 Steel Roofing Work (Phase I)

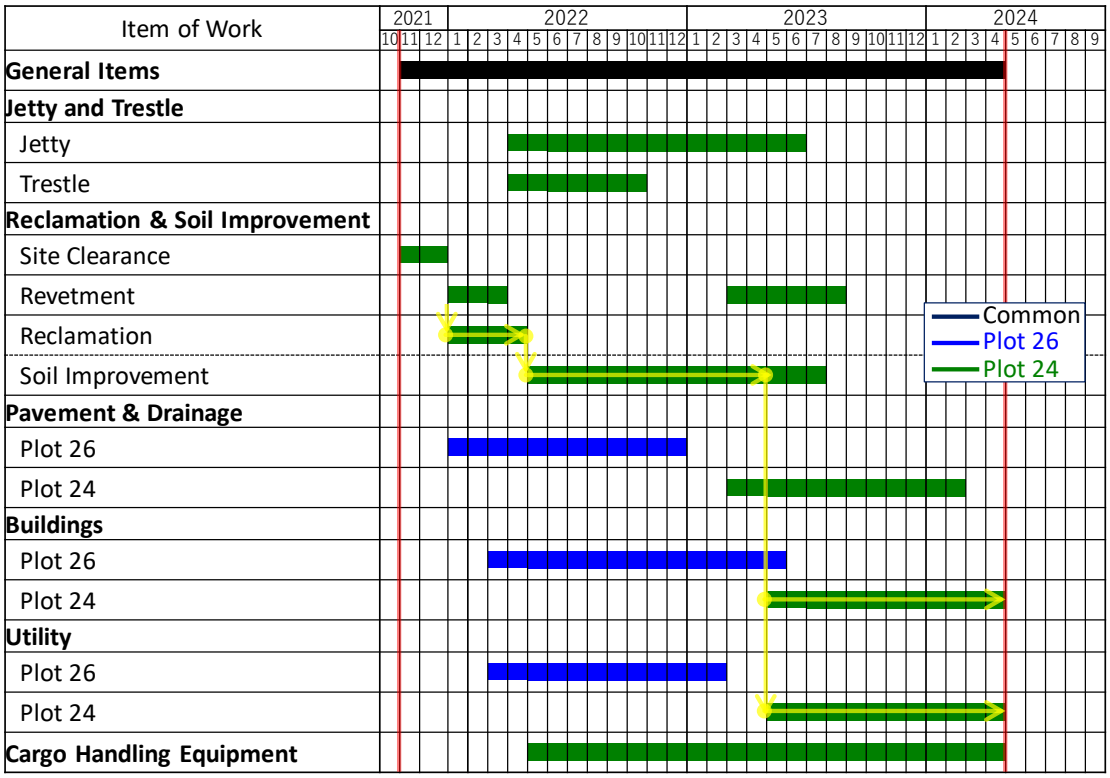
3.5.2 Construction Schedule

(1) Construction Schedule

The construction schedule for Phase II is presented in Table 3.5.1, which includes the procurement period of equipment including fabrication, delivery, installation and commissioning at the site, in addition to the preparatory works for the construction of civil works and buildings.

The critical path (buildings and utility works after the reclamation and soil improvement work) is highlighted by yellow line in the table.

Table 3.5.1 Construction Schedule for Phase II Project

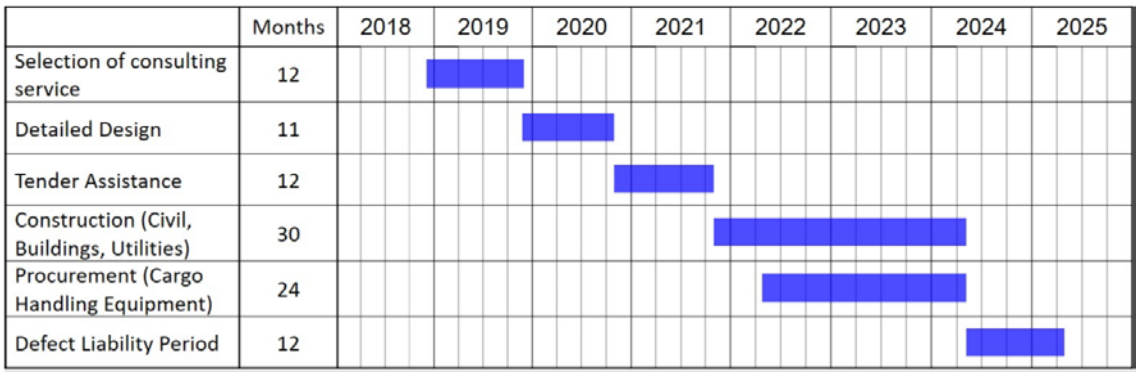


Source: Study Team

(2) Project Implementation Schedule

Since Myanmar side expects to employ a soft loan for the project, the implementation schedule including the period for loan procedure, detailed design and tender assistance, etc. is as shown in Table 3.5.2.

Table 3.5.2 Project Implementation Schedule for Phase II Project



Source: Study Team

3.6 Terminal Operation Plan

[Phase II & Phase III Project]

Basic operational conditions for terminal facility planning (Phase II and III) reported in "2.4 Terminal Facility Planning" of the report are addressed in this section. Main issues addressed are as follows; 1) Business unit, 2) Targeted container handling volume and its breakdown, 3) SEZ related cargo volume & material flow, 4) Customs inspection procedures & truck flow, 5) Organization & workforce deployment plan, and 6) Cargo handling equipment procurement plan.

3.6.1 Business Unit

Appropriate business units on the Plots 22 to 26 based on criteria such as 1) efficient berth utilization, 2) preventing monopoly, 3) business strategy of the potential operator are addressed as follows;

[Efficient Berth Utilization]

In the Phase I stage of the Project, two (2) terminal jetties (Plots 25 and 26) were planned to be as one business unit. However, regarding the backyard area, only one (1) Plot (Plot 25) was included in the Phase I Project. The remaining yard area (Plot 26) was not assigned. In the Phase II stage, the scope was expanded to three (3) Plots (Plot 24/25/26) with both jetties and backyard areas. Regarding the business unit of the Phase II Project, dividing this area into two business units (i.e., Plot 25/26 and Plot 24) will not make sense because the operation area of Plot 24 is too narrow to continue sustainable business.

As a result, the operation of three Plots (Plot 24/25/26) as one business unit is recommendable in the Phase II Project from the viewpoint of efficient use of the infrastructure (jetty and hinterland area).

Regarding the business unit in the Phase III Project, Plot 22 & 23 is planned to be operated as an independent business unit from the following points;

1) As described in the Phase II layout planning, quay-lines of Plot 22/23 (400m length) and Plot 24/25/26 (600m length) are not in a straight line (inflective at 8-degrees). Therefore, a calling vessel cannot be berthed at the area where the jetties are joined; accordingly, each jetty has no choice but to be operated independently.

2) As Plot 22/23 has two berths (total length of 400 m), two vessels can be accommodated at the same time. Therefore, Plot 22/23 can be operated as an independent terminal.

3) A Japanese terminal operator, who was awarded Plot 25/26 concession, has a strong interest to operate Plot 24/25/26 as a business unit in the Phase-II Project. However, the operator does not show any interest in the project at Plot 22/23 at present stage, because Phase I (Plot 25/26) terminal is still in construction and has not yet started its operation. Therefore, it is too risky to make the facility (layout

plan) based on the assumption that Plot 22-26 will have a quay length of 1,000m and be operated as one integrated business unit.

[Preventing Monopoly]

In the Thilawa Area Port, MITT owned by Hutchison Port Holdings has been conducting terminal operations for 22 years. This terminal has an area of 70 ha including a berth of 1,000 m in length; in 2017 MITT recorded 170 thousand TEUs of container throughput. It will stand against the newcomer as a strong competitor. Hence, there is no concern of a monopoly emerging in the ODA Terminal.

[Strategy of Potential Operator]

In March 2018, long term concession agreement for the ODA Terminal (Phase I) was signed between MPA and a Japanese Terminal Operator. Scope of concession is two berths of Plots 25 & 26 (400 m) and the backyard area of Plot 25 including yard facilities and equipment. The concessionaire is keen to obtain the operational right for the facilities of the backyard of Plot 26 when it is developed in near future.

When the terminal facilities of Plot 24 are developed according to the increase in cargo demand forecast in this Study, the above-mentioned Operator will strongly desire to be the concessionaire of Plot 24 in order to increase the efficiency of terminal operations.

3.6.2 Container Handling Volume and its Breakdown

① Targeted container handling volume: 600,000 TEUs per year

② Breakdown of each type of container: Refer to Table 3.6.1

Table 3.6.1 Container Handling Volume by Type

Type of Container		Long-term Proportions		Short-term Proportions		Current Proportions
		Proportion (%)	Container Volume (TEU/Year)	Proportion (%)	Container Volume (TEU/Year)	Proportion (%)
Import	Full Container	90%	270,000	90%	270,000	95%
	Empty Container	10%	30,000	10%	30,000	5%
Export	Full Container	80%	240,000	60%	180,000	55%
	Empty Container	20%	60,000	40%	120,000	45%
Total	Full Container	85.0%	510,000	75.0%	450,000	75.0%
	Empty Container	15.0%	90,000	25.0%	150,000	25.0%
Grand Total		100.0%	600,000	100.0%	600,000	100.0%

Note: Long-term Proportions are assumed after the year of 2030.
Short-term Proportions are assumed in the year from 2025 to 2030.

Source: Study Team

3.6.3 SEZ related Cargo Volume & Material Flow

(1) Cargo Volume related to the Thilawa SEZ

Import and export cargoes generated at the Thilawa SEZ are described in chapter “2.2 Cargo Demand

Forecast in the Port". Among these cargoes, import cargoes are mainly the imported materials which factories or distributers in the SEZ consume, and export cargoes are the products of the factories in the SEZ for export. The volume of these import and export cargoes in TEU base is shown in Table 3.7.2 (Thilawa Port Cargo Volume related to Thilawa SEZ).

The import cargoes are unloaded at both Yangon city terminals and Thilawa Area terminals including the ODA Terminal. About 70% of the import cargo is assumed to be unloaded at the Thilawa Area terminals owing to locational advantage. The remaining 30% of the import cargo is assumed to be unloaded at the Yangon city terminals. On the other hand, it is assumed that most export cargoes are loaded at the Thilawa Area terminals including the ODA Terminal. The volume of these import and export cargoes handled at the Thilawa Area terminals is shown in Table 3.7.2 (Thilawa Port Cargo Volume related to Thilawa SEZ).

Among these Thilawa Port Cargoes related to the Thilawa SEZ, 50% of the cargo is assumed to be handled at the ODA terminal, whereas the remaining 50% is assumed to be handled at MITT. As a result, 78,000 TEUs of full container cargoes (import: 27,000TEUs, export: 51,000 TEUs) will be handled at the ODA terminal in 2025, whereas 142,000 TEUs (import: 49,000 TEUs, export: 93,000 TEUs) will be handled in 2030. These figures are shown in Table 3.6.2 (ODA Terminal Cargo Volume related to the Thilawa SEZ).

Table 3.6.2 Cargo Volume related to The Thilawa SEZ in the Phase II Project (Plot 24/25/26)

	Thilawa SEZ Cargo Volume *1 (TEU)		Thilawa Port Cargo Volume related to Thilawa SEZ (TEU)		ODA Terminal Cargo Volume related to Thilawa SEZ (TEU)		Remarks
	2025	2030	2025	2030	2025	2030	*1 Full Container (Refer to "2.2 Cargo Forecast")
Import	**75,317**	**138,908**	53,000	97,000	**27,000**	**49,000**	
Export	**100,687**	**185,699**	101,000	186,000	**51,000**	**93,000**	
Total	**176,004**	**324,607**	154,000	283,000	**78,000**	**142,000**	

Source: Study Team

(2) Share of SEZ related Cargoes

Percentage of SEZ related container volume (full containers) to the total container volume (600,000 TEUs per annum) is shown in Table 3.6.3. For the import cargoes, SEZ related cargoes will account for about **10%** of the total full containers (270,000 TEUs) in 2025 and 18% in 2030. For the export cargoes, SEZ related cargoes will account for about 28% of the total full containers (180,000 TEUs, assumed by the short-term proportions) in 2025 and 39% of the total full container volume (240,000 TEUs, assumed by the long-term proportions) in 2030. Generally, effect of the SEZ cargoes to the ODA terminal is much higher for export cargoes than import cargoes (Refer to Table 3.6.3).

Cargo volume related to SEZ effects terminal operation in many aspects, especially work load and required facilities for customs inspection in the terminal. From a long-term viewpoint, SEZ cargoes will account for one third (1/3) of in total (import and export) cargoes. This means that one third of customs inspection work would be shared by SEZ customs.

Table 3.6.3 Share of SEZ related Cargoes to the Total ODA Terminal Cargoes

Type of Container				Container Volume by Type	Material Flow (TEU)					
							2025		2030	
Short-term Proportions	Import	Full Container	90%	270,000	Thilawa SEZ related Cargo Volume		27,000	10%	49,000	18%
					Cargo Volume other than SEZ	Total	243,000	90%	221,000	82%
						FCL	230,850	95%	209,950	95%
						LCL	12,150	5%	11,050	5%
		MT Container	10%	30,000						
		Import Total	100%	300,000						
							2025		2030	
	Export	Full Container	60%	180,000	Thilawa SEZ related Cargo Volume		51,000	28%	93,000	52%
					Cargo Volume other than SEZ	Total	129,000	72%	87,000	48%
						FCL	129,000	100%	87,000	100%
		MT Container	40%	120,000						
		Export Total	100%	300,000						
							2025		2030	
	Total	Full Container	75%	450,000	Thilawa SEZ related Cargo Volume		78,000	17%	142,000	32%
					Cargo Volume other than SEZ	Total	372,000	83%	308,000	68%
						FCL	359,850	97%	296,950	96%
						LCL	12,150	3%	11,050	4%
		MT Container	25%	150,000						
		Grand Total	100%	600,000						
							2025		2030	
Long-term Proportions	Import	Full Container	90%	270,000	Thilawa SEZ related Cargo Volume		27,000	10%	49,000	18%
					Cargo Volume other than SEZ	Total	243,000	90%	221,000	82%
						FCL	230,850	95%	209,950	95%
						LCL	12,150	5%	11,050	5%
		MT Container	10%	30,000						
		Import Total	100%	300,000						
							2025		2030	
	Export	Full Container	80%	240,000	Thilawa SEZ related Cargo Volume		51,000	21%	93,000	39%
					Cargo Volume other than SEZ	Total	189,000	79%	147,000	61%
						FCL	189,000	100%	147,000	100%
		MT Container	20%	60,000						
		Export Total	100%	300,000						
							2025		2030	
	Total	Full Container	85%	510,000	Thilawa SEZ related Cargo Volume		78,000	15%	142,000	28%
					Cargo Volume other than SEZ	Total	432,000	85%	368,000	72%
						FCL	419,850	97%	356,950	97%
						LCL	12,150	3%	11,050	3%
		MT Container	15%	90,000						
		Grand Total	100%	600,000						

Source: Study Team

(3) Container Logistic Flow between Thilawa SEZ and Thilawa Port

Comparison of logistic flow and customs procedures for import container cargoes between the Thilawa

SEZ and Thilawa Port, as well as the conventional city terminals and their hinterland industrial parks is shown in Figure 3.6.1.

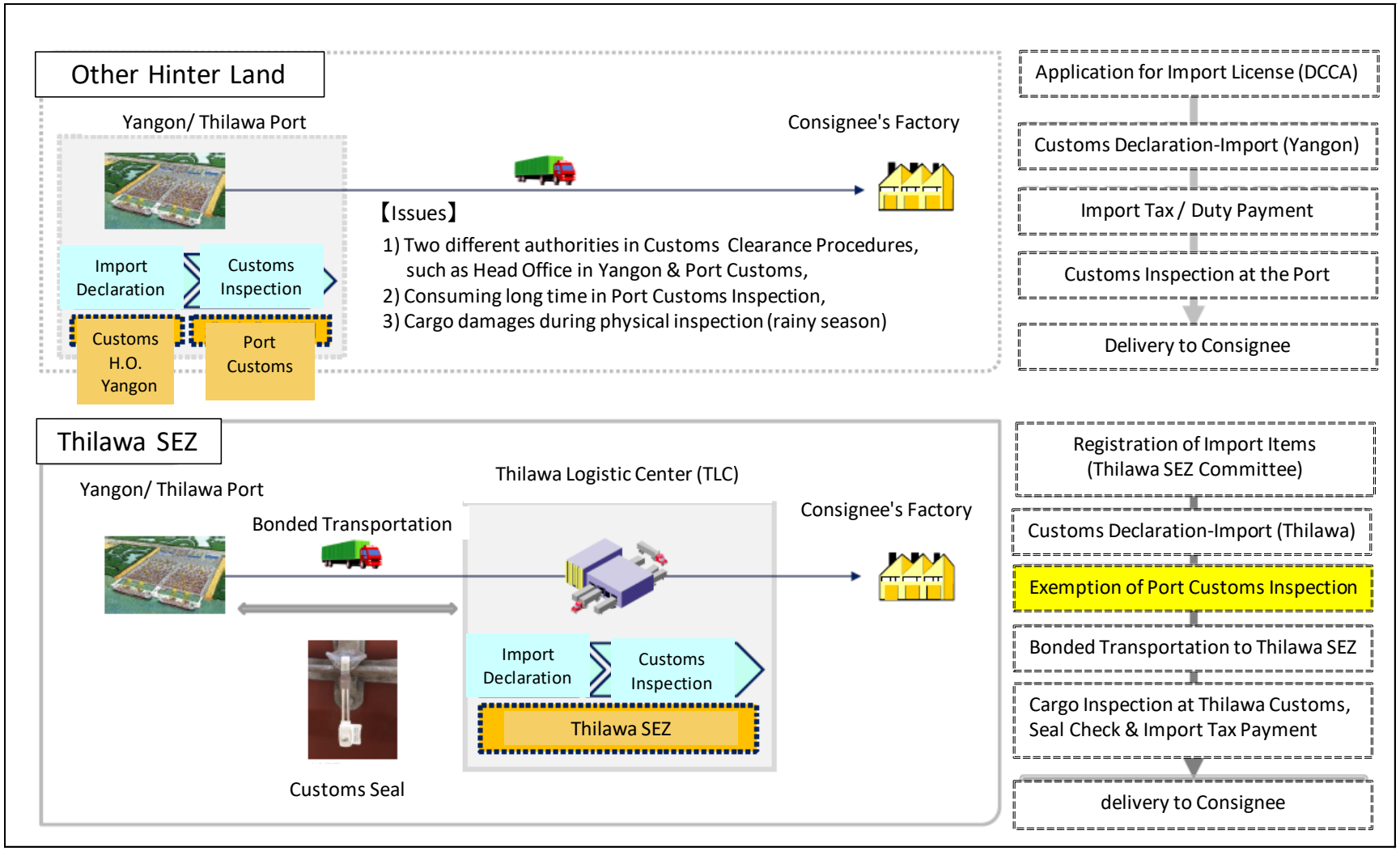
Conventional customs procedures in Myanmar for import container cargoes consist of four (5) steps; 1) application for import license to DCCA (Department of Commercial and Consumer Affairs), 2) customs declaration to the customs head office in Yangon, 3) import tax payment, 4) customs inspection at the port, and 5) delivery of cleared (domestic) cargo to the consignee. Customs procedures in Myanmar cannot be said to meet international standards.

The biggest issue is that there are two different authorities in customs, customs head office in Yangon and port customs, and each exercise independent authority depending on circumstances. The former executes document screening and import tax evaluation, while the latter executes document check and cargo inspection. Because of double document check by the different authorities, customs clearance (especially in the port) takes a long time, seriously hampering the logistics process in the port.

To remedy this situation, two new measures were introduced to expedite and simplify customs procedures between Thilawa SEZ and Thilawa Area port terminals; 1) Bonded transport between Thilawa SEZ and port terminals and 2) Thilawa Logistic Center (TLC).

Since the establishment of the above facilities, the new customs procedure for SEZ cargo is as follows; 1) registration of import items to Thilawa SEZ Committee, 2) customs declaration to Thilawa customs office, 3) bonded transport to Thilawa SEZ, 4) cargo inspection at the Thilawa Customs, seal check and import tax payment, 5) delivery of cleared cargo to the consignee’s factory in the SEZ.

In this logistics system, consignee exempts cargo inspection in the port. Import containers related to the SEZ are affixed with a Customs Seal at the port and are transported to TLC in bond. The same procedures are also applied to the export containers from the SEZ. Accordingly, work related to container inspection in the port has been dramatically reduced under the new system.



Source: Study Team

Figure 3.6.1 Comparison of Thilawa Import Cargo Flow between SEZ and the City Terminals (other Hinterland Area)

(4) Thilawa Logistic Center (TLC)

Up to now, three TLCs were set up in the SEZ; 1) TLC/ TGL (Thilawa Global Logistics), 2) TLC/ Yusen (Yusen Logistics (Thilawa)) and 3) TLC/ Nittsu (Nittsu Logistic Myanmar). Established in 2016-2017, they have similar functions to bonded warehouses (CFS), customs inspection area, cooling / refrigerator warehouse, etc..

Table 3.6.4 Thilawa Logistic Center

Name of the Facility	Operator	Site Area (Ha)	Bonded Warehouse (㎡)	Yea r of Foundation
Thilawa Logistic Center / TGL	Thilawa Global Logistics Co. Ltd.	4.75	5,000	2016
Thilawa Logistic Center / Yusen	Yusen Logistics (Thilawa) Co. Ltd	3.00	6,300	2017
Thilawa Logistic Center / Nittsu	Nittsu Logistics Myanmar Co. Ltd	5.05	4,000	2017

Source: Study Team

3.6.4 Customs Inspection Procedures and Truck & Container Flow

(1) Current Situation of Customs Inspection Procedures

Before transporting export containers to the terminal or extracting import containers from the terminal, exporter or importer have to declare cargoes for clearance at the customs head office (central office) in Yangon. After obtaining permission at the customs head office, container cargoes must clear inspection by the customs officer at the terminal (CFS customs or port customs) for shipping or withdrawal of the cargo.

1) Customs procedures for import container cargoes

At the time of extracting an import container from the terminal, importer (consignee) applies for container cargo inspection with the relevant documents, including permission of the customs head office, to the CFS (Port) customs at the terminal. After examining the documents, CFS (Port) customs instruct the importer on the inspection procedures to be followed. There are three categories in the procedures:

① Green Category: The container cargoes are cleared without any additional inspection or examination (cleared only by document assessment).
② Yellow Category: Container cargoes are obliged to undergo an X-ray inspection. (cleared by document assessment and X-ray inspection)
③ Red Category: Container cargos are obliged to undergo a physical examination at the CFS. (cleared by document assessment and physical examination)

After completion of the procedures in each category, importer can proceed to the next step.

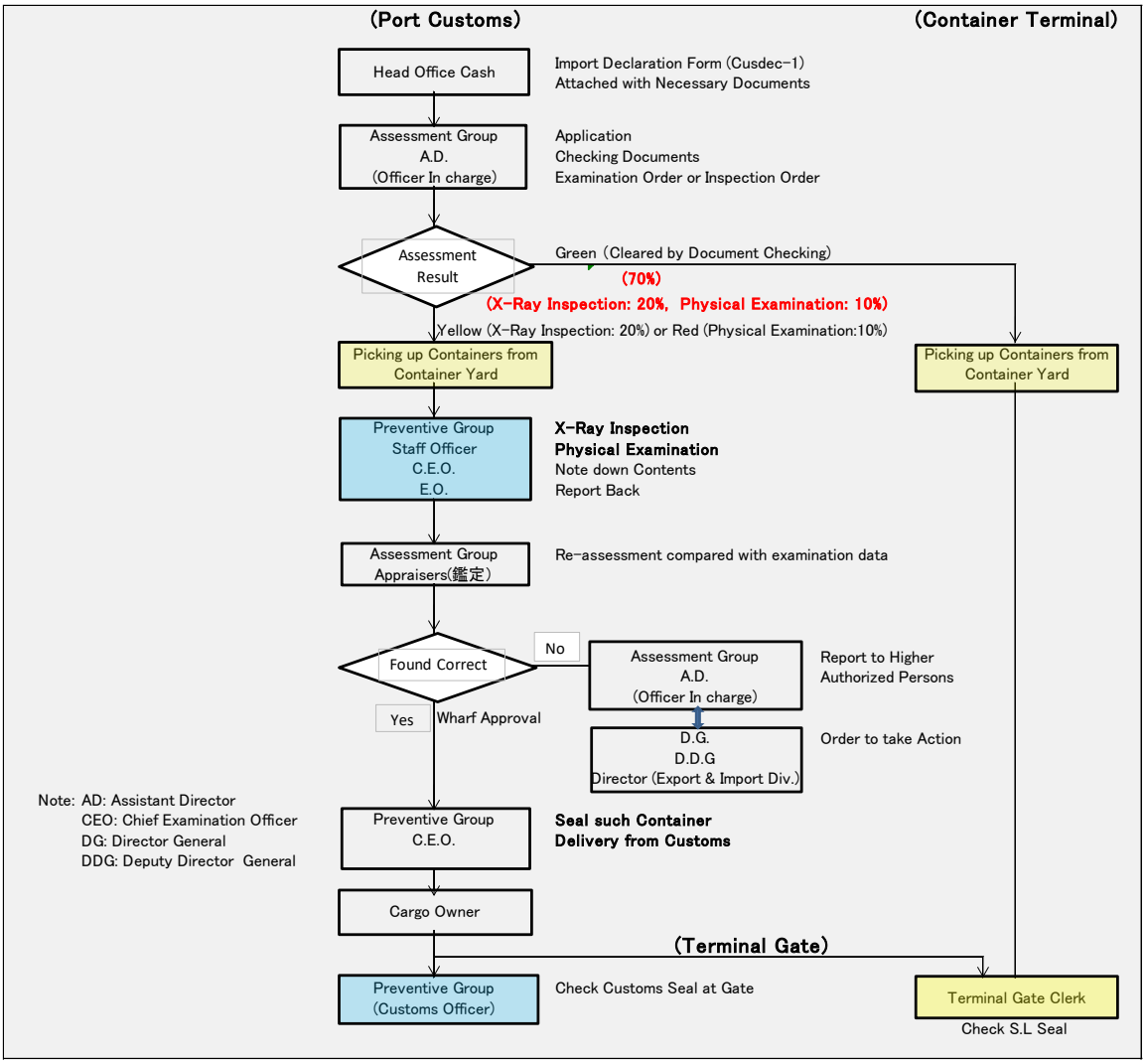
In the case of Thilawa SEZ related containers, cargo owner can apply for bonded transportation and CFS

customs officer sets seals (Customs Seal) on the container door. Hence, the applicant exempts cargo inspection from the port customs.

The customs procedures of import container cargo are illustrated in Figure 3.6.2, and truck flows in the terminal for customs inspection, including terminal gate, X-ray inspection, and physical examination in CFS, as well as parking areas for the trucks arranged by the importers, are shown in Figure 3.6.3.

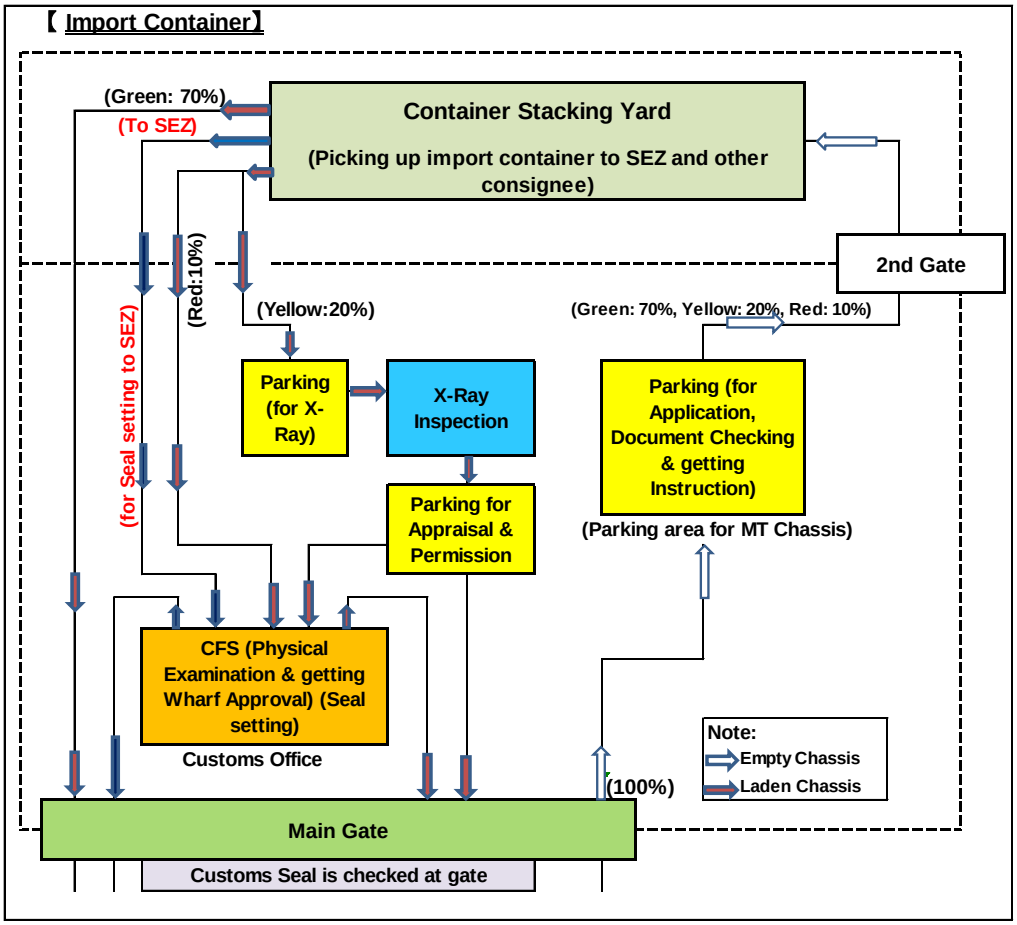
At present, more than thirty per cent (30%) of import containers fall under the Red Category. However, Myanmar customs are attempting to reduce the proportion of this category to ten percent (10%) by introducing MACCS which came into operation in 2016. The proportion of each category of import containers is expected to become as follows in the near future;

① Green Category: seventy percent (70%)
② Yellow Category: twenty percent (20%)
③ Red Category: ten percent (10%)



Source: Study Team

Figure 3.6.2 Import Container Inspection Process (Current Process)



Source: Study Team

Figure 3.6.3 Truck & Container Flow Chart for Customs Inspection (Import Container)

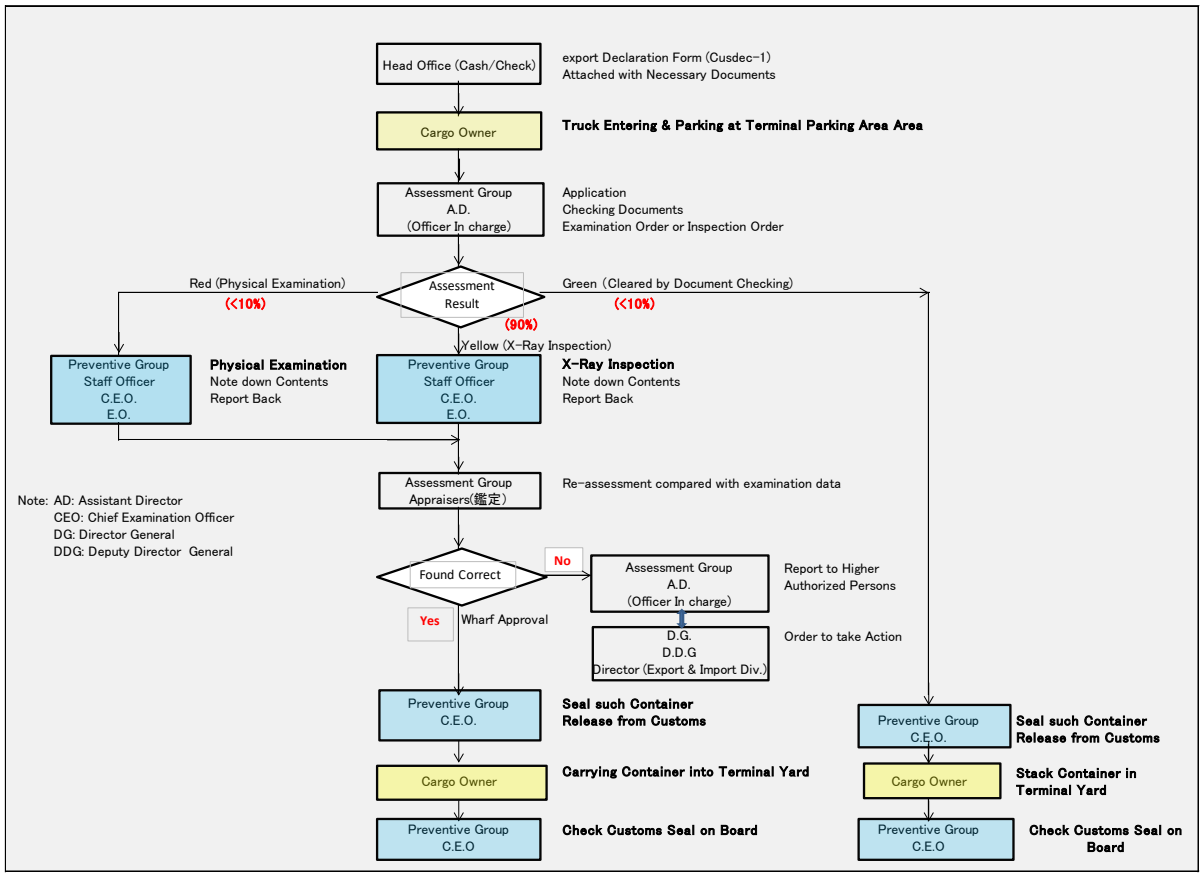
2) Customs procedures for export container cargoes)

At the time of export container stacking in the yard, exporter (shipper) applies for container cargo inspection with the relevant documents, including permission of the customs head office, to the CFS customs at the terminal. After assessment of the documents, CFS customs instruct the exporter on the inspection procedures to be followed. There are three categories in the procedures which are the same as import procedures described above.

After completion of the procedures in each category, containers are sealed by the CFS customs and sent to the stacking yard. The customs seal is checked by customs at the time of loading. At present, about ninety percent (90%) of the export containers fall under the Yellow Category, while the remaining ten (10%) of the export containers either fall under the Red or Green Categories. The customs procedures of export container cargo inspection at the terminal are illustrated in Figure 3.6.4. Truck flows in the terminal for export container customs inspection, including terminal gate, X-ray inspection, and physical examination in CFS, as well as parking areas for the trucks arranged by the exporters, are shown in Figure 3.6.5.

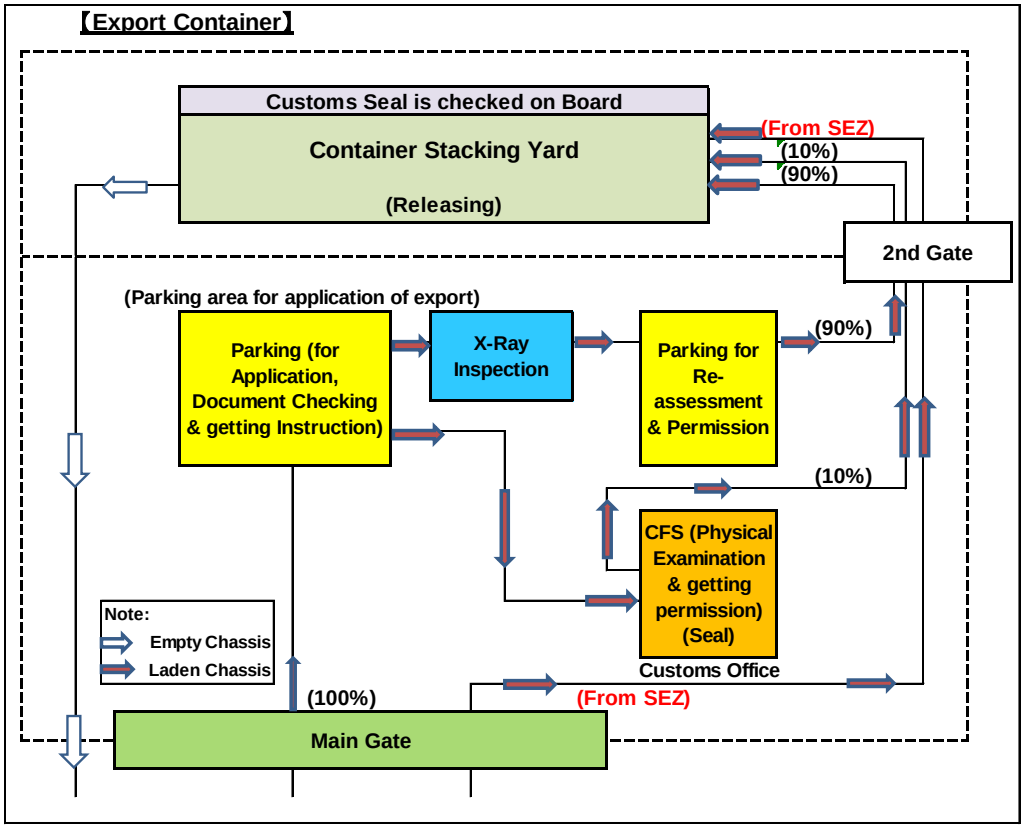
In the case of Thilawa SEZ related containers which have been cleared at the SEZ customs and transported

in bond, CFS customs officer only checks the seals on the transported container. As with import containers, the applicant exempts cargo inspection from the port customs. In the future, this procedure would be more simplified; These SEZ related container can be received directly at the terminal yard and the seal will be checked at the time of ship loading by the port customs.



Source: Study Team

Figure 3.6.4 Export Container Inspection Process (Current Process)



Source: Study Team

Figure 3.6.5 Truck & Container Flow Chart for Customs Inspection (Export Container)

(2) Customs Inspection Procedures with MACCS

In November 2016, electronic customs clearance system was introduced to Myanmar Customs with Japanese technical and financial assistance. The system was named MACCS (Myanmar Automated Cargo Clearance System), and was modeled on NACCS (Nippon Automated Cargo Clearance System).

[Main Functions of MACCS]

By introducing MACCS, conventional paper-based procedures are expected to be replaced by a paperless system on an internet web environment. Main functions of MACCS are as follows (See Table 3.6.5);

1) Import and export declaration for customs clearance through customs homepage including electronic declaration and electronic document submission.
2) Auto screening of declared cargoes based on the screening criteria
3) Auto tax calculation and auto tax payment, which enables automated tax calculation based on declared trade price (CIF) and registered tax rate and automated tax payment from applicant's deposit account.
4) National single window networks among the systems of the following Ministries;
   ① Ministry of Commerce (MOC),
   ② Myanmar Port Authority (MPA),
   ③ Ministry of Agriculture and Irrigation (MOAI),
   ④ Food and Drug Administration (FDA),

⑤ Ministry of Labor, Immigration and Population (MOLI&P), etc.

5) Other functions such as;

① Manifest Registration,

② Cargo Tracking,

③ Bonded Transportation, etc.

Table 3.6.5 Main Functions of MACCS

Main Items	Function	Description	Remarks
Import/ Export Declaration	Electronic Declaration	Import, Export, Transit, etc.	Customs Broker can access and declare to the Customs H/P from their office.
	Electronic Document Submission	Invoice (PDF), B/L(PDF), etc.	
	Auto-Tax Calculation	Automated calculation based on declared trade price (CIF) and registered tax rate	
	Auto-Screening of Declared Cargoes (Green/ Yellow/ Red)	Automated examination of declared cargoes based on screening criteria	
Auto-Tax Payment	Electronic Tax Payment	Tax payable automatically from applicants' deposit account	Short notice from tax collection to customs
National Single Window	National Single Window Network among related Ministries' System	Customs :MACCS	Electronic data communication through Single Window Platform
		Import/Export License : MOC	
		OGA Inspection result: FDA, MOAI, MOLI&P	
		Manifest Information: MPA	
Cargo Control	Manifest Registration	Registration of Manifest Data	Common use of manifest information among related system
	Cargo Tracking	Tracking of cargo movement and status related to loading/ unloading/ release from CY, etc.	Cargo movement and status information control
	Bonded Transportation	Bonded Transportation Control (application , approval, tracking, etc.)	Electronic application of Bonded Transportation

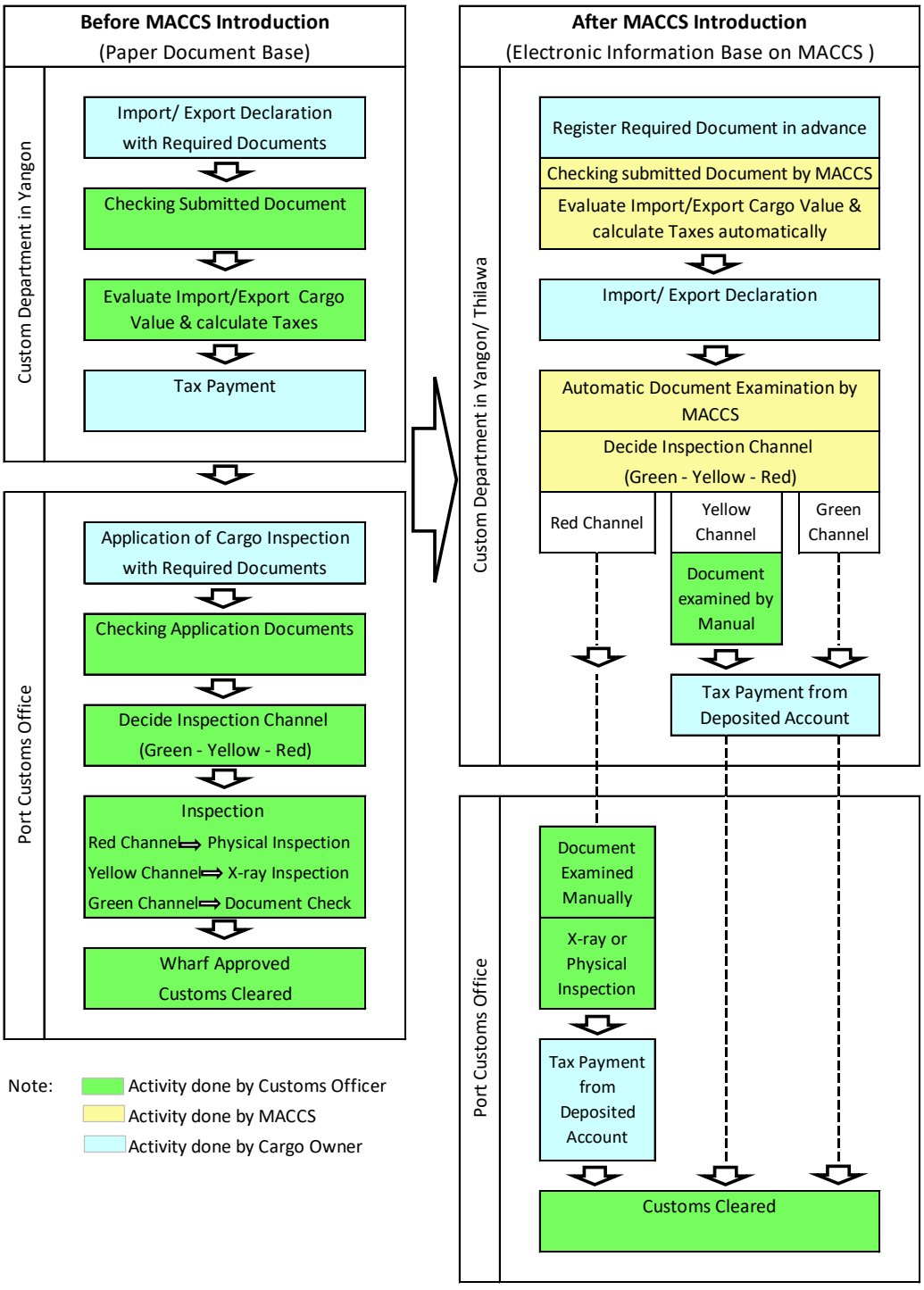
Source: Study Team

Among these functions, the auto screening sub-system is a key factor for reducing cargo inspection works at the port. By continuous use of MACCS, screening data is accumulated in the MCIS (Myanmar Customs Intelligent Database System) and accuracy of screening criteria will be improved. As a result, proportion of Green category is expected to rise while the Red /Yellow category is expected to descend to the targeted level.

Considering that MACCS was only introduced two years ago and that Japanese customs will continue to provide long-term support, targeted level of Red/ Yellow category for the Phase II facility plan is to be set as the same targeted level which was estimated in the Phase I Project.

[Customs Procedures on MACCS]

Customs procedures using MACCS and conventional method are illustrated in Figure 3.6.6. Activities carried out by the customs officer are indicated in green, activities carried out by the cargo owner (applicant) are shown in light blue while automated procedures performed by MACCS are shown in yellow.



Source: Study Team

Figure 3.6.6 Custom Clearance Process after the Introduction of MACCS

In conventional customs procedures, an applicant has to pass through the following two barriers; 1) submission of import/ export declaration to the customs head office in Yangon with necessary documents, 2) Application of cargo inspection to the port customs with all the documents including those submitted to the head office. In order to perform cargo inspection, the port customs has to check the parity of declared cargo on the document and actual cargo in the container (items, quantity). Generally, almost all the cargoes in the container are corresponding to the applicant declaration. However, substantial number of applicants' declarations is not trusted by the port customs officer. Hence a large percentage of containers are inspected at the port as described in the previous section. This situation is the main reason for the time-consuming process at the port: it imposes a heavy load on the total logistics system in the port.

By introducing MACCS, including MCIS (Myanmar Intelligent Customs System), and accumulating cargo inspection and document examination data, accuracy of auto-screening system will gradually be improved. As a result, customs inspection procedures in the port will facilitate an effective logistics system in the port.

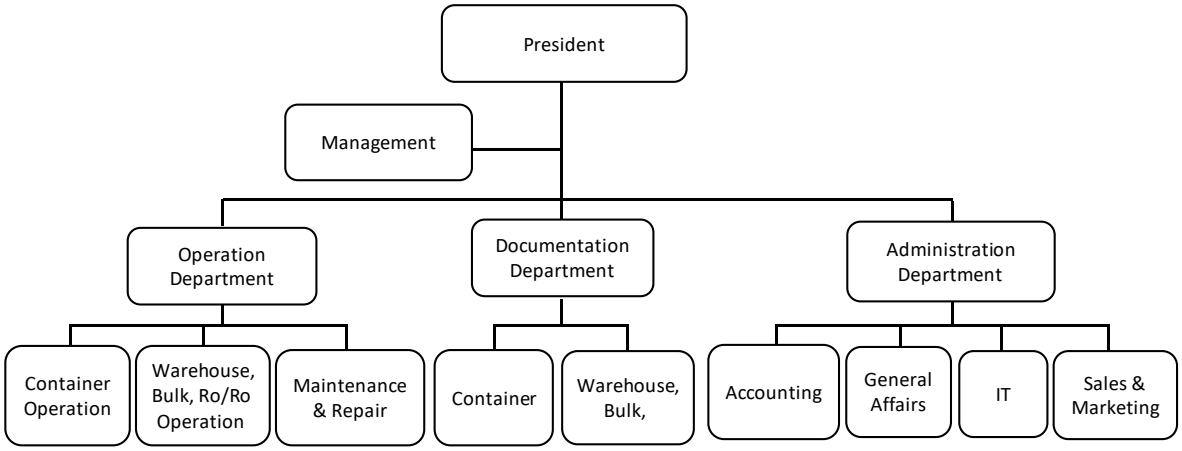
When MACCS reaches its highest performance level, almost all container cargoes (especially import container cargoes) will be approved by the auto-screening system (Green Channel in MACCS terms) or by customs officers' examination through electronic document in MACCS (Yellow Channel in MACCS terms). And they can be received by (or delivered from) the terminal yard directly to the consignee without any inspection by port customs. This performance level has been reached in EU countries, Japan and the USA. However, it will take years to achieve the final target of MACCS.

In conclusion, the proportion of each inspection category (Green/ Yellow/ Red) as the precondition for Phase II (as well as Phase III) facility planning will be maintained at the same level as what was adopted in Phase I Project. It is thought that jumping to the final target would premature and risky at this stage.

3.6.5 Organization and Workforce Plan

(1) Organization Chart

A model organization chart of Thilawa Multipurpose International Terminal (TMIT), hereinafter called the ODA terminal), is shown in Figure 3.6.7. Generally, a multipurpose terminal is required to have the following six functions; 1) management, 2) administration (accounting, general affairs, IT), 3) operations (containers, warehouse, bulk, Ro/Ro), 4) documentation (import/ export document, gate check, tally), 5) maintenance and repair and 6) marketing & sales. Some of these functions are grouped into a bigger organizational unit such as a department. In this model, maintenance and repairing function is aggregated into operation department, and marketing & sales function into the administration department.



Source: Study Team

Figure 3.6.7 Organization Chart of Thilawa International Multipurpose Terminal

(2) Workforce Deployment Plan

Workforce assignment plan for the Phase II Project and operational and facility conditions for the estimation of workforce, which are corresponding to the capacity of 600,000 TEUs, are shown in Tables 3.6.6 and 3.6.7. This workforce plan was derived by estimating the required number of personnel for each job based on the Phase I Original Plan which is corresponding to the capacity of 200,000 TEUs.

For reference, similar estimation was carried out in the case of the capacity of 400,000 TEUs (See Tables 3.6.6 and 3.6.7), which will be the same scale of workforce as the Phase III Project.

Table 3.6.6 Operational and Facility Conditions for Workforce Estimation

	Phase-I Original Plan	[Reference*1]	Phase-II Plan
Capacity	200,000TEU	400,000TEU	600,000TEU
Number of Vessels at Berth	1 Vessel	2 Vessel	3 Vessel
Nontainer Yard	Plot 25	Plot 25+26 (Plot 22 + 23)	Plot 24+25+26
Number Main Equipment			
QGC	2	4	6
RTG	6	12	18
Tractor Head	12	24	36

Source: Study Team

In order to prepare the Phase II workforce plan, the jobs are categorized into four (4) groups as follows;

[Category A]

Types of jobs in this category include “QGC operators, RTG operators, tractor-chassis drivers and other cargo handling equipment operators”. The number of workers for this job depends directly on the quantity of equipment and cargoes to be handled at the terminal. The size of the workforce of this category accounts for about 45% of the total workforce. Compared with Phase I (200,000TEUs), the size of the workforce of Phase II (600,000TEUs) for this category is three (3) times larger.

[Category B]

Types of jobs in this category include “warehouse (CFS) worker, gate clerks & checkers”. The number of workers for this job depends on the quantity of facilities. For example, CFS of the Phase II consists of two (2) buildings, whereas there was only one (1) building in Phase I. Number of gate lanes of Phase II is fourteen (14) lanes, whereas there were nine (9) lanes in Phase I. The size of the workforce of this category accounts for about 20%-25% of the total. Compared to Phase I, the size of the workforce of Phase II for this category is two (2) times larger.

[Category C]

Types of jobs include “maintenance staff and documentation staff”. The number of workers for this job does not directly depend on the quantity of equipment and cargo volume. However, the size of the workforce somewhat (indirectly) depends on the quantity of equipment and cargo volume. The size of the workforce of this category accounts for about 20% of the total workforce. The size of the workforce of Phase II for this category is estimated two (2) times larger than Phase I.

[Category D]

Types of jobs include “Management, administration staff and managers of other departments”. The number of people for these positions does not depend on the cargo volume or the quantity of equipment / facilities, but on the terminal and company management policy. The size of the workforce of this category accounts for about 10%-15% of the total workforce. The size of the workforce of Phase-II for this category is estimated one and half (1.5) times larger than Phase I

Based on the above, recommendable Workforce Plan for Phase II Project is shown in Table 3.6.7. Total size of the workforce is estimated at 380 persons. Considering that Japanese container terminals employ about 250 to 350 workers to handle 600,000 TEU to 800,000 TEUs per year, the workforce plan of the Thilawa ODA terminal seems appropriate.

For reference, recommendable Workforce Plan for Phase III Project, which assumes container handling capacity at 400,000 TEUs is shown in Table 3.6.7. Total size of the workforce is estimated at about 280～290 persons.

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Table 3.6.7 Workforce Plan for Terminal Operation

Job Area & Positions		Working Room/ Anteroom	Phase-1 Plan Capacity: 200,000 TEU Original Plan (2014)	Phase-1 Plan Capacity: 200,000 TEU Operator's Idea (2018)	Phase-1 Plan Capacity: 200,000 TEU Remarks	[Reference] Capacity: 400,000 TEU Original Plan (2014)	[Reference] Capacity: 400,000 TEU Operator's Idea (2018)	[Reference] Capacity: 400,000 TEU	Phase-2 Plan Capacity: 600,000 TEU Tentative Plan (2018)	Phase-2 Plan Capacity: 600,000 TEU Operator's Idea (2018)	Phase-2 Plan Capacity: 600,000 TEU	Note
Management												
	President	Administration Building (3F)	1	1		2	1		1	1		Big Difference
	Vice President			1			1		1	1		
	General manager			1			1		1	1		
	Manager			1			1		1	1		
	Sub Total		**1**	**4**		**2**	4		**4**	**4**		
Administration Department												
	Marketing & Sales		2	2		2	2		2	2		—
	Accounting		4	4		4	5		5	6		* Workforce increases depend on Production Capacity.
	General Affairs		4	4	plus 14 (driver)	4	5	plus 24 (driver)	5	6	plus 34 (driver)	
	IT		2	3		2	3		3	3		—
	Sub Total		**12**	**13**	**(R.D.P.C:12)**	**12**	**15**		**15**	**17**		
Operation Department												
	Senior Manager	Administration Building (4F)	12	1		12	1		15	1		
	Container Operation Section											
	Manager			1			1			1		* Workforce increases depend on Production Capacity.
	Assistant Manager						1			1		
	Superintendent			6			8			10		
	Controller			6			7			8		
	Sub Total		**12**	**14**	**(R.D.P.C:12)**	**12**	**18**		**15**	**21**		
	Site Superintendent	Marine Lounge	2	3	1 vesselx1 person+1	2	3	2 vesselsx1 person	3	3	3 vesselsx1 person	* depends on vessel at berth
	QGC Operator		8	8	2 setsx2 persons x2s	16	16	4 setsx2 persons x2s	24	24	6 setsx2 persons x2s	* depends on equipment quantity
	RTG Operator		18	22	6 sets x2person x1.5s	36	44	12 sets x2person x1.5s	54	66	18 sets x2person x1.5s	
	Tractor Head Driver		18	22	12 setsx1 person x1.5s	36	44	24 setsx1 person x1.5s	54	66	36 setsx1 person x1.5s	
	MT Container Lifter		5	8	3setsx1 person x1.5s	10.5	16	7 setsx1 person x1.5s	13.5	24	9 setsx1 person x1.5s	
	Reach Stacker											
	Sub Total		**51**	**63**	**(R.D.P.C:60)**	**101**	**123**		**149**	**183**		
	Warehouse(CFS)・Bulk cargo/ Ro/Ro Operation Section											
	Assistant Manager	CFS	1			1			**1**			
	Reach Stacker Operator		5	3	3 setsx1 person x1.5s	6	3	4 sets x1 person x1.5s	6	3	4 sets x1 person x1.5s	* depends on equipment quantity
	Engine F/L(24T) Operator			1			2			2		
	Engine F/L(10-12T) Operator											
	Engine F/L (3-4T) Operator		19	8	19 setsx1 person x1s	24	16	24 set x 1 person x 1s	30	24	30 set x 1 person x 1s	* depends on equipment quantity
	CFS Battery Fork Lift Operator											
	CFS Battery Lifter Operator											
	Miscellaneous			2			4			6		
	Sub Total		**25**	**14**	**(R.D.P.C:30)**	**31**	**25**		**37**	**35**		
	Maintenance & Repair Section											
	M & R manager	Maintenance Shop	10	1		16	1		22	2		*Depend on cargo volume
	Assistant Manager			**2**			**2**			**2**		
	Mechanic			**8**			**12**			**16**		
	Electrician			**6**			**9**			**12**		
	Support personnel (Fuel Supply Car driver, etc.)			**8**			**12**			**16**		
	Sub Total		**10**	**25**	**(R.D.P.C:16)**	**16**	**36**		**22**	**48**		
	Sub Total of Operation Department		**98**	**116**		**160**	**202**		**223**	**287**		

Job Area & Positions			Working Room/ Anteroom	Phase-1 Plan Capacity: 200,000 TEU			[Reference] Capacity: 400,000 TEU			Phase-2 Plan Capacity: 600,000 TEU			Note
				Original Plan (2014)	Operator's Idea (2018)	Remarks	Original Plan (2014)	Operator's Idea (2018)		Tentative Plan (2018)	Operator's Idea (2018)		
Car Drivers					**14**		**24**	**24**		**34**	**34**		
Documentation Department													
	Manager			**1**	1		1	1		1	1		
	Container	CY Import		5	5		5	7		7	9		
		CY Export	**Administration Center (2F)**	3	3		5	5		7	7		* Depends on cargo volume
		Vanpool(Empty Container)		3	3		4	4		5	5		
		CY Document Sub Total		**12**	**12**	**(R.D.P.C:15)**	**15**	**17**		**20**	**22**		
		Gate Booth Clerk		10	16	1 person x 8 lanes x 1s	12	30	1 persons 12 lanes 1s	16	40	1 persons 15 lanes x 1s	* Depends on cargo volume
		Gate Checker	**Administration Center (1F)**	10	16	+ 2 (2nd gate)	16	30		20	40		
		Gate Booth Sub Total		**20**	**32**	**(R.D.P.C:20)**	**28**	**60**		**36**	**80**		
	Warehouse, Bulk Cargo, Ro/Ro	CFS Document Manager, Import		4	6		8	8		8	10		* Depends on number of warehouse
		FS Export		4	3		8	5		8	7		
		CFS Checker	**Administration Center (2F)**	8	10		16	20		16	30		
		CFS Sub Total		**16**	**19**	**(R.D.P.C:16)**	**32**	**33**		**32**	**47**		
	Ship Side Tally Clerk		-	**6**	**5**	1 person x 4gangx1.5s	**12**	**10**	1 person x 8 gangx1.5s	**18**	**15**	1 person x 12gangx1.5s	* depends on vessels at berth simultaneously
	Sub Total of Documentation Department			**54**	**68**		**87**	**120**		**106**	**164**		
Terminal Total				**165**	**215**		**285**	**365**		**382**	**506**		

Shipping Line/ Agents	Shipping Line/ Agents	**管理棟(2F)**	**16**		**(R.D.P.C : 16)**	**16**		2persons x8 Firms	**16**		2persons x8 Firms	Same as Phase-1
Customs Office	Customs Officer	**管理棟**	**30**		**(R.D.P.C:30)**	**30**			**40**			Same as Phase-1
(Administration Center +CFS)												
	Customs Inspector	**CFS**			**(R.D.P.C:15)**			(No.1+No2CFS)			(No.1+No2CFS)	

Source: Study Team

3.6.6 Cargo Handling Equipment Plan

(1) Phase II Project

Required quantity of cargo handling equipment for the Phase II Project is shown in Table 3.6.8. Quantity of equipment to be procured in the Phase II Project is the balance between total required quantity covering Plot 24/25/26 and total quantity of Phase I. The equipment of the initial plan in Phase I has already been procured in the Phase I Project. The additional equipment in Phase I came at the request of the Operator and will be procured in the Phase I budget. Hereinafter, total required quantity of equipment to cover whole operation of Plot 24/25/26 is addressed in this section.

[Main Equipment for Container Handling Operation]

To achieve the capacity of 600,000 TEUs per annum, six (6) QGCs are required. Three (3) RTGs are to be assigned for one QGC, two (2) RTGs for quayside operation and one (1) RTG for landside operation. Six (6) trailer-chassis are to be assigned for one QGC. Five (5) of them are to be assigned for loading / unloading operation while the remaining one (1) set is used for container transportation services in the yard, as well as between the yard and CFS or customs inspection. This one set of tractor-chassis is recommended to be procured by the private operator.

[Yard Equipment for Container/ Break Bulk/ General Cargo Handling]

Other than RTGs, three (3) Reach Stackers and six (6) empty container (MT container) lifters are deployed in the Yard. Reach Stackers, which offer very flexible use, are to be assigned for full container handling in the yard, special cargo (dangerous cargo) handling at the SCA area and de-stuffing of full containers in the yard, etc. MT container lifters are mainly assigned for MT container yard operation for mounting/demounting on seaside chassis for loading/ unloading operation, for lifting/un-lifting services to the city trailer-chassis. The minimum numbers of MT container lifters (3 sets) are covered by the ODA loan, whereas the remaining three (3) sets are recommended to be procured by the private Operator when the cargo volume increases to a certain level.

One (1) Fork Lift (with 24 Ton capacity for heavy weight cargoes), two (2) Fork Lifts (10-12 Ton capacity for middle weight cargoes) are assigned for Break Bulk and General cargo operation in the yard. Four (4) Fork Lifts (3 Ton capacity for light weight cargoes) are assigned for miscellaneous general cargo handling and miscellaneous work in the maintenance shop, etc.

[Battery driven Fork Lift & Cargo Lifter for CFS Cargo Handling Work]

Six (6) Fork Lifts and six (6) Cargo Lifters (both battery driven with three (3) Ton capacity) are to be deployed for each CFS to participate in the CFS cargo handling operation, i.e. cargo lifting/ withdrawing to/ from the rack in the CFS, truck mounting/ de-mounting at the platform of CFS, etc. The minimum numbers of Fork Lifts (3 sets) and Cargo Lifters (3 sets) are covered by the ODA loan whereas the remaining three (3+3) sets are recommended to be procured by the private operator when required.

[Miscellaneous Equipment]

Required quantity of miscellaneous equipment such as Fuel Supplying Vehicle which supplies fuel for the RTG diesel engine, Reach Stacker/ MT Handler diesel engine, Fork Lifts. Commuting Buses and other vehicles for terminal workers' use are estimated based on "the Preparatory Survey on Yangon Port in Thilawa Area and Logistics Depot Development in the Republic of the Union of Myanmar (PPP Study Report conducted by JICA, January 2015). These miscellaneous vehicles are recommended to be procured by the private operator as required.

Table 3.6.8 Required Quantity of Cargo handling Equipment in Phase-2 Project

	Type of Equipment	Capacity	Phase-1 Project (ODA Loan)							Phase-1 (PPP Study Report)			Phase-2 Project (ODA Loan & Private Investment)					
			Quantity in Initial Plan (a)*1			Additional Quantity (b)*2			Total Quantity (d)	Required Quantity *3			Total Required Quantity Covering Plot 24/25/26 (c)			Investment Quantity in Phase-2 (c-d)		
			ODA Loan	Private Invest.	Total	ODA Loan	Private Invest.	Total		ODA Loan	Private Invest.	Total	ODA Loan	Private Invest.	Total	ODA Loan	Private Invest.	Total
1	QGC	40.6T	2		2	1		1	3	2		2	6		6	3		3
2	RTG	40.6T	6		6	3		3	9	6		6	18		18	9		9
3	Reach Stacker	40.6T	3		3				3	3		3	3		3			
4	MT Container Lifter	10T 5-Tear									1	1	3	3	6	3	3	6
5	Tractor Head	207x2, 40'x1	6		6	5		5	11	6	8	14	30	6	36	19	6	25
6	Trailer Chassis		6		6	5		5	11	6	16	22	30	6	36	19	6	25
7	Engine Fork Lift	24T									1	1	1		1	1		1
8	Engine Fork Lift	10T-12T									1	1	1	1	2	1	1	2
9	Engine Fork Lift	3T-4T	2		2				2	2		2	4		4	2		2
10	CFS Battery Fork Lift	3T									6	6	6	6	12	6	6	12
11	CFS Battery Lifter	3T									6	6	6	6	12	6	6	12
12	Fuel Supplying Vehicle										1	1		1	1		1	1
13	Pick-up Car										2	2		2	2		2	2
14	Company Vehicle										4	4		4	4		4	4
15	Commuting Bus	(29-Passanger)									6	6		6	6		6	6

Note: *1 Quantity in Initial Plan : Actually Procured in Phase-1 Project

*2 Additional Quantity: Additionally planned equipment upon the Operator's request, and will be procured as a part of Phase-1 Project

*3 Required quantity which was reported in JICA PPP Study. This Study was participated by the Operator.

Source: Study Team

(2) Phase III Project

Cargo handling deployment plan for the Phase III Project (Plot 22/23 with container handling capacity of 400 thousand TEUs) which is formulated through the same procedures as the Phase II Project described above is outlined in Table 3.6.9. In light of the nature this survey is "The Data collection Survey for the Development of Yangon Port", the required number of cargo handling machines is tentatively set at this stage. In addition, the required equipment is planned to be procured through an ODA loan.

Table 3.6.9 Required Quantity of Cargo Handling Equipment (Plot 22 - 23)

No.	Name of Equipment	Capacity	Phase-3 (ODA Loan)	
			Quantity (*Note)	Note
1	QGC	40.6Ton	**4**	Plot22-23 (2 berths) is to be operated with four (4) QGCs.
2	RTG	40.6Ton	**12**	Three (3) RTGs are equipped per one QGC
3	Reach Stacker	40.6Ton	**2**	Two (2) reach stackers are equipped for full container handling other than RTG area.
4	MT Container Lifter	10Ton	**4**	Four (4) MT container lifter are equipped for empty container yard operation.
5	Tractor Head	20'x2, 40'x1	**24**	Six (6) Tractor-Chassis are equipped per one QGC (5 sets for seaside operation, 1 set for container moving services between yard and CFS.
6	Trailer Chassis		**24**	
7	Engine Fork Lift	24Ton	**1**	For general cargo handling, break bulk cargo handling and miscellaneous work, one (1) 24 Ton fork lift, one (1) 10-12 Ton fork lifts, and two (4) 3-4 Ton fork lifts are to be deployed in the yard and maintenance shop.
8	Engine Fork Lift	10-12Ton	**1**	
9	Engine Fork Lift	3-4Ton	**2**	
10	CFS Battery Fork Lift	3Ton	**6**	Six (6) battery driven handy fork lifts (3 ton) and six (6) pallet lifters (3 Ton) are to be assigned for CFS operation and customs inspection support.
11	CFS Battery Lifter	3Ton	**6**	
Note: * Quantity of equipment to be invested by ODA Loan is the minimum quantity which is limited to essential ones for basic terminal operation.				

Source: Study Team

4 Management and Operation of Port

4.1 Present Situation of Port Management in Myanmar

4.1.1 Organization, Function and Responsibility of MPA

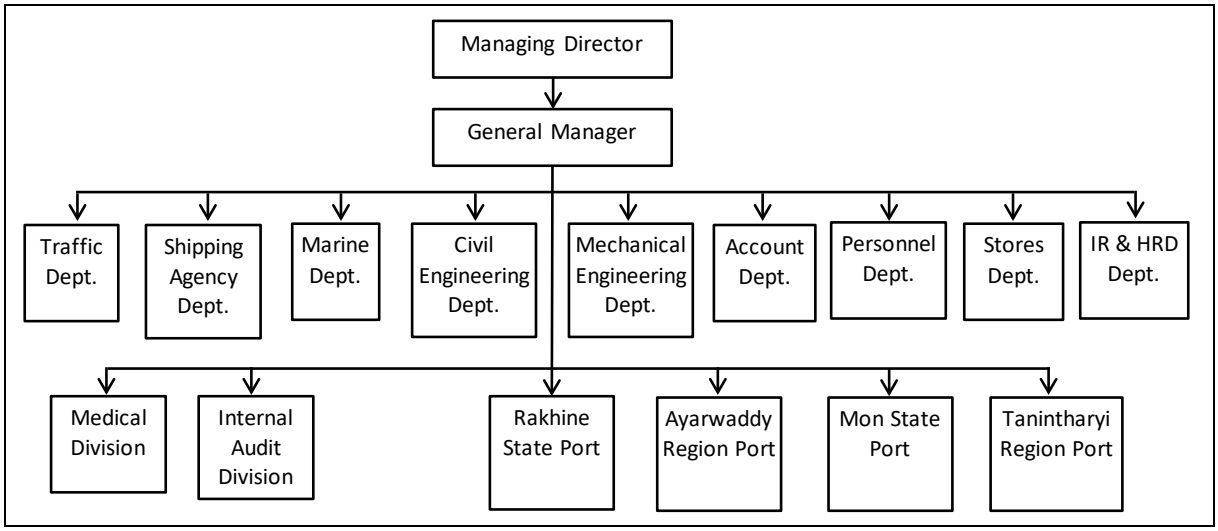
(1) Organization

MPA is a state-owned company responsible for the administration and management of all coastal ports in Myanmar as well as providing cargo handling and ship berthing services for calling ships. In particular, MPA provides stevedoring, storage and delivery services for consignees and shippers, and pilotage, tug boat, mooring/unmooring, water/fuel supply, ship communication and other services for calling ships. MPA also serves for the development and maintenance of port facilities, channel and basin, navigation aids, cargo handling equipment and service boats.

MPA consists of nine departments, two divisions, and four regional offices as shown in Figure 4.1.1. The full quota of MPA is 11,577 including officers and staff. Present number of officers and staff is 2,852 as of March 2018, which is only 25% of the full quota. The full quota of each department and division is shown in Table 4.1.1 as well as the present number of officers and staff as of 2016, 2017 and 2018. As the number of officers and staff was 3,400 as of July 2012, it has decreased to 2,852 recently due to the transfer of operation services to private companies. The staff size will continue to decrease as MPA is shifting to a landlord port authority.

Considerable manpower has been allocated to the Traffic Department, Marine Dpt., Civil Engineering Dpt., and Mechanical Engineering Dpt., however, there have been significant decreases in the staff sizes of these four departments. Ratios of present number of staff among the quotas of each department are 22% in the Traffic Dpt., 14% in the Civil Engineering Dpt., 19% in the Mechanical Engineering Dpt., 44% in the Marine Dpt. and 53% in the Shipping Agency Dpt. Main reason for the decrease in staff size is the shift of operations from MPA to private operators. In addition, declining staff numbers of the Marine Dpt. and Shipping Agency Dpt. may be due to the rationalization of marine services and less need for agency business of MPA.

As of March 2018, MPA has 216 officers and 2,636 staff members, a total of 2,852 members, which are 71%、23%、25% of its strength respectively. Number of officers and staff members of each department is summarized in Table 4.1.1.



Source：MPA

Figure 4.1.1 Organization of MPA

Table 4.1.1 Full Quota and Present Number of Officers and Staff

Department/Division/Local Offices	Strength			3/2016	3/2017	3/2018	3/2018
	Officer	Staff	Total	Total	Total	Total	Fill Rate
Managing Director	1		1	1	1	1	100%
General Manager	1		1	1	1	1	100%
Traffic Dpt.	27	4,410	4,437	1,142	1,011	966	22%
Shipping Agency Dpt.	15	215	230	120	121	123	53%
Marine Dpt.	100	1,036	1,136	537	516	505	44%
Civil Engineering Dpt.	51	1,881	1,932	336	297	275	14%
Mechanical Engineering Dpt.	33	1,709	1,742	356	322	329	19%
Account Dpt.	17	172	189	90	92	96	51%
Personnel Dpt.	13	583	596	186	157	157	26%
Stores Dpt.	5	195	200	55	54	47	24%
International Relations and Human Resources Development Dpt.	10	45	55	22	38	34	62%
Medical Division	4	23	27	19	17	14	52%
Internal Audit Division	4	51	55	35	32	31	56%
Rakhine State Port	3	320	323	115	114	110	34%
Ayarwaddy Region Port	9	245	254	63	55	58	23%
Mon State Port	10	250	260	59	57	57	22%
Tanintharyi Region Port	1	138	139	47	40	48	35%
Total	304	11,273	11,577	3,184	2,930	2,852	25%

Source: MPA

(2) Role, Function and Responsibility of MPA

The Yangon Port Act was promulgated in 1879 after which the Commissioner of the Port of Yangon began to develop the port. The new Yangon Port Act (No. 4/1905) was promulgated in 1905, which empowered the commissioner's function and encouraged the development of the Yangon Port. In addition, Port Act (No.

15/1908, India Act XV) was established in 1908 to clarify rules and regulations on ship navigation, port tariff, and other necessary procedures for port users. After World War II, the port was reconstructed and managed by the Board of Management for the Port of Yangon. The Board was reorganized as the Burma Port Corporation in March 1972, and the Myanmar Port Authority (MPA) was established in 1989.

In April 2015, new Myanmar Port Authority Act (No. 21/2015) was promulgated and the Yangon Port Act of 1905 and the Out-ports Act (No. 2/1914) were repealed. Although the new Myanmar Port Authority Act of 2015 was established as the basic law on ports including a clause on port tariff, which was previously regulated by the Port Act of 1908, the Act is not fully implemented due to lack of related orders and regulations. Therefore, the board of MPA is not yet organized and the chairman of the Board is not yet nominated.

1) Roles and Responsibilities of MPA

Chapter VII of the Myanmar Port Authority Act stipulates “Functions, Duties and Powers of the Myanma Port Authority”, which can be summarized as follows:

a) To implement port development projects with the approval of the Ministry;
b) To adopt the work programs and implement them for the development of port industry and facilitation of port services;
c) To increase its income, lower the production cost and service cost, and increase cargo handling productivity;
d) To prevent, maintain and protect so as to prevent the waste, loss and destruction of the State own property and funds;
e) To manage the fund relating to the MPA to be established under the MPA Act;
f) To manage the provision of fuels and other requirements for the vessels within the port limit and to issue a business license to such businesses;
g) To issue a business license to the tow vessels, tug vessels, dredging vessels and salvage vessels;
h) To exercise other powers conferred by the Ministry for the facilitation of port functions and operations within the port;
i) To disseminate navigational information within the port limit for public awareness;
j) To prepare and carry out a program for upgrading the capacity of the port staff and to ensure the safety of the port workers;
k) To carry out research and cooperate with other technical institutions for the technical improvement of port services;
l) To investigate ships in the event of dangerous incidents or when their movements lead to destruction or loss within the port limit;
m) To claim damages when water pollution or other negative impacts on the natural environment occurs and to detain the relevant vessels;
n) To direct a vessel which is required to leave from the port within the stipulated time, by giving instructions to the master or owner of the relevant vessel;

o) To take necessary measures for the safety of maritime transport within the port limit in accordance with the conventions relating to the safety of life at sea;
p) To take necessary measures to protect and conserve the port environment from water pollution, waste disposal in the port limit, oil pollution, air pollution, discharge and emission of dangerous materials, toxic materials, and other discharges from ships;
q) To take responsibility for maintaining consigned goods as much as possible, but is not responsible for the loss, destruction, deterioration or deficit of such consigned goods;
r) To be exempted from the responsibility relating to the loss, destruction, deterioration, deficit of goods, wrong delivery of goods or damage of the goods, in case of the occurrence of natural disaster, war, riot, demonstration or block or any other situation which cannot be predicted;
s) To lease port facilities and allow port related business to conduct operations;
t) To conduct port related business after concluding a specific joint venture agreement with the local or foreign investors;
u) To establish a joint venture company for port related business;
v) To manage and maintain the navigational aids, supporting materials and equipment for the incoming and outgoing vessels;
w) To arrange and keep the places for the discharge of duty by custom officers, Immigration officers and quarantine officers.

2) Procedures for Port Development

The Myanmar Investment Commission (MIC), established under Myanmar Investment Law (No.40/2016) 1, is responsible for the approval on private investment in Thilawa area including port development. The MIC consists of 13 members from the following ministries and academia.

-Ministry of the Office of the Union Government,
-Ministry of Commerce (2),
-Union Attorney General Office,
-Ministry of Planning and Finance,
-Yangon Regional Government,
-Ministry of Natural Resources and Environmental Conservation,
-Ministry of Electricity and Energy,
-Directorate of Investment and Company Administration (3),
-Republic of the Union of Myanmar Federation of Chambers of Commerce and Industry,
-Economist

As no member of the Ministry of Transport and Communications is included in the MIC, so that comments from the viewpoint of port planning may be made after the approval of location, which may result in a mix of container terminals, oil terminals and bulk cargo terminals in Thilawa area. The management of ship entry and berth assignment as well as pilotage and tug boat service is done by MPa in THE Thilawa port

[1] Myanmar Investment Law (No.40/2016) ,18th October 2016

area.

4.1.2 Terminal Operators in Main Port and Thilawa Area in Yangon

Six terminals in the inner harbour of Yangon Port are operated by private terminal operators as shown in Table 4.1.2. Some of them have been developed by private investment, some have been transferred from MPA to private companies, while some are being operated in a JV between a private company and MPA. Only berths nos. 5 to 7 of Sule Terminal remain as a general cargo terminal directly operated by MPA.

Among the 37 plots in the Thilawa area of Yangon Port, Plots nos. 22-26 are allotted to MPA and the others are for private investors. Plots no. 25-26 are now being developed by MPA, and Plots nos.22-24 will be developed by MPA. Some plots have already been developed by private investors and other plots are allocated to private companies for their development as shown in Table 4.1.3. As of now, 13 plots are already in operation and 24 plots are under construction or under planning for development by concessionaires.

Table 4.1.2 Terminal Operators of Yangon Main Port

Terminals	Operators	Cargo	Established, Term of Operations
Asia World Port Terminal (AWPT) 614m	AWPT (Asia World Co. Group)	Container/ General	No.1 in 1998, BOT 25 y, 5 y. x3 No.2 in 1996, BOT 25 y No.3 in 2001, BOT 30y, 5y. x3 No.4 in 2006, BOT 30 y, 5y x3
Hteedan Port Terminal (HPT) 440m	AWPT (Asia World Company Group)	Container/ General	in 2010, BOT 30 y.
Myanmar Industrial Port (MIP) 700m	MIP (Myanmar Annawa Swan er Shin Groups Co, Ltd.*)	Container/ General	No.1 in 2003, BOT 25 y No.2 in 2012, BOT 30 y, 15y x2 No.3 Planned
Ahlone International Port Terminal (AIPT), 600m	AIPT (Myanmar Economic Corporation)	Container/ General	in 2015, BOT
Bo Aung Gyaw Terminal (TMT Terminal) 457m	TMT (The Myanmar Terminal Ltd., KT Group)	Container/ General	in 2010, ownership transferred from MPA, no limited term, KT Group took over in 2016
Sule Pagoda Wharf (SPW) No.1-No.4, 548m	Myanmar Sule Terminal Ltd. (MPA 40%, MIP 60%)	Container/ General	Operation by a JV of MPA and MIP since 2016
Sule Pagoda Wharf (SPW) No.5-No.7, 478m	MPA	General	planned

Note: * Funded by the Myanmar Economic Corporation
Source: Study Team based on websites of terminal operators

Table 4.1.3 Terminal Operators of Thilawa Area

Plot	Operators	Cargo	Status
1	Myat Myttar Mon Service Com. Ltd (Local) Apex Gas & Oil Public Co., Ltd Shwe Taung Development Co., Ltd (Local)	Liquid Bulk	Operation
2 (1/3)			
2 (2/3)		General/Bulk	
3	PUMA Energy Group Pte. Ltd.	Liquid Bulk	Operation
4	Myanmar Integrated Port Limited Terminal (MIPL) Affiliated to Austin Navigation Asia Pte. Ltd	General/Bulk	Operation since 1998 25 year BOT
5	Myanmar International Terminals, Thilawa（MITT） Affiliated to Hutchison Port Holdings	Container General/Bulk	Operation since 1998, 25 year BOT, possible 15 year extension
6			
7			
8			
9			
10	MPA-Continental Port Ltd. (MIP will succeed these plots)	Container General/Bulk	Contracted
11			
12	Myanmar Economic Holdings Ltd	Container General/Bulk	Under Construction
13			
Space			
14		Liquid Bulk	Contracted
15	Elite Petrochemical Co., Ltd (Htoo+Ayeyar Shwewah) and Max Myanmar Service Co., Ltd	Liquid Bulk	Operation
16			
17	Green Asia Services Co., Ltd Denko Petrochemical Co., Ltd Thuriya Energy Depot Management Co., Ltd	Liquid Bulk	Operation
18			
19	New Day Energy Services Co., Ltd	Liquid Bulk	Contracted
20	Wilma Myanmar Port Terminals (Thilawa) Co., Ltd	Grain	Operation from 2018
21			
22	MPA	Container General/Bulk	None
23			
24	MPA (ODA), Thilawa Multi-Purpose International Terminal (TMIT)	Container General/Bulk	Operation from 2019
25			
26			
27	Myanmar Edible Oil Industrial Public Co., Ltd	Edible Oil	Contracted
28	Myanmar Agribusiness Public Corporation Ltd	Grain	Contracted
29	Myanmar Agriculture & General Development Public Co., Ltd	Grain	Contracted
30	Diamond Star Co., Ltd	Grain	Under Construction
31(2/3)			
31(1/3)	IGE Services Co., Ltd Kaung Myanmar Aung Shipping Co., Ltd	Liquid Bulk	Contracted
32			
33	Padauk Shwe Wah Petrochemical Co., Ltd	Liquid Bulk	Partly Operation
34	Myanmar Economic Corporation	Ship Breaking	Contracted
35			
36			
37			

Source: MPA

4.1.3 Lessons Learnt from New Port Development and Challenges

When a new port is developed far from an old port, as in the case of Thilawa area, shippers and consignees may not be willing to move from the old port to the new port. Development of port facilities alone is not enough to attract shippers and consignees. Users demand an access road and railway connection as well as

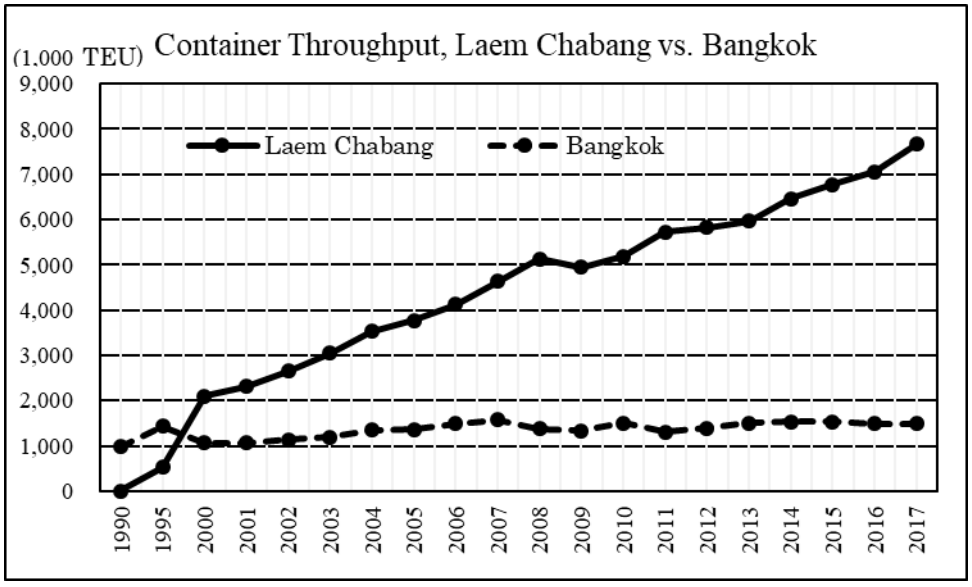
offices for shipping agents, forwarders, customs brokers, and shipping companies. Moreover, government services such as customs, immigration, quarantine and animal/plant inspections are also required. Incentives and regulations for the use of new/old port are also important to encourage the use of the new port such as tariff reduction at the new port and setting limits on cargo handling at the old port to prevent traffic congestion.

Following the development of the first two terminals in Thilawa area in 1998, i.e. MITT and MIPL, 10 terminals are now in operation in 13 plots as of the end of 2017. The first stage of the Thilawa SEZ was also completed and factories and warehouses as well as offices of customs, shipping agents, customs brokers and forwarders have already been set up in the area. In this connection, difficulties commonly associated with utilization of a new port have been considerably reduced in the Thilawa area, however, road/railway connection has not yet been developed which is the biggest bottleneck of port development in the Thilawa area.

As JICA pointed out in their report entitled “Lessons Learnt from the Development of New Port (JICA Annual Project Review 2016)” and at their seminar on “Lessons Learnt from New Port Development (May 2017)”, there are both successful cases and unsuccessful cases of new port development. JICA conducted a study on the cases of Subic Bay Port and Batangas Port in the Philippines, Laem Chabang Port in Thailand and Cai Mep Thi Vai Port in Vietnam. The report concluded the development of an access road, navigational channel maintenance, and arrangement of soft infrastructure for port operations were vital to success. Delay in the development of an access road results in an overload at the old port. In this regard, government policy on the use of the old port plays is important to achieve a proper demarcation between the old and new ports.

The development of Laem Chabang Port in Thailand is a good example of a successful new port development. In 1990, almost all containers of Thailand, one million TEUs, were handled at Bangkok Port. When the new Laem Chabang Port opened in 1991, the Government introduced a policy to cap the container handling at Bangkok Port at one million TEUs. Though the new port could not attract much cargo for several years after its opening, container throughput gradually increased due to the development of new highways and railways. Container throughput of Laem Chabang reached 3 million TEU in 2003, 5 million in 2008, 7.67 million in 2017 as shown in Figure 4.1.2. Container throughput at Bangkok Port increased to 1.5 million TEU, which exceeded the proposed ceiling but the government’s policy was effective for proper demarcation of the new and old ports.

For the operation of new Laem Chabang Port, Thai Port Authority gave a concession simultaneously to four operators for operating their four terminals. Consequently, the Laem Chabang Port gained a reputation as a very competitive port with efficient services.



Source: Study Team

Figure 4.1.2 Demarcation between New and Old Ports

Taking into consideration the abovementioned lessons, following measures will be effective for successful development of container and multi-purpose terminals in Thilawa area.

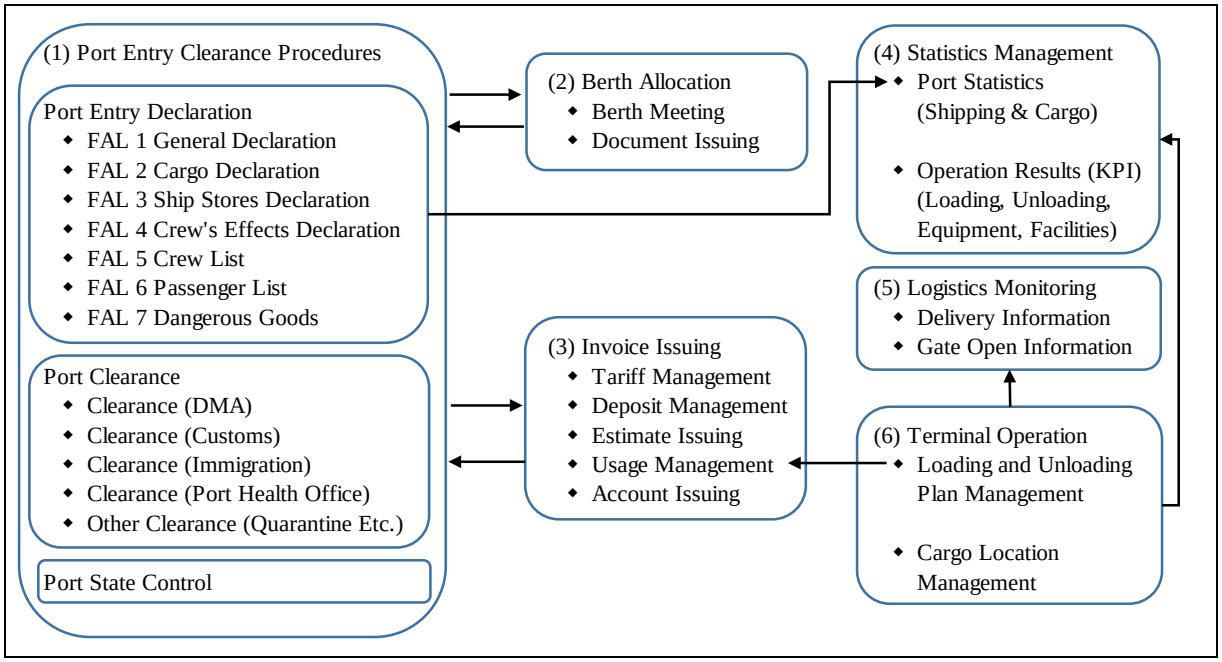
- To urgently develop a highway between Thilawa area and outskirts of Yangon City;
- To extend the railway in Thilawa area to Plot 26 or nearby;
- To encourage barge transportation from Thilawa to the upstream, and develop jetties for barge transportation;
- To set a limit of cargo handling in the inner harbour up to a certain level in view of traffic congestion and redevelopment of water front in Yangon City;
- To allow private operators to decide cargo handling charges by negotiation with shipping companies and consignees/shippers within the ceiling of MPA's tariff;
- To encourage operators to increase their productivity, variable concession fee shall be calculated based on the volume of cargo, not based on the possible revenue, and the rate of variable fee shall be reduced if cargo handling exceeds a certain level;
- To encourage the development of ICD between Thilawa and the outskirt of Yangon City.

4.1.4 Port EDI and MACCA

The Project for National Single Window and Customs Modernization by Introducing Automated Cargo Clearance System (MACCS) has been implemented by the technical cooperation and grant aid of Japan since 2014, and the system entered into operation in November 2016. The Project for Port EDI for Port Modernization has also been implemented since 2015 and the system was officially opened in May 2018. Port EDI (Electronic Data Interchange) is designed for port entry declaration, port clearance for departure, and other documentation related to cargo handling and storage in a port.

(1) Port EDI

Port EDI system comprises 6 modules, i.e. 1) Port entry and clearance procedures, 2) Berth allocation, 3) Invoice issuing, 4) Statistics management, 5) Logistics monitoring, and 6) Terminal operation as shown in Figure 4.1.3.



Source: MPA

Figure 4.1.3 Modules of Port EDI System

Cargo manifest, submitted to the customs, is transferred to the Port EDI through MACCS, and conveyed to the terminal operation module. The terminal operation module of Port EDI receives cargo information through MACCS and TOS of each terminal, and produces loading/unloading information, storage information, delivery information and other information necessary for port users.

1) Port Entry and Clearance Module

The following seven documents necessary for port entry declaration, which are designed in accordance with the standard forms stipulated in the Convention on Facilitation for International Maritime Traffic. Harbour master of MPA will approve the entry of a ship with concurrence of related ministries and agencies.

- Form FAL 1 General Declaration
- Form FAL 2 Cargo Declaration
- Form FAL 3 Ship’s Stores Declaration
- Form FAL 4 Crew's Effects Declaration
- Form FAL 5 Crew List
- Form FAL 6 Passenger List
- Form FAL 7 Dangerous Goods

2) Berth Allocation Module

Receiving and summarizing information listed hereunder, this module provide necessary data for the berth meeting of MPA. Harbour master informs ships of time of berthing, location of berth or anchorage and other requirements based on this module.

- Location of ships in the port limit and ship details moored at each berth;
- Ship details anchored in port waters;
- Information on ship call declaration (General, Container, Tanker or Other)
- Tidal information

3) Invoice Issuing Module

Based on cargo manifest and ship entry declaration, Shipping Agency Dpt., Marine Dpt., and Traffic Dpt. estimate charges and fees of ship entry, pilotage, tug services and cargo handling at terminals. After completing cargo handling at terminals, charges and fees are adjusted by this module and invoices are issued to shipping companies, consignees, and shipping agents in following forms.

- Combined Bill (including Abstract Statement of Port Dues and Other Charges, and Night Fee)
- Disbursement Account (each time of call)
- General Account (monthly)

4) Statistics Module

Statistics of ship calls, type and volume of cargo loaded and discharged, productivity of cranes and other data can be generated by this module every day, month, year or other necessary term. It enables prompt monitoring of port performance by KPI such as gross/net productivity of container handling, berth occupancy, cargo dwelling time and the like, which are important information for MPA to decide a policy for efficient and timely port operation. Each terminal is required to input cargo loading and discharging daily plan before 9 am every day, and also input cargo delivery plan and transportation plan before 4 pm every day. Port EDI system provides the following information which port users can access from the web.

- General information on calling ships (including pilotage)
- General information on cargo handling (including equipment, pilotage and others);
- Information of accounting record (Access to these information is limited);
- Port performance indicators based on daily operation;
- Import and export commodity (group wise, region wise, terminal/berth wise, and others)

5) Logistics Monitoring Module

Shippers, consignees and truck operators are able to know the location and status of their cargo through this module, into which each terminal inputs the most recent status of cargo and the plan of cargo handling in a timely manner. By inputting container numbers or BL numbers in the Port EDI system, users can easily monitor the following information.

・Possible time of cargo pick-up at CY and gate open time;
・Status of cargo through TOS of each terminal.

6) Terminal Operation Module (Sule Terminal)

Berths nos.5-7 of Sule Wharf and the yard behind are only one terminal directly operated by MPA, so that TOS of this terminal is directly linked to the Port EDI system. This module is designed to provide following information.

・Information of export and import cargo;
・Navigational information and ship details of calling vessel:
・Container information (Status, location, cargo, origin/destination, time of entry and delivery, others)
・Billing information
・Yard Planning
・Yard Operation
・Gate Operation
・Vessel Planning

(2) MACCS

Myanmar's new system for customs clearance entitled "Myanmar Automated Cargo Clearance System (MACCS)" was inaugurated in November 2016. MACCS was developed with the technical and financial assistance of Japan based on Nippon Automated Cargo and Port Consolidated System (NACCS) and "Customs Intelligence Database System (CIS)" of Japanese Customs.

MACCS has been introduced in the customs offices of Yangon International Airport, Yangon Port Inner Harbour and Thilawa Area, and Thilawa SEZ and will be expanded to customs offices in Myawaddy, Tachileik (border with Thai), and Muse (border with China).

At the time of inauguration, 243 customs brokers, 680 customs specialists, and 947 importers/exporters are registered on MACCS. In order to access MACCS, users are required to install the software, obtain ID and password, and input necessary information on the system. Registered users are able to make customs declaration on the web and monitor the status of their cargo at any time.

Importers are requested to deposit a certain amount to pay import duties. In case of green lane, no inspection is required so that customs clearance will be made in a short time if import duties can be debited from the deposit account.

Before the inauguration of MACCS, customs duties are assessed by customs officer based on standard price of each commodity. However, the method for levying customs duties has changed from the standard price to actual price based on CIF, which shall be declared by importers. The new method is the standard adopted under a WTO agreement on the assessment of customs duties. However, it may take some years to change the method completely, so that both of the old and new methods may be applied for the time being.

Following this change, importers are requested to keep customs declaration documents for 7 years for the post-inspection. Customs office has warried about under declaration by means of fake contracts or false declaration, so that the Ministry of Commerce issued an instruction on the inspection of prices of imported goods and goods for export in June 2017 (Instruction No.38/2017). Smooth transition is fully expected by importers and exporters.

4.1.5 Port Tariff and Fee Collection

Competitive port services play a key role in promoting maritime transportation and trade of Myanmar as well as competitive shipping services to/from Myanmar. However, port service charges are controlled by official port tariff and port operators cannot collect fees and charges (except in the case of foreign operators).

MPA has the power to decide the port tariff with approval of relevant ministries and collect fees and charges from shipping companies including cargo handling charges. Cargo handling charges are paid to private terminal operators after deducting concession fees. Foreign terminal operators in Thilawa area are allowed to collect fees and charges directly from shipping companies based on the official tariff.

(1) Tariff Comparison with Ports in the Region

Port charges and fees are estimated at Yangon Port, Chittagong Port, Sihanoukville Port, Bangkok Port and VICT in Ho Chi Minh Port when a typical size of vessel enters the port and discharges a certain number of containers as shown in Table 4.1.4, Table 4.1.5 and Table 4.1.6.

Preconditions for Comparison

- Container vessel of 26,000 GT (30,000 DWT) with a loading capacity of 2,300 TEUs,
- Import Laden 995 TEU, Empty 15 TEU,
- Export Laden 492 TEU, Empty 498 TEU
- Ship’s LOA=190 m,
- Berthing Hours = 2 days, and
- Average container dwell time = 5 days

Table 4.1.4 Comparison of Port Dues

Port Dues (Shipping Co./Agent)	**Tariff (Yangon)**	**Yangon**	**Chittagong**	**Sihanoukville**	**Bangkok**	**VICT (Vietnam)**
		USD	USD	USD	USD	USD
Tonnage Dues	USD 25 /100GT	6,500	6,266	6,500	7,975	1,664
Channel Dues	-	-	-	9,620	-	5,200
Light Dues	USD 0.2 /GT	5,200	-	-	-	-
Pilotage (Basic)	USD 15 /500GT	780	1,859	1,950	1,233	3,900
Launch (Medium)	USD 155 /6 hours	310			380	
Draft Fee & Assistant HM Fee	460 for a 9.2m, 100 for AHM	560	-	-		-
Tug boat (Large Harbor Tug)	USD 2,000 /6 hours	4,000	1,580	2,285	1,276	2,800
Port Clearance	-	-	-	100	-	100
Berth Fees	455 /24h for 15,000GT over	910	3,120	5,980	3,445	3,869
Mooring & Unmooring	Ship mooring USD 110 Shore mooring USD 70	180	177	125	-	80
Hatch Opening Closing			-	360	-	168
Fresh Water	USD 3.0 /m3	150	75	75	38	125
Garbage Removal			-	30	5	15
Quay Cleaning Charge			-	-	16	-
Port Dues Sub-Total		18,590	13,077	27,025	14,369	17,921
VAT		0	1,962	27	1,006	0
Sub-Total with VAT		18,590	15,039	27,052	15,375	17,921

Source: Study Team

Table 4.1.5 Comparison of Cargo Handling, Lo/Lo and Storage Charges

Cargo Handling Charges	Myanmar (Yangon)		Chittagong		Sihanoukville		Bangkok		VICT (Vietnam)	
							Handling by Quay Crane		Handling by Quay Crane	
Container Handling Charges	FCL Contaners	USD		USD		USD		USD		USD
20' Laden	125/TEU	54,625	43.4 /unit	18,966	57 /unit	24,909	30.7 /unit	22,270	61.7 /20' Laden	26,963 *
20' Empty	110/TEU	31,790	22.1 /unit	6,387	30 /unit	8,670			40.23 /20' Empty	11,626 *
40' Laden	250/Box	131,250	65.1 /unit	34,178	86 /unit	45,150	52.1 /unit	33,218	92.09 /40' Laden	48,347 *
40' Empty	220/Box	24,640	33.2 /unit	3,718	43 /unit	4,816			59.61 /40' Empty	6,676 *
Others	-	-	-	-	5 /unit	8,519	-	-	Container Lashing & Unlashing 1 /unit	1,363 *
Gantry Crane Charges										
20' Laden	15/TEU	6,555	15.0 /unit	6,555	10 /unit	4,370	-	-		-
20' Empty	15/TEU	4,335	7.5 /unit	2,168	10 /unit	2,890	-	-	-	-
40' Laden	30/Box	15,750	22.5 /unit	13,125	20 /unit	10,500	-	-	-	-
40' Empty	30/Box	3,360	11.25 /unit	1,260	15 /unit	1,680	-	-	-	-
Wharfage										
20' Import Laden	-	-	4.92 /unit	1,795	-	-	11.3 /unit	4,143	-	-
40' Import Laden	-	-	9.84 /unit	3,099	-	-	10.4 /unit	10	-	-
20' Export Laden	-	-	2.22 /unit	160	-	-	19.3 /unit	6,087	-	-
40' Export Laden	-	-	4.44 /unit	932	-	-	17.8 /unit	125	-	-
20' Import Empty	-	-	1.23 /unit	1	-	-	11.3 /unit	817	-	-
40' Import Empty	-	-	2.46 /unit	17	-	-	10.4 /unit	3,004	-	-
20' Export Empty	-	-	1.23 /unit	354	-	-	19.3 /unit	4,058	-	-
40' Export Empty	-	-	2.46 /unit	258	-	-	17.8 /unit	1,868	-	-
Conservancy (Wharfage)	Khat 100/ton	800			1.0 /unit5)			-		
Lift On/Lift Off Charges										
20' Import Laden	included in Container Handling Charges	-	12.06 /unit	4,400	63 /unit	22,995	47.5 /unit	17,354	10.9 /20' Laden	4,763
40' Import Laden		-	18.08 /unit	5,696	96 /unit	30,240	81.3 /unit	25,606	8.1 /20' Empty	2,341
20' Export Laden		-	12.06 /unit	434	0, 22, 42 /unit	1,397	15.3 /unit	1,104	19.3 /40' Laden	10,133
40' Export Laden		-	18.08 /unit	1,899	0, 17, 57 /unit	3,088	27.6 /unit	5,798	12.8 /40' Empty	1,434
20' Import Empty		-	4.52 /unit	0	63 /unit	63	12.3 /unit	12	22.8 /Over 40' Lade	-
40' Import Empty		-	6.78 /unit	0	96 /unit	672	20.9 /unit	146	17.6 /Over 40' Emp	-
20' Export Empty		-	4.52 /unit	0	0 /unit	0	12.3 /unit	3,534		
40' Export Empty		-	6.78 /unit	0	0 /unit	0	20.9 /unit	2,190		
Container Storage Charges	7 days free		4 days (Import), 4 days (Export), 0 days (Empty) free		5 days free		3 days free		6 days (Import) 4 days (Export) free	
Laden Containers	2.0 /TEU/day	0	6.0 /20'/day	2,406			4.9 /20' Laden	4,290		
Empty Containers	2.0 /TEU/day	0	12.0 /40'/day	5,040			9.8 /40' Laden	10,307		
							0.8 /20' Empty	222		
			Labour Welfare Fund		Gate Fee	373	1.5 /40' Empty	172		
Others				108	Delivery Order Fee 5 /Document		3.2 /truck	4,362		
Cargo Handling Sub-Total		273,105		112,955		170,332		150,695		113,646
	VAT	0	VAT	16,943	VAT	17,033	VAT	10,549	VAT	1,867

Source: Study Team

Table 4.1.6 Comparison of Total Cost at Ports

unit: USD

Port Dues and Charges	Yangon	Chittagong	Sihanoukville	Bangkok	VICT (Vietnam)
Cargo Handling Sub-Total	273,105	112,955	170,332	150,695	113,646
VAT	0	16,943	17,033	10,549	1,867
Port Dues Sub-Total	18,590	13,077	27,025	14,369	17,921
VAT	0	1,962	27	1,006	0
Total (without VAT)	291,695	126,032	197,357	165,065	131,567
Total (including VAT)	291,695	144,937	214,417	176,619	133,434

Source: Study Team

Port dues for a 30,000 DWT container ship is similar to those of regional ports except the case of Sihanoukville. However, berth charges of Yangon Port are lower than other cases and light dues are not charged in other cases. Consequently, terminal operators receive less from berthing charges and MPA receives more from light dues.

MPA's container handling charges include Lo/Lo charge and wharfage which are 1.5 to 2.3 times higher than other cases. In particular, container handing charges are levied on a TEU basis, so that charges on 40 footers are considerably higher than the other cases. Handling charges on 40 footers should not be twice that 20 footers in consideration of actual handling cost.

Total cost of Yangon Port for a model ship entry and cargo handling is 1.4 to 2.2 times of other ports. Taking into account that private terminal operators refund cargo handling charges to ship operators, port tariff should be revised, or allow private terminal operators to modify their tariff within the ceiling of MPA's tariff.

(2) Collection of Port Dues and Cargo Handling Charges

As the port tariff of Myanmar is twice higher or more compared with other regional ports, private terminal operators refund some portion of the port tariff to shipping companies after having received cargo handling fees from MPA. In Thilawa area, foreign private operators are allowed to collect cargo handling charges, Lo/Lo fees, storage fees, berth fees, hatch opening/closing fees, and water supply fees, based on the official tariff. After receiving charges and fees collected by MPA based on the port tariff, both of local and foreign operators pay back some portion of cargo handling charges to shipping companies.

MPA collects port dues and cargo handling fees estimated from the entry declaration and cargo manifest with an extra 20% in advance. After receiving a report on actual amount of cargo handling from a terminal operator, MPA adjusts the charges, and transfers the charges to the terminal operator after deducting concession fees agreed with the operator.

Cargo handling charges of MPA include ordinary Lo/Lo charges, so that terminal operators collect additional fees caused by extra moves, transportation, or storage charges after a free period. Such fees and charges are also subject to variable part of concession fees.

4.2 Port Management System and PPP

4.2.1 Port Management Reform

Since its establishment, MPA had been the sole agent for providing port services till 1994 when the development of a private terminal was approved by the Myanmar Investment Committee. In the inner harbour, AWPT was developed by BOT scheme from 1994 and opened in 1997, and MIP opened in 2003 under BOT scheme. In Thilawa area, MITT was developed by foreign capital and opened in 1998.

MPA is proceeding to a landlord type port authority by privatizing terminal operations and reducing its own services. However, MPA controls ship entry, berth allocation and regulates port tariff, which means that private operators cannot operate their terminals completely at their own discretion.

Cargo throughput at ports of Myanmar will increase in line with economic growth, and more port facilities will be required to meet the demand for maritime transportation. In order to develop modern large scale and productive port facilities, it is important that MPA initiates such development by means of PPP scheme in addition to BOT scheme.

As summarized in Table 4.1.2, MPA operates only Berths nos.5-7 of the Sule Terminal by own capacity and other terminals are operated by private companies in the forms of 1) operation concession to private operators, 2) JV with MPA and private company, and 3) BOT development by private investors. MPA has already changed to a landlord type port authority which is the standard form of a modern port management body.

As a landlord port authority, it is important for MPA to tackle the following tasks and issues.

1) Preparation of National Port Policy and Master Plan

Ports of Myanmar faces several problems such as 1) high port tariff compared with regional ports, 2) ship draft is limited to 9 meters and mother vessels cannot call, 3) low productivity in cargo handling, and 4) no master plan or port policy to cope with these problems. It is urgently necessary to establish a national port policy and master plan for port development and management, including cargo demarcation between the inner harbour and Thilawa area, and incentives to encourage the use of Thilawa area, and regulations to reduce traffic congestion in Yangon City.

2) Terminal Operator’s Discretion in setting Cargo Handling Charges

Terminal operators cannot decide their own cargo handling charges and fees due to the compulsory tariff of MPA. Service provider shall be able to decide charges and fees of their services. It will be appropriate that MPA will allow the entry of private shipping agents in the business of SAD and will not monopolize the agent service. Variable part of concession fees will be levied based on cargo volume, not on nominal revenues based on port tariff, which will give private operators an incentive cargo and real revenues.

3) Maintenance of Navigation Channel

Siltation and sedimentation in the approach channel severely limits the draft of calling vessels, thereby hampering ship entry and departure. It is imperative to regularly survey the water depth and dredge the approach channel in a timely manner. As part of privatization, it may be possible to transfer pilotage service, tug boat service, and maintenance dredging work to private companies.

4) Development of Access Road and Railway

To encourage the use of Thilawa terminals and reduce traffic congestion in Yangon City, it is indispensable to develop a highway between Thilawa and the outskirt of Yangon City. Special investment shall be made by MPA to develop highway connection and railway extension to Thilawa area, in particular in the adjacent area to the port.

4.2.2 PPP for Port Development and Management

PPP laws or government ordinances are promulgated in more than 60 countries2), however, no such law has been established in Myanmar. Ministry of Planning and Finance released a policy document on PPP in 2016 for public comments3), which included a draft on the scale and type of PPP projects, rules for procurement, establishment of PPP committee, and possible assistance of the government.

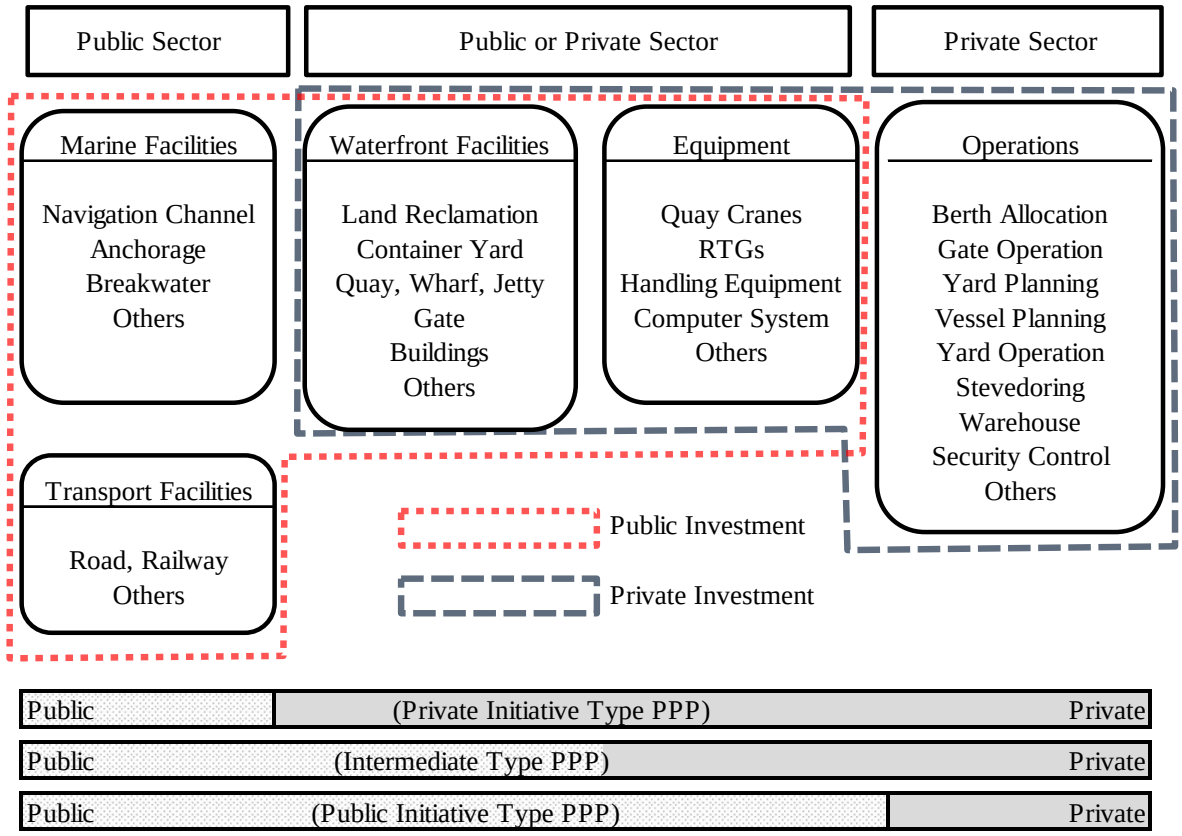
In case of port development projects, demarcation between the public and private sectors is usually planned as shown in Figure 4.2.1. Public sector is responsible for the development of marine facilities such as channels, basins and breakwaters while the private sector participates in operational aspects. Development of waterfront facilities and procurement of cargo handling equipment are shared by the public and private sectors. In case of a project that needs a large initial investment and anticipates low profitability at the initial stage, the public sector will develop all facilities and install cargo handling equipment. Conversely, if a project is profitable and has low risks, the private sector will develop all facilities and procure cargo handling equipment.

Taking into account that terminal development in Thilawa area faces difficulty in terms of land transportation and would not be attractive for investors at the initial stage, the public sector is expected to develop all infrastructure and superstructures and the private sector participates in operations. Phase 1 and 2 of the development of Thilawa Multi-Purpose International Terminal shall be developed under the public initiative type PPP.

As the cargo volume increases, the private sector will procure additional cargo handling equipment and expand the cargo handling capacity. In order to encourage private investment, it may be appropriate to reduce the ratio of variable part of concession fee.

[2] PPP in Infrastructure Resource Center, World Bank Group, 2016

[3] Myanmar Public-Private Partnership Policy Document (including a Legal Review of PPP-related issues)



Source: Study Team

Figure 4.2.1 Demarcation between Public and Private Sector

5 Draft Cooperation Guidelines

5.1 Yangon Port Development Plan

5.1.1 Yangon Main Port

(1) Container Terminals

Since the container terminals at Yangon Main Port shown in Figure 2.1.2 are developed and operated by private companies under BOT contracts with MPA, these terminals will continue to be operated at the existing locations until the current contracts expire. The existing terminals are located in a narrow area between the city area and the Yangon River and thus the terminals interfere with city functions and generate traffic congestion which also hampers port functions. Therefore, after the BOT contracts expire, it is necessary to relocate the terminals gradually to a brand-new area in order to separate the terminals from city function area.

Thilawa Area Port is supposed to be a candidate site for relocating container terminals in Yangon Main Port, however, all 37 Plots shown in Table 5.1.1 except for Plots 22 to 26 (owned by MPA) are allocated to private operations based on BOT contracts with MPA. Therefore, there is no room in Thilawa Area Port for the relocation of container terminals from Yangon Main Port. One other possible option would be to convert MILP's general cargo terminal (200m) to a container terminal.

Therefore, it is necessary to develop a brand-new port to handle the container cargo expected in the future at Yangon Port. The new port development direction after the completion of Thilawa Are Port will be discussed in section "5.1.2 Thilawa Area Port".

(2) Domestic Terminals

The coastal and inland water transport of cargo and passengers are handled at such areas as Lamadaw, Pansodan and Botathaung. Pansodan and Botathaung where passenger transport is the major operation are situated very close to the city area. MPA has a plan to convert these areas into urban development areas including shopping centers, office buildings and passenger terminals by making use of the amenity-rich waterfront nature of these areas.

Lanmadaw area (total length of about 1,500 m as shown in Figure 5.1.1) where the cargo handling area is quiet narrow (maximum width is 150 m and minimum width is 20 m) handles almost all domestic cargo. In order to improve the cargo handling productivity, it is necessary to redevelop this area. Since this area is adjacent to the city area, it is recommended to use this area as an amenity-rich waterfront urban development space including shopping centers and office buildings. In addition to Lamadaw area, the port area at Kyeemyindang (see Figure 5.1.2) which exclusively handles bananas is recommended to be redeveloped similar to Lamadaw area redevelopment.

Source: Study Team (Google Earth)

Figure 5.1.1 Layout Plan of Lamadaw Area Redevelopment

If the port facilities at Lamadaw and Kyeemyigang area are to be relocated, candidate areas for the relocation would have to have a sufficient water depth and be as close as possible to Yangon (large market). From this viewpoint, the eastern area of Thanlyin where sufficiently deep water area and land area are available was once evaluated as a candidate site (see Figure 2.3.4).

However, the Myanma Petrochemical Enterprise (MPE) of the Ministry of Electricity and Energy owns the area shaded in orange in Figure 2.3.4 and operates the refinery. Further south of this area, there is a sufficiently deep water area for port development. However, this area cannot be used for the port development because it is owned and occupied by the navy.

Therefore, it is not possible to relocate the port facilities at Lamadaw and Kyeemyigang area in the vicinity of Yangon. The redevelopment of Lamadaw and Kyeemyigang area at their present locations is only solution that satisfies the requirement of providing space for urban development including waterfront amenity while still maintaining port function. The concrete redevelopment plan shall be formulated in the close consultations with the port users because the redevelopment should be conducted without disturbing the daily port operations.

Source: Study Team (Google Earth)

Figure 5.1.2 Layout Plan of Area Redevelopment

5.1.2 Thilawa Area Port

37 Plots in Thilawa Area Port are operated or will be operated by private companies under the BOT contracts with MPA. The major cargoes to be handled at terminals are grain and liquid cargo as shown in Table 4.1.3.

According to the Middle Case container demand forecast discussed in the section 2.3, it is necessary to start the operation of Phase II terminal (Plots 24 and 26) which is expected to be developed by JICA's ODA loan in 2025 and Phase III terminal (Plots 22 and 23) in 2029. Assuming that the project preparation (including a study, financing, detailed design and procurement) will take 4 years and construction works 5 years, the project formulation of Phase III should be started in 2020.

Thilawa Area Port will not be able to handle the entire container demand in 2030 even after the completion of Phase III terminal. Therefore it is necessary to develop a port in a brand-new area. In the vicinity of Thilawa Area Port, the norther part is occupied by the navy base and the southern part faces very shallow water area, so that it is not possible to develop a new port at this area. Therefore, it is necessary to develop a new deep-sea port at a brand-new area including off the Yangon river mouth.

It is necessary to investigate natural condition surveys such as bathymetry, wave and sedimentation in advance of the formulation of a new port development plan. The study (including natural condition survey) for the formulation of a new port development plan need to be started by 2020.

5.2 Project Implementation Scheme

5.2.1 Development of Plot 24 and Plat 26

Phase 2 of the Thilawa Multi-Purpose International Terminal (TMIT) project is to develop the yard in Plot 26 and the berth facilities and yard in Plat 24. TMIT is designed to have three berths with a total length of 600 meters in the area of Plots 24, 25, and 26. If Plot 24 becomes an independent terminal, the Plot 25/26 terminal and the Plot 24 terminal would have difficulties in yard operation, berth allocation, QGC assignment, and their productivities will stay at low level. Therefore, it is not advisable to operate these Plots.

It is rational to include Plot 24 in the concession contract of the Plots 25/26 agreed in March 2018, which has an operation period of 38 years and possible extension of 20 years. When the contract is revised in 2023 before completion of Phase 2, Plot 24 should be grouped together with Plots 25 and 26 and all three Plots should have the same operation period.

Together with reviewing the fixed fee to include Plot 24, the variable fee will also be reviewed from the viewpoint of forming a direct link to cargo throughput instead of the revenue from cargo handling. It may be appropriate to adopt a gradual decrease in the variable fee ration when the cargo throughput exceeds a certain level, which will encourage terminal operators to handle more cargo and increase their productivity.

5.2.2 Development of Plot 22 and Plot 23

When the cargo handling at the terminal of Plots 24/25/26 reaches its capacity, a new terminal will be opened in the area of Plots 22/23. As the access road and highway will be completed and related facilities/services will be established in Thilawa by then, Plots 22/23 can be developed by the private initiative type PPP or the intermediate type PPP shown in Figure 4.2.1.

Integrated operation of Plots 24/25/26 and the Plots 22/23 would be more productive than separate operation in view of economies of scale, so that it is advisable to operate Plots 22-26 as one integrated terminal. However, separate operation might encourage competitive between two parties or be an advantage when coping with change in cargo types.