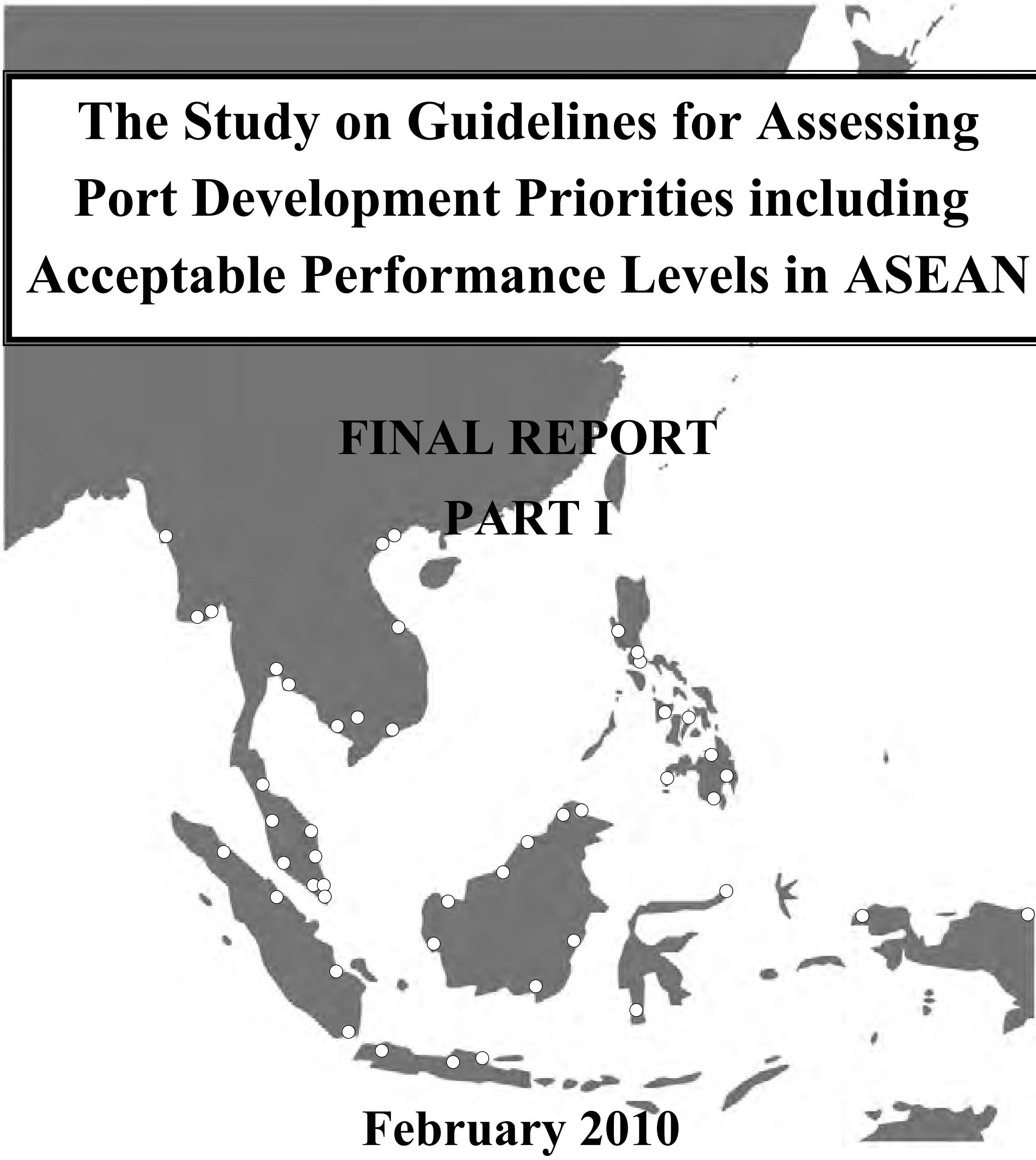
ASEAN Maritime Transport Working Group

The Study on Guidelines for Assessing Port Development Priorities including Acceptable Performance Levels in ASEAN



FINAL REPORT
PART I

February 2010

Japan International Cooperation Agency

The Overseas Coastal Area Development Institute of Japan (OCDI)
Mitsubishi Research Institute, Inc. (MRI)

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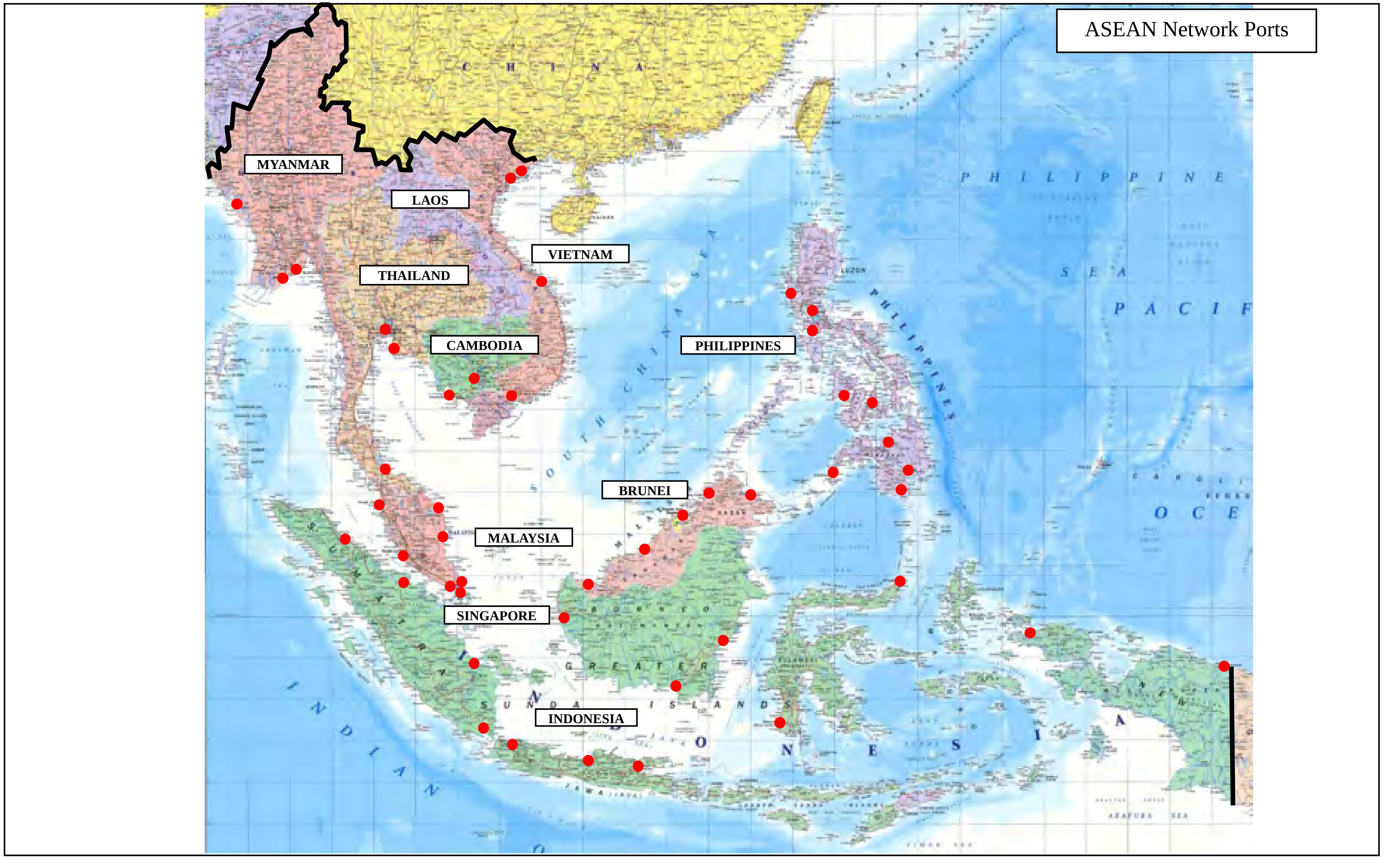

ASEAN Network Ports

ABBREVIATIONS

AEC	ASEAN Economic Community
APA	ASEAN Ports Association
APEC	Asia Pacific Economic Cooperation
ASEAN	Association of South East Asian Nations
ATM	ASEAN Transport Ministers Meeting
CFS	Container Freight Station
DF/R	Draft Final Report
DGST	Directorate General of Sea Transportation
DOTC	Department of Transportation and Communication
EDI	Electronic Data Interchange
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
F/R	Final Report
FTA	Free Trade Agreement
GMS	Greater Mekong Sub-region
IADA	Intra Asia Discussion Agreement
IC/R	Inception Report
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JTCA	Japan Transport Cooperation Association
JETRO	Japan External Trade Organization
MPPM	Maritime Policy Planning Model
MRI	Mitsubishi Research Institute, Inc.
MTWG	Maritime Transport Working Group
OCDI	The Overseas Coastal Area Development Institute of Japan
QMS	Quality Management System
STOM	Senior Transport Officials Meeting
TEU	Twenty-foot Equivalent Units（TEU）
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
WTO	World Trade Organization

Executive Summary

1 Study Objectives

Based on the cooperation framework between JICA and the ASEAN secretariat agreed in June 2008, JICA organized a study team, which consists of the Overseas Coastal Area Development Institute of Japan and Mitsubishi Research Institute Inc., to assist in the implementation of measure no.6 of ASEAN Maritime Roadmap from March 2009. JICA study team collaborated with Brunei Darussalam, Lead Coordinator for measure no.6, and Malaysia, Lead Coordinator for related measures and Vietnam, Chair Country of MTWG.

ASEAN member countries have already nominated 47 network ports in the early stage of the Roadmap and agreed to improve all network ports to the acceptable performance levels and develop necessary port infrastructure to meet the demand for network ports. Therefore, guidelines to assess the acceptable performance levels and capacity of network ports are sought to identify necessary projects for improving ASEAN maritime transportation. Guidelines may be necessary to show the bench mark for cargo handling productivity, ship accommodation and other operational requirements. Bench marks for port infrastructure and super structure may also be sought in the guidelines.

2 Cargo Throughput Capacity of Port

2-1 Estimation of the Cargo Handling Capacity of Terminals

In order to maximize the cargo handling capacity of a terminal, it is indispensable that all related facilities are properly developed and managed, namely channels and anchorages for vessel navigation, roads and railways for hinterland transportation, tugboats and pilot services for ship entry and departure, and breakwaters to ensure the calmness of basin. In view of these factors, terminal throughput capacity is determined by the following four capacities.

1) Cargo handling capacity of the terminal
2) Ship traffic capacity of the navigation channel including restrictions on navigable ships
3) Hinterland transportation capacity of roads and railways, and capacity of inland depots
4) Capacity and time necessary for processing documentation for port entry, customs clearance and other import export activities

2-2 Container Handling Performance Estimate Model

Among many factors deemed to have an influence on terminal cargo throughput, following 5 factors are chosen for inductive modeling for terminal capacity assessment.

a) Length of Berth (m/Berth)
b) Water Depth（m）
c) Number of Quay Cranes (Unit/Berth)
d) Productivity of a Quay Crane (Unit/hour)
e) Area of Container Terminal (m^2/Berth)

The estimate model is formulated by means of multiple linear regression analysis using data sets of container terminals with high berth productivities. Taking into account the combinations of the above 5 factors, 31 cases are examined. Parameter of “Water Depth” is excluded from the estimate model due to less significance as a parameter.

2-3 Standard Productivities of Container Terminal Facilities

1) In major terminals for trunk liner services, the productivity of quay gantry cranes is about 30 units per hour or higher. Berth productivities are more than 100 units per hour. Highest berth productivity reaches more than 200 units per hour.
2) In feeder ports, the productivity of quay gantry cranes is about 20-25 units per hour and berth

productivity is about 40-50 units per hour.

3) In multi-purpose berths or general cargo berths, the productivity of portal cranes is about 20 units per hour or less.

While the sizes of calling container vessels vary greatly by ports, acceptable time for loading and unloading is less than 24 hours. Berth productivities are therefore required to cope with this time frame, and shall be 200 units per hour or over at a large scale busy transshipment port, 100 units per hour or over at major trunk liner ports.

2-4 Conventional Terminal

Productivity of conventional terminals is largely affected by length and depth of berths and lifting capacity of cranes. In the terminals where direct delivery is implemented without temporary placement at transit sheds, an appropriate cargo handling plan should be prepared including the arrangement of delivery measures. In case containers are handled in conventional terminals, the installation of quay cranes is indispendable for efficient container handling.

2-5 Dry Bulk and Liquid Bulk Terminal

Capacity of a dry bulk terminal is primarily affected by water depth and length of the quay, as well as cargo handling machines. When assessing the capacity of a dry bulk terminal, it should be considered whether quay water depth and length of the quay and cargo handling facilities fit in well with the kind and the volume of the handling cargo, and the dimension of the called vessels. Liquid bulk cargoes are loaded and unloaded by pumps through pipes. Therefore, the capacity of a liquid bulk terminal is determined mainly by the water depth of the berthing facility, and the scale and capability of pumps, pipelines and storage tanks.

2-6 Ro/Ro Terminal

The operations of Ro/Ro terminals varies depending on the types of Ro/Ro ships, i.e. ships for vehicles only, vehicles and cargo, or vehicles and passenger. The international shipping services in ASEAN region are mainly served by vehicles carriers. The dimensions of required facilities for vehicles carriers including quays and yards should be determined in consideration of the purpose of the terminal (e.g. for exporting only, exporting & importing, transship, etc.), the size of targeted calling ships, calling frequency and calling order in the service loop.

2-7 Approach Channel

Approach channels need to provide appropriate depth, width and alignment in order for vessels to be able to navigate safely and smoothly. Requirements for each channel shall be identified based on its location and calling vessels. In order to analyze these conditions and calculate required depth and width in detail, it is necessary to use statistical and probabilistic methods or simulation model. In the guidelines, rough calculation methods are proposed for evaluating the present situation and examining the necessity of improvement.

2-8 Hinterland Transport

Liquid bulk cargoes are loaded and unloaded by pumps through pipes. Therefore, the capacity of a liquid bulk terminal is determined mainly by the water depth of the berthing facility, and the scale and capability of pumps, pipelines and storage tanks.

2-9 Electronic Port Documentation and Single Window

Electronic notification on port entry to port authority, immigration, customs, quarantine and other necessary offices can expedite documentation and maximize the capacity of port cargo throughput. Single window for port documentation and introduction of IT system plays an important role in enhancing the performance of port operations. Together with electronic port documentation, it is indispensable to integrate the customs clearance information system, terminal operation information system, port management information system, and other port related information systems into one information platform.

3 Assessment of Port Development Priorities
3-1 Indices of Assessment

Cost benefit analysis is a good tool to evaluate project alternatives and select the most cost effective one. However, it can be difficult to calculate the benefit to a region when the implementation of a project is expected to have wide effects. It is therefore recommendable that initial screening of projects shall be implemented by means of rating important factors related to port development. The checklist is shown in the guidelines. From the viewpoint of ASEAN maritime network, emphasis shall be placed on 1) responding to maritime transport demand, 2) reduction in maritime transport cost, and 3) coping with regional transportation corridors.

3-2 Expected Performance Levels of Container Terminal Operation

The same performance cannot be expected at every container terminal due to the difference in sizes of calling vessels, terminal facilities, volume of cargo handling, and other operational factors. The capacity of container terminals in the ASEAN region is analyzed and expected performance levels are proposed as follows.

	Minimum Performance (1000TEUs/Berth)	Best Performance (1000TEUs/Berth)
Type 1. World class transshipment port serving as a hub of trunk line services	-	600-750
Type 2. World class port serving as a main gateway to their country	350	470-730
Type 3. Large scale port serving manly for inter regional container shipping	250	350-500
Type 4. Small scale port serving mainly for intra regional container shipping	125	190-260
Type 5. Small scale port (terminal) mainly for coastal and/or sub-regional services	-	70-100

3-3 Expected Sizes of Calling Vessels

About 4,500 full container ships are registered in the world as of June 2008. The 500-999 TEU class accounts for the largest number of vessels at 814 followed by the 1,000-1,444 TEU class with 677. The main size of feeder container vessels in the ASEAN region has a capacity of around 1,000 TEUs or less. In the future, larger vessels of 2,000 TEUs, i.e. around 30,000 DWT, may be introduced due to the effect of stepping down of large size of container vessels from trunk liner services.

Besides the vessels in the 2,000 TEU class, the 4,000-4,999 TEU class is largest. Vessels of this class are Panamax size and used to be deployed in long distance trunk liner services, but have been replaced with over Panamax vessels. Container vessels of this class may be deployed in inter-regional trunk liner services in Asia. Therefore, large scale ports serving for regional container services will be required to accommodate container vessels of this class.

3-4 Roles in line with Regional Corridor Projects

There are three regional corridor plans in the Greater Mekong sub region, namely, East-West Corridor, North-South Corridor, and Southern Corridor. There are also plans to strengthen the connection between the Philippines and Malaysia by ferry from Sandakan to Zamboanga, and connection between Malaysia and Indonesia by Ro/Ro and/or Ferry service from Penang to Medan.

Ports necessary for these projects shall be given a priority.

4 Application of Guidelines

4-1 Types of Network Ports and Expected Roles

Types of network ports are classified from the viewpoint of the scale of cargo throughput, transshipment port or origin-destination port, area of partner ports on liner services, and the dimensions of port facilities. Through on-site visits, classification of network ports is recommended as follows.

Types	Ports
1. World class transshipment port serving as a hub of trunk line services	Port Klang; Tanjung Pelepas; Singapore
2. World class port serving as a main gateway to their country	Tanjung Priok (Jakarta); Manila; Laem Chabang; Ho Chi Minh
3. Large scale port serving mainly for inter regional container shipping	Tanjung Perak; Tanjung Emas (Semarang); Penang; Johore (Pasir Gudang); Kuching; Bangkok; Hai Phong; Cai Lan
4. Small scale port serving mainly for intra regional container shipping	Muara; Sihanoukville; Belawan; Palembang; Panjang; Makassar; Balikpapan; Banjarmasin; Pontianak; Kuantan; Bintulu; Kota Kinabalu; Yangon; Thilawa; Batangas; Subic Bay; Cebu; Iloilo; Cagayan de Oro; Davao; Zamboanga; Da Nang
5. Small scale port (terminals) mainly for coastal and/or sub-regional services	Phnom Penh; Bitung; Dumai; Jayapura; Sorong; Kemaman; Sandakan; Kyaukphyu; General Santos; Songkhla

4-2 Estimate of Container Terminal Performance

The result of productivity analysis on container terminals in the ASEAN region is summarized and the expected performance of container terminals is shown in Chapter 6.2. Expected performance may be realized when the terminal facilities are well installed and the operation is conducted appropriately. Possible performance of a container terminal mainly depends on numbers of quay gantry cranes available, their productivities, the length and water depth of a berth, and the size of container terminal area, subject to conditions that other factors like hinterland transportation are well organized and managed appropriately.

Applying a formula shown in the guidelines, expected performance can be calculated by the model shown in Table 6.2-1, which is designed on an Excel sheet. The output of this model is an estimation of the performance of a container terminal in terms of TEUs per berth.

4-3 Procedures for Assessing Development Priorities

Following studies on measures no.5 and 6, demand forecast for network ports will be executed in the course of measure no.7 of the Roadmap. In order to cope with future cargo throughput estimated at each network port, their acceptable performance can be examined by the method given in the guidelines. In case that cargo throughput came near to or over the estimated performance in network ports, examination shall be made on their operation productivities and the level of port facilities.

The guidelines also proposed the classification of network ports as shown in Chapter 6.1 and possible ship sizes calling at each class of network port. Navigational restrictions on ship entry shall also be examined in line with the guidelines as well as other operational restrictions.

Summary

1 Objectives and Outline of the Study

1-1 Study Objectives

Based on the cooperation framework between JICA and the ASEAN secretariat agreed in June 2008, JICA organized a study team, which consists of the Overseas Coastal Area Development Institute of Japan and Mitsubishi Research Institute Inc., to assist in the implementation of measure no.6 of ASEAN Maritime Roadmap from March 2009. JICA study team collaborated with Brunei Darussalam, Lead Coordinator for measure no.6, and Malaysia, Lead Coordinator for related measures and Vietnam, Chair Country of MTWG.

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1-2 Study Outline

(Inception Report)

Inception report of the study was presented at the 17th MTWG meeting from 10-12 March, 2009, in Hue. The report included the study schedule, a plan to distribute questionnaires to network ports, a provisional plan for study visits and identified necessary items for the guidelines.

(Joint Coordination Meeting)

Following the discussion at the 17th MTWG meeting, a coordination meeting was organized by Malaysia, Brunei Darussalam, Vietnam, Japan and ROK in Penang from 13-14 April, 2009, in order to avoid duplication and prepare a questionnaire for network ports. While Brunei Darussalam could not join the meeting due to an unforeseen reason at the last minute, four countries met in Penang and made a unified questionnaire.

(Questionnaire Survey)

Lead coordinators sent the draft questionnaire to MTWG members for comments. Having received no comments or revision requests by mid-May, 2009, lead coordinators distributed the questionnaire to network ports through the focal point of each country in mid-May and requested them to answer the questionnaire in one month. However, only a few completed questionnaires were collected by mid-June, 2009. MTWG recalled the focal point of each country that answers to the questionnaire were expected by mid-September to finalize the study on measures no.5 and 6. Among 47 network ports, answers were collected from 39 ports and factual information on the other 8 ports were collected from their brochures, homepages, interview memos and other materials available.

(On-site Survey)

JICA study team started on-site surveys early in June 2009, and visited 12 network ports in Indonesia using two teams from 9 June to 6 July, 2009. Ports of Sorong and Jayapura were covered by local consultants during the same period. One study team continued on-site surveys of 6 network ports in Malaysia and Muara Port in Brunei Darussalam. Another study team visited Ports of Johor and Tanjung Pelepas late in July and the Ports of Kuantan and Kemaman in mid-August, 2009.

One study team visited the Ports of Hai Phong and Cai Lan, Vietnam, early in August before the 18th MTWG meeting. After the meeting, one study team visited the Ports of Da Nang and Ho Chi Minh, Vietnam, and then 7 network ports in the Philippines from 16 August to 18 September, 2009. Another study team visited 2 network Ports of Bangkok and Laem Chabang, Thailand, and then 3 ports in Myanmar, the Port of Singapore, and two ports in Cambodia from 16 August to 20 September, 2009. Port of Songkhla, Thailand, and Ports of General Santos and Zamboanga, the Philippines, were also covered by local consultants during the same period.

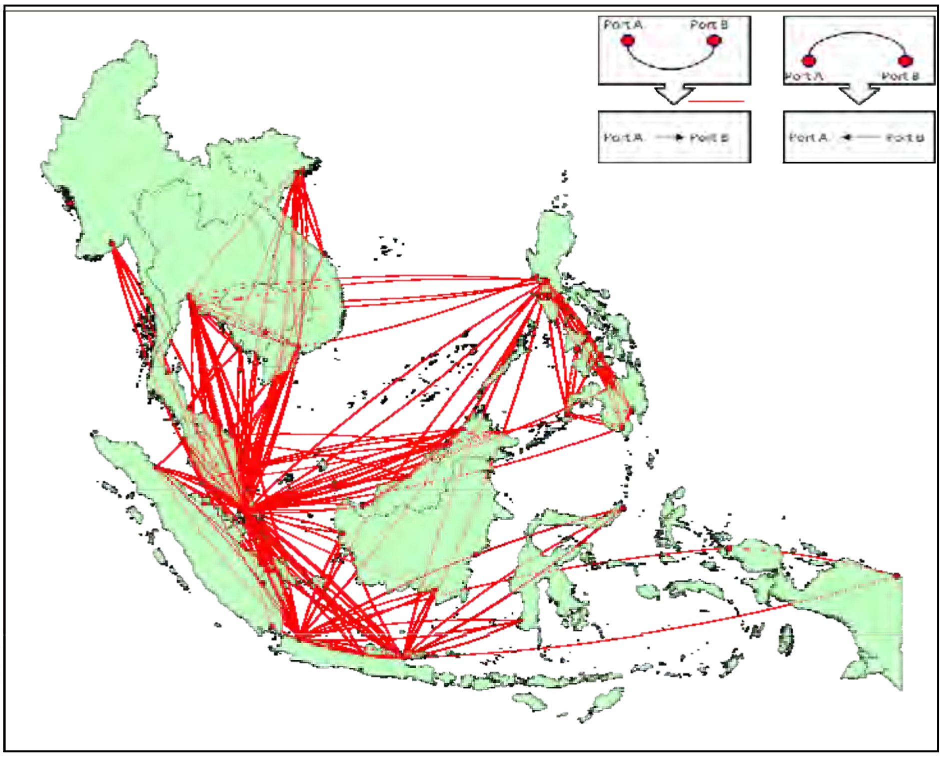
2 Maritime Network and Ports Situation in ASEAN

2-1 Network Ports

In terms of container throughput in the ASEAN region, Port of Singapore ranks first handling nearly 30 million TEUs in 2008. This figure includes the container throughput of PSA Singapore terminals and Jurong Port. Second largest container port is Port Klang handling nearly 8 million TEUs. Following these two ports, Port of Tanjung Pelepas handled 5.6 million TEUs and Port of Laem Chabang did 5.2 million TEUs. And furthermore, ports of Tanjung Priok, Ho Chi Minh and Manila handled more than 3 million TEUs in 2008. Classification of network ports is proposed in section 6.1 of the report.

2-2 Intra ASEAN Liner Network

Singapore was the only one center in the region in 1992. But through economic growth and port development, main ports of Thailand, Indonesia, Malaysia, Philippines have come to handle more than 3 million TEUs in 2008. ASEAN maritime transportation grows to have several hubs in the network. Shipping services between network ports are analyzed based on the database of container liners as of August 2008 as follows:



Shipping services between network ports (More than two services per month)

3 Level Maritime Infrastructure

Maritime transport network is basic infrastructure for achieving a single market in the ASEAN region and to this end efficient and competitive shipping service is of critical importance. However, economic development of ASEAN countries is at different stages, and the maritime transport infrastructure remains at poor levels in some countries while some countries' infrastructure has reached the highest level in the world. Efficient shipping service requires the same level of port infrastructure at every terminal on a service route. In particular, it is very important for network ports to satisfy the minimum requirement which entails securing a sufficient water depth of the navigation channel, installing quay side cranes, and developing dedicated bulk cargo terminals.

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4-1 Estimation of the Cargo Handling Capacity of Terminals

In order to maximize the cargo handling capacity of a terminal, it is indispensable that all related facilities are properly developed and managed, namely channels and anchorages for vessel navigation, roads and railways for hinterland transportation, tugboats and pilot services for ship entry and departure, and breakwaters to ensure the calmness of basin. In view of these factors, terminal throughput capacity is determined by the following four capacities.

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6-2 Estimate of Container Terminal Performance

The result of productivity analysis on container terminals in the ASEAN region is summarized and the expected performance of container terminals is shown in Chapter 6.2. Expected performance may be realized when the terminal facilities are well installed and the operation is conducted appropriately. Possible performance of a container terminal mainly depends on numbers of quay gantry cranes available, their productivities, the length and water depth of a berth, and the size of container terminal area, subject to conditions that other factors like hinterland transportation are well organized and managed appropriately.

Applying a formula shown in the guidelines, expected performance can be calculated by the model shown in Table 6.2-1, which is designed on an Excel sheet. The output of this model is an estimation of the performance of a container terminal in terms of TEUs per berth.

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Following studies on measures no.5 and 6, demand forecast for network ports will be executed in the course of measure no.7 of the Roadmap. In order to cope with future cargo throughput estimated at each network port, their acceptable performance can be examined by the method given in the guidelines. In case that cargo throughput came near to or over the estimated performance in network ports, examination shall be made on their operation productivities and the level of port facilities.

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Chapter 1 Background, Objectives and Outline of the Study

1.1 Background and Objectives of the Study

1.1.1 Background

ASEAN member countries aim at formulating ASEAN Economic Community (AEC) by 2015 and agreed on the AEC Blueprint[1] in 2007, which is a master plan for their implementation from 2007-2015. One of four pillars in the AEC Blueprint is to establish a single market and production base. In line with this direction, ASEAN Transport Action Plan 2005-2010 is being implemented to enhance the transportation in the ASEAN region, which is a prerequisite for competitive trade and investment.

According to the Blueprint, ASEAN Transport Ministers adopted the “Roadmap towards an Integrated and Competitive Maritime Transport in ASEAN” at the 13th ASEAN Transport Ministers (ATM) Meeting in November 2007. The Roadmap listed 20 measures to enhance the maritime transport in the ASEAN region.

ASEAN Transport Action Plan mentioned that the key role of the transport network is to assist in the production, consumption and distribution - or the supply chain - of goods and services. Transportation plays an important role in trade facilitation and the establishment of production base. Weakness of maritime logistics in the ASEAN region is indicated in the lack of quality road transport to ports, poor port infrastructure and sub-optimal shipping networks[2].

The Roadmap proposed 20 measures in five categories, i.e. 1) Developing a single ASEAN voice for common shipping policy, 2) Enhancing the infrastructure of all ports of regional significance, 3) Market integration for single shipping market, 4) Harmonization in fiscal support for shipping operations, ship registration and port tariff, and 5) Human resources and capacity development. List of 20 measures is shown in Appendix-1.

At the 16th meeting of MTWG[3] in September 2008, members agreed to implement several measures through seeking technical assistance from external donors, which are measure no.5 “Develop a database of maritime trade movements to and from within ASEAN (Lead Coordinator Malaysia)”, and measure no.6 “Develop guidelines for assessing port development priorities, including acceptable performance levels (Lead Coordinator Brunei Darussalam)”, measure no.7 “Identify required improvement areas in ASEAN network port performance and capacity, based among others on regular forecasts of maritime trade and requirements (Lead Coordinator Malaysia)” and measure no.8 “Develop project priorities, based on the guideline for assessing port development, to raise performance and capacity levels towards bridging such gaps in ASEAN network ports (Lead Coordinator Vietnam)”. The MTWG meeting nominated the Republic of Korea as a donor for measures no.5 and no.7 is and Japan for measures no.6 and no.8. ROK and Japan agreed to assist the implementation of four measures in cooperation with each other.

Due to the stage of economic development, port infrastructure of ASEAN member countries has a great difference in quality and quantity as well as maritime services and port productivities. Therefore, difficulties are observed in setting up optimal intra-regional shipping routes with optimal size of vessels. Some ports have not enough water depth, nor quay gantry cranes for container handling. Shipping companies and shippers/consignees sometimes suffer from slow operation, low productivity, high stevedoring cost, port congestion, poor land transportation or other poor port services. These are all obstacles to achieving effective and low cost maritime transportation in the region.

At the 17th MTWG meeting in March 2009, the implementation of measures no.5-8 of the

1 Declaration on the ASEAN Economic Community Blueprint, 20 Nov. 2007
2 ASEAN Transport Action Plan 2005-2010, Introduction
3 Maritime Transport Working Group

ASEAN Maritime Roadmap was discussed and time limits for measures no.6 and 7 were slightly revised. The time limits are now settled for measure no.5 by December 2009, measure no.6 by February 2010, measure no.7 by August 2010, and measure no.8 by December 2010. Following the implementation of these four measures, ASEAN member countries will explore funding mechanisms to support the implementation of identified projects in their ports by December 2012. Member countries aim at ensuring that all network ports meet the acceptable performance and capacity levels by December 2015.

Based on the cooperation framework between JICA and the ASEAN secretariat agreed in June 2008, JICA organized a study team, which consists of the Overseas Coastal Area Development Institute of Japan and Mitsubishi Research Institute Inc., to assist the implementation of measure no.6 of ASEAN Maritime Roadmaps from March 2009. JICA study team collaborated with Brunei Darussalam, Lead Coordinator for measure no.6, and Malaysia, Lead Coordinator for related measures and Vietnam, Chair Country of MTWG.

1.1.2 Objectives of the Study

This study is planned to assist Brunei Darussalam in implementing measure no.6 of the ASEAN Maritime Roadmap and prepare draft guidelines for assessing port development priorities including acceptable performance levels. The goal of the Roadmap is to raise the level of port infrastructure and services of regional network ports to meet the request for establishing competitive maritime in the region.

ASEAN member countries have already nominated 47 network ports in the early stage of the Roadmap and agreed to improve the all network ports to the acceptable performance levels and develop necessary port infrastructure to meet the demand for network ports. Therefore, guidelines to assess the acceptable performance levels and capacity of network ports are sought to pick up necessary projects for improving ASEAN maritime transportation. Guidelines may be necessary to show the bench mark for cargo handling productivity, ship accommodation and other operational requirements. Bench marks for port infrastructure and super structure may also be sought in the guidelines.

Specific objectives of this study are as follows:

1) To clarify the present situation of the 47 network ports in terms of port facilities, cargo throughput, ship traffic, port management and operation and other important aspects related to port performance by means of questionnaires and site visits to network ports, as well as by means of reviewing previous studies, existing database and materials,

2) To make draft guidelines for assessing the capacity and productivity of each network port and indicating the necessary level of port facilities, cargo handling equipment, productivity of port operation and related services.

1.2 Outline and Procedures of the Study

1.2.1 Outline of the Study

(1) Study Area

This study will cover the 47 ports located in Brunei Darussalam (1 port), Cambodia (2 ports), Indonesia (14 ports), Malaysia (10 ports), Myanmar (3 ports), Philippines (9 ports), Singapore (1 port), Thailand (3 ports) and Vietnam (4 ports), whose locations are shown in the figure of the front page. All network ports are listed in Table 1.2-1.

Economic indicators of ASEAN countries are summarized in Table 1.2-2. Total population of ASEAN countries is estimated at 580 million in 2008, of which a population of Indonesia accounts for 39 percent. Total GDP amounts to USD 1,480 billion, which is about one third of China. GDP per capita is over USD 40,000 in Brunei Darussalam and Singapore, but that is under USD 1,000 in Cambodia, Laos and Myanmar. There is a large difference in member countries. Total amount of imports and exports is USD 1,455 billion in ASEAN, of which Singapore's trade amounts to 35 percent. Forty percent of the foreign direct investment in ASEAN fell in Singapore. ASEAN countries have therefore a great disparity in their economic power.

The study team made a site visit to network ports jointly with Korean study team during a period of June to September 2009. Visits to Indonesian ports were made separately by JICA study team and Korean study team. Purpose of the site visit was mainly to collect factual information and hold discussions with port authorities. However, the site visits to ports of Jayapura and Sorong in Indonesia, General Santos and Zamboanga in the Philippines, and Songhkla in Thailand were commissioned to local consultants.

Table 1.2-1 ASEAN Network Ports（47 ports）

Country	Network Ports
Brunei Darussalam	Muara
Cambodia	Phnom Penh, Sihanoukville
Indonesia	Belawan, Dumai, Tanjung Priok (Jakarta), Palembang, Panjang, Pontianak, Tanjung Perak (Surabaya), Tanjung Emas (Semarang), Makassar, Balikpapan, Banjarmasin, Bitung, Jayapura, Sorong
Malaysia	Port Klang, Penang, Johore (Pasir Gudang), Tanjung Pelepas, Kuantan, Kemaman, Bintulu, Kuching, Sandakan, Kota Kinabalu
Myanmar	Yangon, Thilawa, Kyaukphyu
Philippines	Manila, Batangas, Subic Bay, Cebu, Iloilo, Cagayan de Oro, Davao, General Santos, Zamboanga
Singapore	Singapore
Thailand	Bangkok, Laem Chabang, Songkhla
Vietnam	Ho Chi Minh, Hai Phong, Da Nang,, Cai Lan

Table 1.2-2 Economic Indicators of ASEAN Countries

	Population (million)	GDP (bil. USD)	GDP/ Capita	CPI 2000=100	Export (bil. USD)	Import (bil. USD)	FDI (bil. USD)
Thailand	66.4	272.1	4,099	127	130.8	128.6	9.6
Singapore	4.7	192.8	41,295	113	271.8	238.7	24.1
Malaysia	27.3	214.7	7,867	122	160.6	131.1	8.4
Philippines	90.3	172.3	1,908	156	47.7	54.1	2.9
Indonesia	227.8	496.8	2,181	206	103.5	80.3	6.9
Vietnam	86.8	90.9	1,047	180	39.6	44.4	6.7
Myanmar	58.8	13.7	233	691	4.5	2.1	0.4
Brunei Darussalam	0.4	17.2	43,725	102	6.8	2	0.2
Cambodia	14.6	10.8	742	153	3.6	3	0.9
Laos	6.3	5.2	829	197	0.9	1.1	0.3
TOTAL	583.4	1,486.5	2,548	-	769.8	685.4	60.4

Source: Population: International Financial Statistics 2008 (IMF)
GDP: World Economic Outlook October 2008 (IMF)
Import/Export: Direction of Trade Statistics 2007 (IMF) Data in 2006
FDI (Foreign Direct Investment: World Investment Report 2008 (UN) Data in 2007

(2) Discussion on Inception Report

Inception report of the study was presented at the 17th MTWG meeting from 10-12 March, 2009, in Hue. The report showed a study schedule, a plan to distribute questionnaire to network ports, a provisional plan for study visits and an idea of necessary items for the guidelines. In accordance with proposals from ROK, agreement was made on the questionnaire and on-site survey that duplication of activities shall be eliminated and coordination meeting be organized in due course.

(3) Joint Coordination Meeting

Following the discussion at MTWG meeting, a coordination meeting was organized by Malaysia, Brunei Darussalam, Vietnam, Japan and ROK in Penang from 13-14 April, 2009, in order to avoid the duplication and prepare a questionnaire for network ports. While Brunei Darussalam could not join the meeting due to unforeseen reason at the last minutes, four countries met in Penang and made a unified questionnaire. Joint on-site survey to network ports by JICA study team and Korean study team were also proposed and provisional schedule was agreed subject to the confirmation in advance.

(4) Questionnaire Survey

Lead coordinators sent the draft questionnaire to MTWG members for comments and received no comment for the revision by mid-May, 2009. Therefore, lead coordinators distribute the questionnaire to network ports through the focal point of each country in mid-May and requested them to answer the questionnaire in one month. However, just a few answers were collected by mid-June, 2009. The study team visited network ports and asked their cooperation in filling in the questionnaire.

The study team reported the situation of answers to the questionnaire at the 18th MTWG meeting in Ho Chi Minh in August 2009. MTWG decided to recall the focal point of each country that answers to the questionnaire were expected by mid-September to finalize the study on measures no.5 and 6. Among 47 network ports, answers were collected from 39 ports and factual information on the other 8 ports were collected from their brochures, homepages, interview memos and other materials available.

The result of collection of answers to the Part II of the questionnaire is shown in Table 1.2-3. Summary of port facilities, cargo throughput, productivities and other key indicators on each network port is shown Appendix-2.

(5) On-site Survey

Following the coordination meeting in Penang, JICA study team visited ASEAN secretariat in Jakarta, Indonesia, and ASEAN Ports Association in Manila, Philippines, to discuss and collect information on the implementation of measures no.3 and no.4 during a period from 19 to 26 April, 2009. The study team also made arrangements for on-site survey to be commissioned to local consultants in Thailand, Indonesia and Philippines.

The study team started on-site survey early in June, 2009, and visited 12 network ports in Indonesia by two teams from 9 June to 6 July, 2009. Ports of Sorong and Jayapura were covered by local consultants during the same period. One study team continued on-site survey of 6 network ports in Malaysia and Muara Port in Brunei Darussalam. Another study team visited Ports of Johor and Tanjung Pelepas late in July and Ports of Kuantan and Kemaman in mid-August, 2009.

One study team visited Ports of Hai Phong and Cai Lan, Vietnam, early in August before the 18th MTWG meeting. After the meeting, one study team visited Ports of Da Nang and Ho Chi Minh, Vietnam, and then 7 network ports in Philippines during a period from 16 August to 18 September, 2009. Another study team visited 2 network Ports of Bangkok and Laem Chabang, Thailand, and then 3 ports in Myanmar, Port of Singapore, and two ports in Cambodia from 16 August to 20 September, 2009. Port of Songkhla, Thailand, and Ports of General Santos and Zamboanga, Philippines, were also covered by local consultants during the same period.

Schedule of on-site survey is shown in Table 1.2-4. Site visits to network ports are made jointly by JICA study team and Korea study team except ports of Indonesia.

(6) Development of Guideline

Guidelines for assessing port development priorities including acceptable performance levels are drafted in accordance with measure no.6 of the Maritime Roadmap. The study team summarized the answers to the questionnaire and analyzed relations between cargo handling capacities and several factors, i.e. size of port facilities, productivity of terminal operations, quantity of quay cranes and other related indicators. Based on answers to the questionnaire and analysis on network ports, the study team proposed Draft Guidelines.

Table 1.2-3 Result of collection of answers to the Questionnaire

Country	No.	Port	Ans.	A: Approach Channe: Pilotage Service	Length, W, D	Tidal Range	Remarks	Anchorage	Hinterland Trasnportation	Port Documentation: Responsible Authority for Port Entry/Departure	Necessary hours required for Port Entry Authorization	One Stop Service	B: Outline of Terminals: No. of Terminals	Berth Length	Shipcalls	DWT	Total Cargo (tons)	Container (TEUs)
Burunei	1	Muara		○	○	○	○	○	○	○	○	○	2	○	○	○	○	○
Cambodia	2	Phnom Penh	N															
	3	Sihanoukville																
Indonesia	4	Belawan		○	○	○	○		○	○	○	○	4	○	○	○	○	○
	5	Dumai	N															
	6	Tanjung Priok (Jakarta)		○	○	○	○	○	○				4	○				○
	7	Palembang		○	○	○	○	○										
	8	Panjang		○	○	○	○	○	○	○	○	○	9	○	○		○	○
	9	Pontianak		○	○	○	○	○	○	○	○	○	3	○	○	○	○	○
	10	Tanjung Perak		○	○	○	○	○	○	○	○	○	6	○	○		○	○
	11	Tanjung Emas (Semarang)		○	○	○	○	○	○	○	○	○	4	○				
	12	Makassar																
	13	Balikpapan																
	14	Bitung			○	○	○		○	○		○	3	○				
	15	Jayapura		○	○	○	○	○	○	○	○	○	3	○	○	○	○	○
	16	Sorong		○	○	○	○	○	○	○	○	○	3	○	○		○	
	17	Banjarmasin		○	○				○	○	○	○	5	○	○	○	○	○
Malaysia	18	Port Klang		○	○	○	○	○		○	○			○	○		○	○
	19	Penang											4	○	○		○	○
	20	Johore (Pasir Gudang)	N															
	21	Tanjung Pelepas	N															
	22	Kuantan		○	○			○	○	○	○		13					
	23	Kemaman		○	○			○		○	○		5	○				
	24	Bintulu		○	○	○	○	○	○	○	○	○	12	○	○	○	○	○
	25	Kuching		○	○	○	○	○	○	○	○		6	○	○	○	○	○
	26	Sandakan	N															
	27	Kota Kinabalu	N															
Myanmer	28	Yangon																
	29	Thilawa																
	30	Kyaukphyu	N															
Philippines	31	Manila		○	○	○		○	○	○	○		17	○	○	○	○	○
	32	Batangas		○	○	○	○	○	○	○	○	○	5	○	○	○	○	
	33	Subic Bay		○	○	○	○	○	○				28	○	○	○	○	○
	34	Cebu	N															
	35	Iloilo		○	○	○	○	○	○	○	○	○	3	○	○	○	○	○
	36	Cagayan de Oro		○	○	○	○	○	○	○	○	○	1	○	○	○	○	○
	37	Davao		○	○	○	○	○	○	○	○	○	1	○	○	○	○	○
	38	General Santos		○	○	○	○		○	○	○	○	14	○	○	○	○	○
	39	Zamboanga		○	○	○	○	○	○	○	○	○	2	○	○	○	○	○
Singapore	40	Singapore		○	○	○	○	○					54					
Thailand	41	Bangkok		○	○	○					○		10	○	○		○	○
	42	Laem Chabang		○	○			○					15	○	○	○	○	○
	43	Songhkla		○	○	○	○	○	○	○	○	○	1	○	○		○	○
Vietnam	44	Ho Chi Minh		○	○	○	○	○	○	○	○	○	24	○	○	○	○	○
	45	Haiphong		○	○	○	○	○	○	○	○	○	26	○	○	○	○	○
	46	Danang																
	47	Cai Lan		○	○	○	○	○					1	○	○	○	○	○

Country	No.	Port	C: Container Terminal: Throughput	Operator	Quay	Yard	Operation	Transportation	Documentation	D: Non-Container Terminal: Major Commodities	Quay	Yard	Operation	Throughput (tons)	Shipcalls	Transportation	Terminal Document
Burunei	1	Muara	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Cambodia	2	Phnom Penh															
	3	Sihanoukville	○	○	○	○	○	○			○	○		○	○		
Indonesia	4	Belawan	○	○	○	○	○	○	○	○	○	○	○			○	
	5	Dumai															
	6	Tanjung Priok (Jakarta)	○	○	○	○	○	○	○								
	7	Palembang	○	○	○	○	○	○						○	○		
	8	Panjang	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	9	Pontianak	○	○	○	○	○	○	○		○	○	○	○	○	○	○
	10	Tanjung Perak	○	○	○	○	○	○		○	○			○	○	○	○
	11	Tanjung Emas (Semarang)	○	○	○	○	○	○		○	○						
	12	Makassar	○	○	○	○	○	○	○								
	13	Balikpapan								○	○			○	○		
	14	Bitung	○	○	○	○	○	○	○	○	○	○				○	○
	15	Jayapura	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	16	Sorong		○	○	○	○	○	○	○	○	○	○	○	○	○	○
	17	Banjarmasin	○	○	○	○	○			○	○						
Malaysia	18	Port Klang	○		○	○	○		○		○	○		○	○		
	19	Penang	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	20	Johore (Pasir Gudang)															
	21	Tanjung Pelepas															
	22	Kuantan	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	23	Kemaman								○	○	○	○	○	○		
	24	Bintulu	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	25	Kuching								○	○	○	○	○	○	○	○
	26	Sandakan															
	27	Kota Kinabalu															
Myanmer	28	Yangon								○	○	○	○	○	○	○	○
	29	Thilawa								○	○	○	○			○	○
	30	Kyaukphyu															
Philippines	31	Manila	○	○	○	○	○			○	○	○	○	○	○	○	
	32	Batangas	○	○	○	○	○	○	○	○	○		○	○	○	○	○
	33	Subic Bay	○	○	○	○	○	○						○	○		
	34	Cebu															
	35	Iloilo	○	○	○	○	○		○	○	○	○	○	○	○	○	○
	36	Cagayan de Oro	○							○	○	○	○	○	○	○	○
	37	Davao	○	○	○	○	○	○	○		○	○	○	○	○	○	○
	38	General Santos	○		○	○	○	○	○	○	○	○	○				○
	39	Zamboanga	○	○	○	○	○	○	○		○		○	○	○	○	○
Singapore	40	Singapore		○	○	○											
Thailand	41	Bangkok	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	42	Laem Chabang	○	○	○	○					○	○	○				
	43	Songhkla	○	○	○	○	○	○	○	○	○	○	○	○	○	○	
Vietnam	44	Ho Chi Minh		○	○	○	○	○	○								
	45	Haiphong															
	46	Danang	○	○	○	○	○	○	○	○	○	○	○	○	○		○
	47	Cai Lan															

Country	No.	Port	E: Dry Bulk Terminal: Major Commodities	Quay	Yard	Operation	Throughput (tons)	Shipcalls	Transportation	F: Liquid Bulk Terminal: Major Commodities	Quay	Yard	Operation	Throughput (tons)	Shipcalls	Transportation
Burunei	1	Muara														
Cambodia	2	Phnom Penh														
	3	Sihanoukville									○			○	○	○
Indonesia	4	Belawan														
	5	Dumai														
	6	Tanjung Priok (Jakarta)														
	7	Palembang														
	8	Panjang														
	9	Pontianak														
	10	Tanjung Perak					○	○						○	○	
	11	Tanjung Emas (Semarang)														
	12	Makassar														
	13	Balikpapan														
	14	Bitung														
	15	Jayapura								○	○	○	○	○	○	○
	16	Sorong								○	○		○	○	○	○
	17	Banjarmasin	○	○	○		○									
Malaysia	18	Port Klang		○	○		○	○			○			○	○	
	19	Penang	○	○		○	○	○	○	○	○	○	○	○	○	○
	20	Johore (Pasir Gudang)														
	21	Tanjung Pelepas														
	22	Kuantan	○	○	○	○	○	○		○	○		○	○	○	○
	23	Kemaman								○	○	○	○	○	○	
	24	Bintulu	○	○		○	○	○	○	○	○		○	○	○	○
	25	Kuching								○	○	○	○	○	○	○
	26	Sandakan														
	27	Kota Kinabalu														
Myanmer	28	Yangon														
	29	Thilawa														
	30	Kyaukphyu														
Philippines	31	Manila														
	32	Batangas														
	33	Subic Bay								○	○			○	○	
	34	Cebu														
	35	Iloilo														
	36	Cagayan de Oro														
	37	Davao														
	38	General Santos	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	39	Zamboanga														
Singapore	40	Singapore														
Thailand	41	Bangkok														
	42	Laem Chabang														
	43	Songhkla	○				○	○								
Vietnam	44	Ho Chi Minh														
	45	Haiphong														
	46	Danang	○	○	○											
	47	Cai Lan														

Table 1.2-4 On-site Survey Schedule

Date		Team 1	Team 2
6/9	TUE		
6/10	WED	[DGST]	
6/11	THU	[ASEAN Secretariat]	
6/12	FRI		[Pelindo II]
6/13	SAT		
6/14	SUN		
6/15	MON	Surabaya Port	Pontianak Port
6/16	TUE		
6/17	WED		Tanjung Priok Port
6/18	THU	Semarang Port	
6/19	FRI		
6/20	SAT		
6/21	SUN		
6/22	MON	Banjarmasin Port	Palembang Port
6/23	TUE		
6/24	WED		
6/25	THU	Makassar Port	Panjang Port
6/26	FRI		
6/27	SAT		
6/28	SUN		
6/29	MON	Balikpapan Port	Belawan Port
6/30	TUE		
7/1	WED		
7/2	THU	Bitung Port	Dumai Port
7/3	FRI		
7/4	SAT		
7/5	SUN		
7/6	MON	[Jakarta]	[Jakarta]
7/7	TUE		
7/8	WED	[KL]	
7/9	THU	Port Klang Port	
7/10	FRI		
7/11	SAT		
7/12	SUN		
7/13	MON	Penang Port	
7/14	TUE		
7/15	WED		
7/16	THU	Kuching Port	
7/17	FRI		
7/18	SAT		
7/19	SUN		
7/20	MON	Bintulu Port	
7/21	TUE		
7/22	WED		
7/23	THU	Kota Kinabalu Port	
7/24	FRI		
7/25	SAT		
7/26	SUN		
7/27	MON	Sandakan Port	Johore Port
7/28	TUE		
7/29	WED		Tanjung Pelepas Port
7/30	THU	Muara Port	
7/31	FRI		
8/1	SAT		

Date		Team 1	Team 2
8/2	SUN		
8/3	MON	[VINAMARINE]	
8/4	TUE	Haiphong Port	
8/5	WED		
8/6	THU	Cailan Port	
8/7	FRI		
8/8	SAT		
8/9	SUN		
8/10	MON		
8/11	TUE	[18th MTWG]	Kuantan Port
8/12	WED		
8/13	THU		Kemaman Port
8/14	FRI		
8/15	SAT		
8/16	SUN		
8/17	MON	Danang Port	[Marine Department]
8/18	TUE		Bangkok Port
8/19	WED		
8/20	THU	Ho Chi Minh Port	Laem Chabang
8/21	FRI		
8/22	SAT		
8/23	SUN		
8/24	MON	[Manila]	[MPA]
8/25	TUE	Manila Port	Yangon Port
8/26	WED		
8/27	THU	Subic Bay Port	Thilawa Port
8/28	FRI		[MPA]
8/29	SAT		
8/30	SUN		
8/31	MON	Batangas Port	Kyaukphyu Port
9/1	TUE		
9/2	WED		
9/3	THU	Iloilo Port	[Yangon]
9/4	FRI		
9/5	SAT		
9/6	SUN		
9/7	MON	Cebu Port	Singapore Port
9/8	TUE		
9/9	WED		
9/10	THU	Davao	
9/11	FRI		[Bangkok]
9/12	SAT		
9/13	SUN		
9/14	MON	Cagayan de Oro Port	[MOT]
9/15	TUE		Phnom Penh Port
9/16	WED		Sihanoukville Port
9/17	THU	[Manila]	
9/18	FRI		[Phnom Penh]
9/19	SAT		
9/20	SUN		

1.2.2 Study Procedures

(1) Work Flow

The study started from March, 2009. Firstly, the study team prepared the Inception Report including a study method, study schedule, review of previous studies, on-site survey plan and key factors of port capacity assessment. Work flow of the study is shown in Figure 1.2-1. Based on preliminary studies on network ports, the study team drafted a questionnaire on details of port facilities, cargo throughput, navigational conditions and information concerning port/terminal operations.

At the beginning of the study, distribution of the questionnaire was planned at early stage, however, it was deferred to mid-May, 2009, due to unification of the questionnaire with that of measure no.5. After the coordination meeting in April, the questionnaire was finalized in mid-May and distributed to MTWG member countries.

It took four months since the distribution to collect answers to the questionnaire, but answers from several ports were not obtained. Necessary information on these ports were collected by means of interviews on site visits, port brochures obtained, homepages of ports and other available method.

(2) Study Team Members

The study team was organized by six members, in which four members are from the Overseas Coastal Area Development Institute of Japan and two members were from Mitsubishi Research Institute Inc. Member list is shown hereunder.

Mr. Tatsuyuki SHISHID,	Chief/Port Development Policy,	OCDI
Dr. Sumio SUZUKI,	Port Planning I,	OCDI
Mr. Masahiro YOSHIMI,	Port Management and Operation,	OCDI
Dr. Takeshi KOKADO,	Cargo Handling,	OCDI
Dr. Hiroshi MORI,	Port Planning II (Demand Analysis),	MRI
Mr. Kazuhito HACHIYA,	Transport Economy (Logistics),	MRI

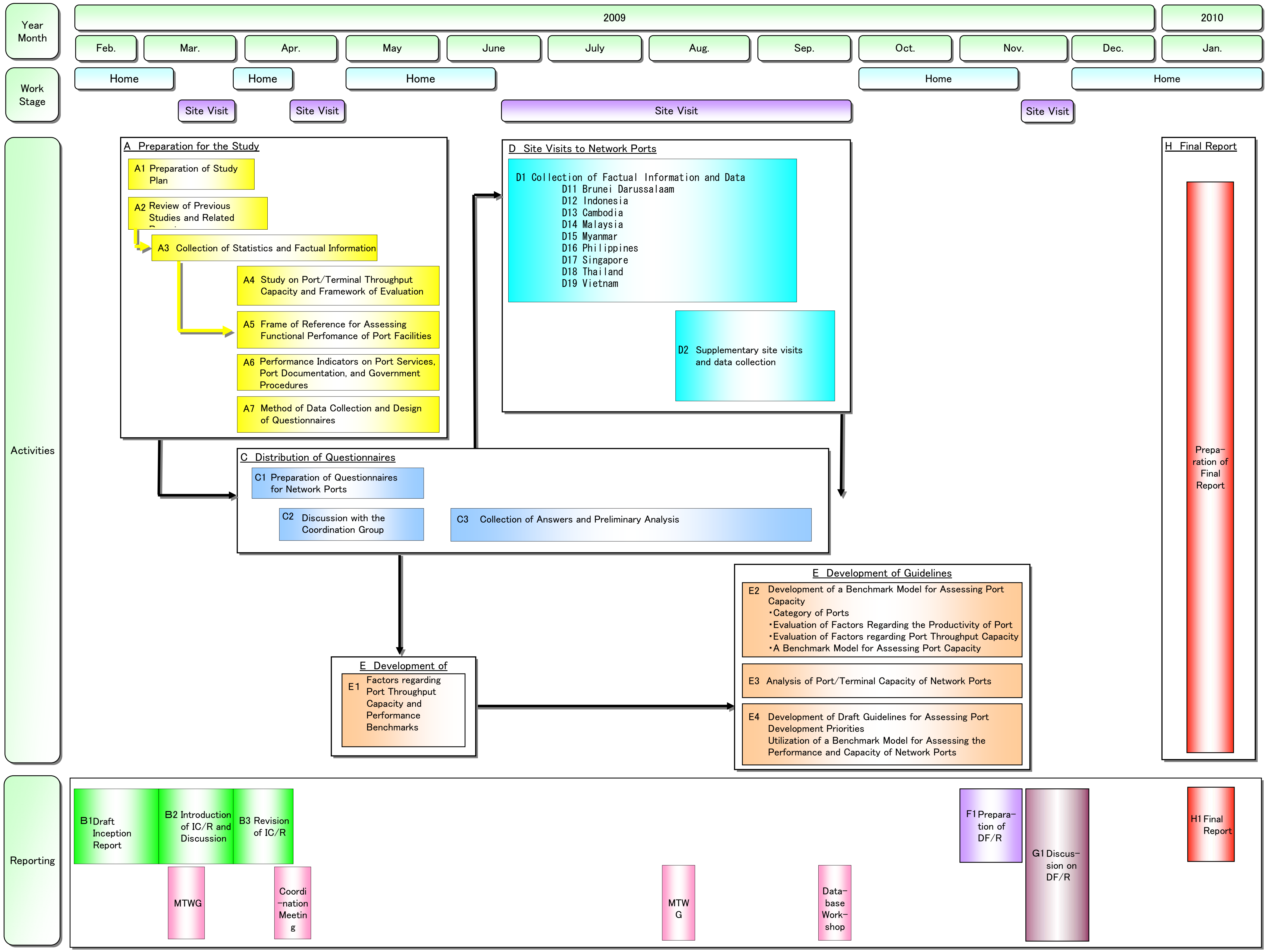


Figure 1.2-1 Work Flow

(3) Related Organizations

Related organizations of MTWG member countries are listed in Table 1.2-5, where the study team visited and collect factual information. The study team also had a discussion with these related organizations on port activities, recent developments and future plans under their jurisdiction or management.

Table 1.2-5 Related Organizations of Member Countries

Countries	**Organizations**
Brunei Darussalam	Ports Department & Marine Department, Ministry of Communications
Cambodia	Merchant Marine Department, Ministry of Public Works and Transport Sihanoukville Autonomous Port, Phnom Penh Autonomous Port
Indonesia	Directorate General of Sea Transportation Indonesia Port Corporation I, II, III, IV Port Authorities of Network Ports
Malaysia	Maritime Division, Ministry of Transport Sabah Ports Authority, Port Authorities in Sarawak and Peninsula
Myanmar	Department of Marine Administration, Ministry of Transport Myanmar Port Authority
Philippines	Department of Transportation and Communications Philippine Ports Authority, Cebu Port Authority, Subic Bay Metropolitan Authority
Singapore	Maritime and Ports Authority of Singapore
Thailand	Marine Department, Ministry of Transport, Ports Authority of Thailand
Vietnam	Vietnam Maritime Administration (VINAMARINE) of Ministry of Transport, Maritime Administration Offices

Chapter 2 Maritime Network and Ports Situation in ASEAN

2.1 Network Ports

ASEAN Transport Cooperation Framework Plan was made in 1999, in which 33 ports were identified as network ports to be included in the ASEAN regional transport network. Following this plan, MTWG[1] discussed the maritime network in the ASEAN region in January 2000, and selected 46 ports as ASEAN network ports. STOM[2] held in April 2000, approved the plan of the MTWG. Based on the implementation of the ASEAN Maritime Transport Development Study in 2002, one port was added to the network ports and now 47 ports are listed in the ASEAN network ports.

Each network port is selected to be part of the Trans-ASEAN Transportation Network from the viewpoint of its geographical location, role of the port, demand for the port and other necessity for the port. Additional network ports may be nominated in accordance with the economic evolution in ASEAN countries. Location of the present 47 network ports and their total cargo throughput are shown in Figure 2.1-1 and their actual cargo throughput volumes are indicated in Table 2.1-1. Port of Singapore handled more than 500 million tons in total, in which container cargo amounted to 300 million tons and liquid cargo to 167 million tons. Next biggest port in terms of volume is Port Klang handling 150 million tons in total, in which 130 million tons are container cargo. In addition, ports of Ho Chi Minh, Tanjung Pelepas, Laem Chabang and Balikpapan handled more than 50 million tons of cargo.

In terms of container throughput in the ASEAN region, Port of Singapore ranks first handling nearly 30 million TEUs in 2008. This figure includes the container throughput of PSA Singapore terminals and Jurong Port. Second largest container port is Port Klang handling nearly 8 million TEUs. Following these two ports, Port of Tanjung Pelepas handled 5.6 million TEUs and Port of Laem Chabang did 5.2 million TEUs. And furthermore, ports of Tanjung Priok, Ho Chi Minh and Manila handled more than 3 million TEUs in 2008. Classification of network ports is shown in section 6.1 of the report.

Liner shipping services from/to ASEAN network ports were identified from the Containership Databank[3] and compiled as shown in Appendix-3 and summarized inFigure 2.1-3. The shipping services listed in the databank are between major/medium class ports and local routes are therefore omitted. Number of services shown in Figure 2.1-3is not inclusive of local services in the region. Liner services to/from the Port of Singapore in the databank is about 250 per week followed by 123 of Port Klang, 87 of Tanjung Priok, 75 of Laem Chabang, and 64 Tanjung Perak. These ports play the role of the hub in the region.

Outline and present situation of each network port are summarized in PART II of the report.

1 The first meeting of the Maritime Transport Working Group
2 The 9th Senior Transport Officers Meeting
3 The Containership Databank, MDS Transmodal, 2008

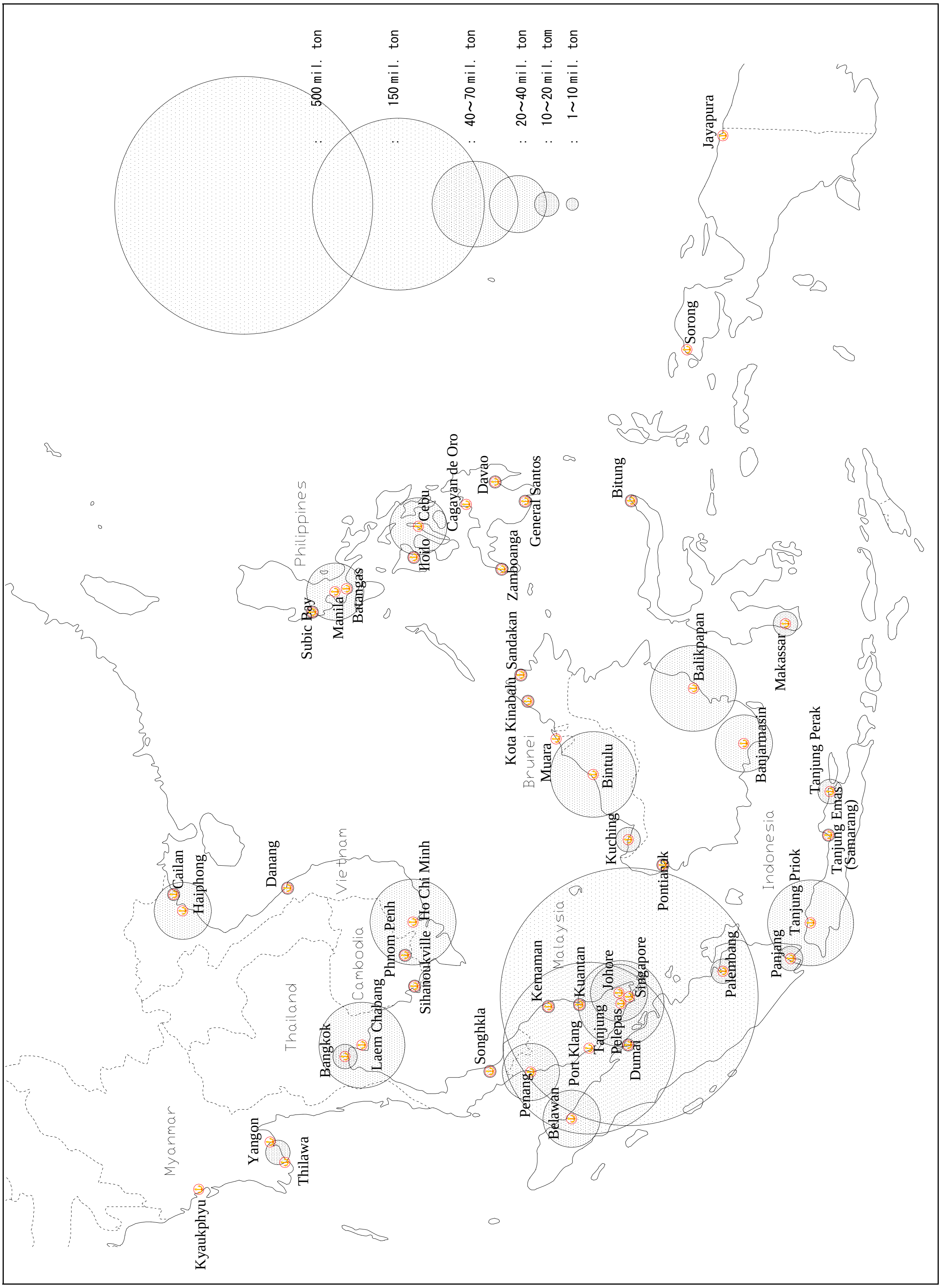


Figure 2.1-1　Location and Total Cargo Throughput of Network Ports

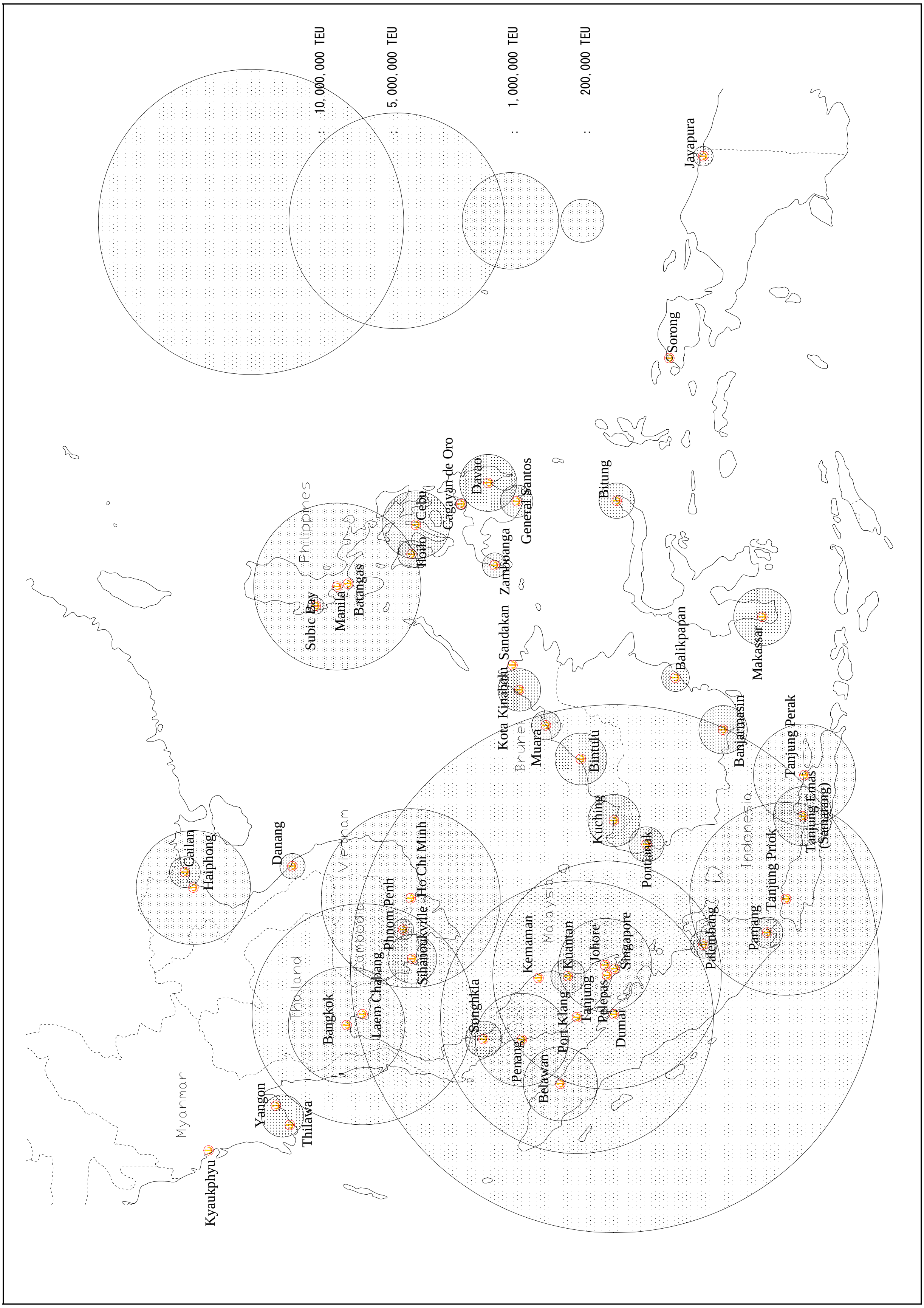
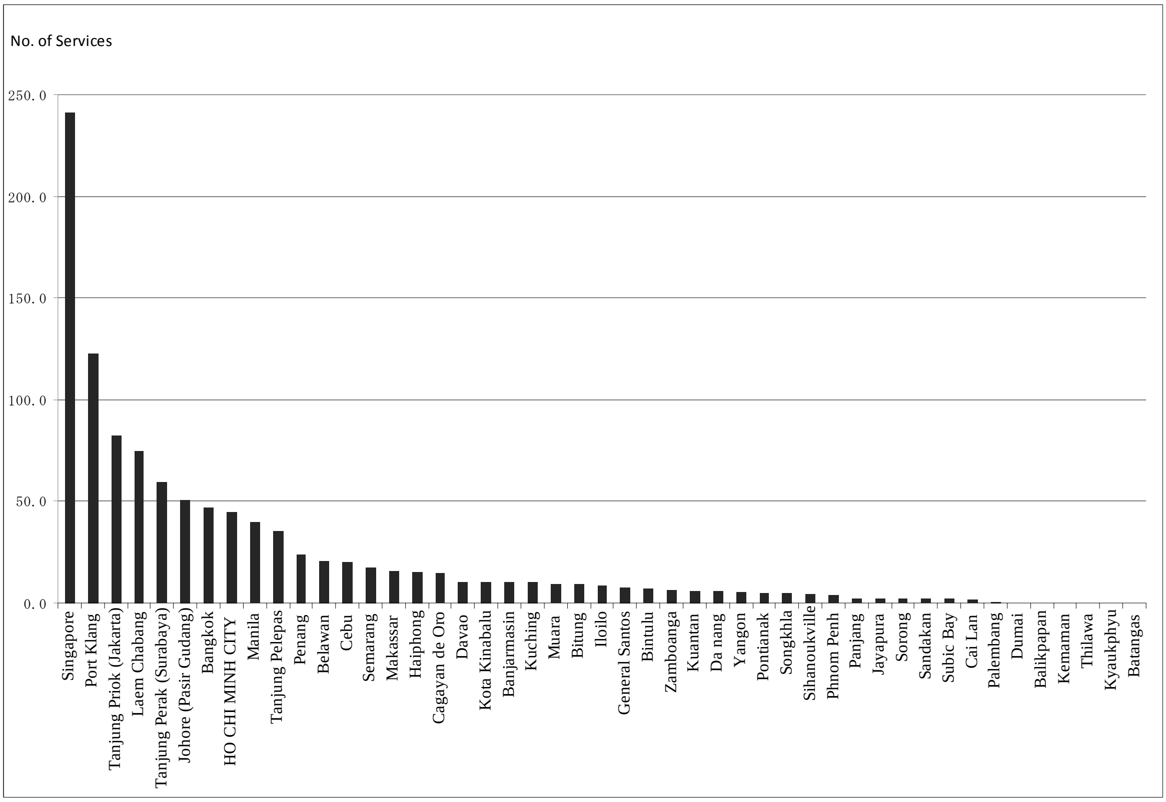


Figure 2.1-2 Container Throughput of Network Ports

Table 2.1-1 Total Cargo and Container Throughput of Network Ports

Coutry	Port	Total Throughput 2008 tons		Container 2008 TEU	
Brunei	Muara	948,033		90,372	
Cambodia	Phnom Penh	1,119,645	*	47,349	*
	Sihanoukville	2,057,966		258,775	
Indonesia	Belawan	20,094,000		590,069	
	Dumai	6,168,000	*	0	
	Tanjung Priok (Jakarta)	69,053,516	**	3,984,278	
	Palembang	10,964,803		78,469	
	Panjang	15,314,929		104,142	
	Pontianak	4,233,845		132,732	
	Tanjung Perak	12,011,157		1,119,353	
	Tanjung Emas (Semarang)	6,784,097		373,644	
	Makassar	10,147,382		353,247	
	Balikpapan	53,383,910		82,961	
	Bitung	3,971,338		134,756	
	Jayapura	882,834		42,563	
	Sorong	909,422	*	9,339	
	Banjarmasin	38,601,118		251,543	
Malaysia	Port Klang	152,348,510		7,973,117	
	Penang	25,999,896		929,639	
	Johore (Pasir Gudang)	25,312,782		936,000	
	Tanjung Pelepas	57,100,000	**	5,600,000	
	Kuantan	9,405,465		127,061	
	Kemaman	3,913,410		0	
	Bintulu	40,470,300		290,167	
	Kuching	11,460,182		291,063	
	Sandakan	9,910,000		0	
	Kota Kinabalu	6,758,793		193,854	
Myanmar	Yangon Thilawa	12,003,103		189,690	
	Kyaukphyu	21,627		0	
Philippines	Manila	40,303,151		2,997,022	
	Batangas	606,626		497	
	Subic Bay	3,135,870	**	29,370	
	Cebu	26,348,803		495,829	
	Iloilo	2,236,789		81,936	
	Cagayan de Oro	327,623		13,636	
	Davao	3,597,396		349,006	
	General Santos	1,936,854		113,886	
	Zamboanga	1,575,206		64,960	
Singapore	Singapore	515,415,000		29,918,000	
Thailand	Bangkok	17,767,818		1,460,713	
	Laem Chabang	54,837,542		5,240,075	
	Songkhla	1,830,381		140,356	
Vietnam	Ho Chi Minh	64,591,113		3,433,621	
	Hai Phong	25,054,027		1,398,654	
	Da Nang	2,784,517		61,881	
	Cai Lan	2,740,700		102,061	

* Data in 2007 ** Estimated



Note: Local services are not included.
Source: MDS Transmodal, Containership Databank, 2008

Figure 2.1-3 Liner Shipping Services (except Local Services) from/to Network Ports

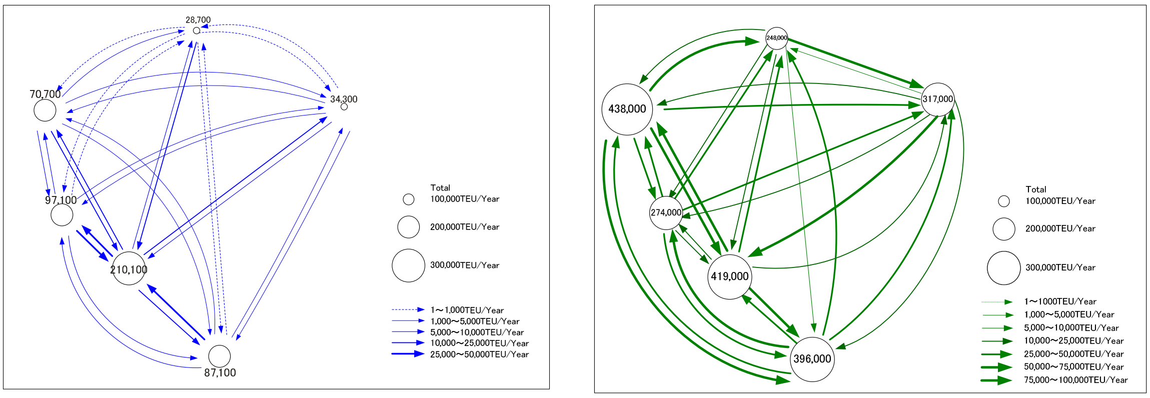
2.2 Intra ASEAN Liner Network

As a result of the remarkable growth of economies in ASEAN, the volume of cargoes which are shipped to/from ASEAN members is rapidly increasing. Accordingly, the seaborne routes have been developed. In the world of seaborne cargo, containerization has become very fundamental, and most general cargoes are containerized especially in trunk seaborne routes.

In ASEAN containerization is in progress to connect the trunk routes from local ports and to connect between local ports. Due to containerization, liner services by non-container ships are decreasing on in major routes. Liner containership networking become the basic network for seaborne trades and good networking, necessary for the growth of the region.

Figure 2.2-1 shows the volume and OD of seaborne container cargoes within the region. Containerization remarkably began in 1980 along trunk routes. In the ASEAN region, Singapore Port was developed cope with containerization. The port took advantage of its location along the route between East Asia and Europe. The volume of cargos and port activities dramatically increased in Singapore Port.

As shown in Figure 2.2-1(a), Singapore was the only one center in the region in 1992. But through economic growth and port development, Thailand, Indonesia, Malaysia, Philippines have come to handle more container cargoes. Trade among ASEAN increased as shown in Figure 2.2-1(b) by 2004.



(a) 1992 (b) 2004

Drafted from International Transportation Handbook, Ocean Commerce Ltd.

Figure 2.2-1 Seaborne Container Cargo Trade among ASEAN

Liner Network has been built up in accordance with the increase of container cargo demand. In general, the network of containership routes has the following characteristics;

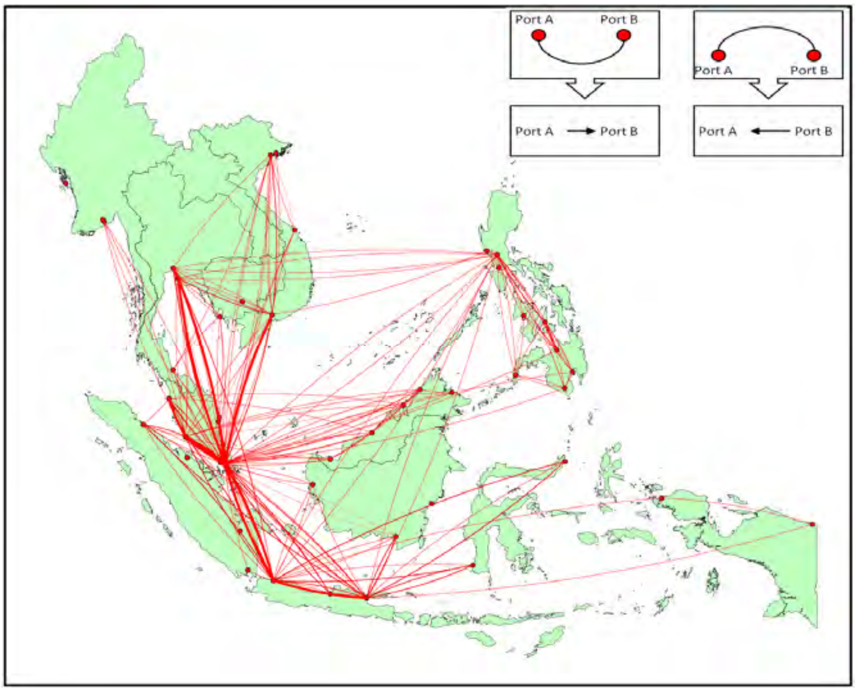
1) Large vessels are allocated to trunk routes to pursue effective transportation.
2) Feeder vessels are operated between ports where trunk routes call and ports where large vessels don't call.
3) Where the cargo demand in a port is not enough for a feeder vessel, the feeder vessels has to call on several ports in a circular route.
4) The vessels on the routes become liner vessels.
5) As the result of the vessel allocation, a hub & spoke network is created.

These characteristics are observed in the ASEAN liner network. Figure 2.2-2(a) shows the container liner routes between the 47 ports which are the target of this study. This figure is based on the database of container liners as of August 2008. [(Source: The Containership Database: MDS Transmodal Containership Databank) (Note: Routes where liners go on more than twice a month. Calls to ports other than the 47 network ports are excluded.) This belongs under the figure.]

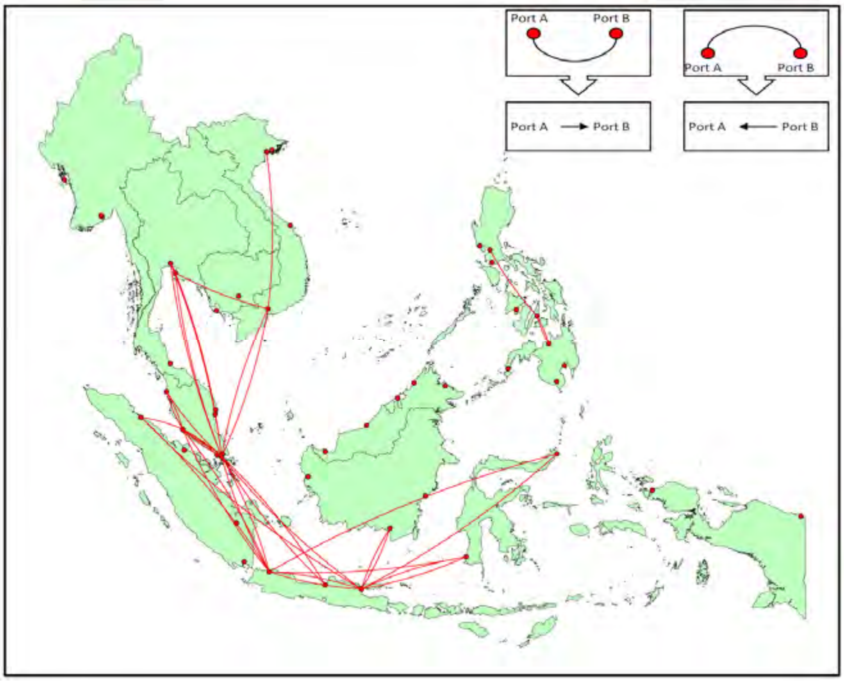
As seen in the figure, there are a lot of liner routes in the ASEAN region. Singapore Port, where trunk lines drop, attracts many ports among the 47 ports. Ports with large cities, such as Bangkok, Jakarta, Surabaya, Manila, Hanoi, Hohchiminh also attracts many routes.

However, the links to/from such ports are not strong compared to links of Singapore. Figure 2.2-2(b) shows the liner routes where at least 7 vessels are allocated in a week. The routes extracted here are routes which connect to Singapore, routes in East Indochina, routes in Indonesia, and routes in the Philippines. Philippines and Indonesia are geographically close, but the connection between them in the network is not strong.

In conclusion, the current liner network is basically built around Singapore. Other links are closed in local areas. But in future, the liner network will be developed to connect to each other directly in line with the growth of the ASEAN economy.



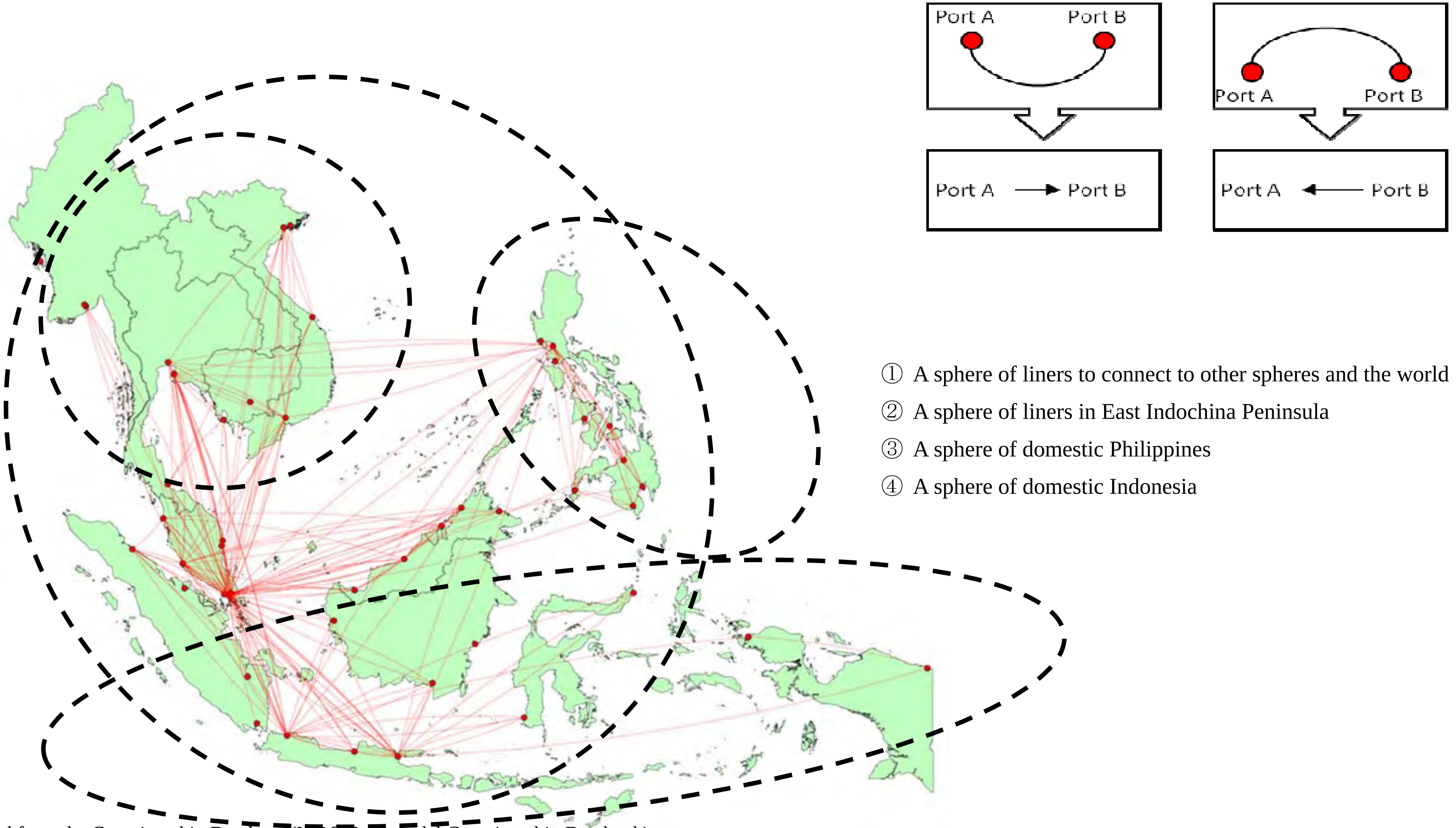
(a) More than twice a month



(b) More than 7 times a week

Drafted from the Containership Database (MDS Transmodal Containership Databank)

Figure 2.2-2 Container Liner Routes among ASEAN Region (August, 2008)



Drafted from the Containership Database (MDS Transmodal Containership Databank)

Figure 2.2-3 Container Liner Routes among ASEAN Region (August, 2008)

2.3 Clarification and Comparison of 47 Network Ports

In this study, we clarify the present situation of the 47 network ports in terms of port facilities, cargo throughput, ship traffic, port management and operation and other important aspects related to port performance by means of questionnaires, etc. Figure 2.3-1 - Figure 2.3-5 show correlation of the cargo throughput and a factor as follows:

a) Length of Berth (m/Berth)
b) Water Depth（m）
c) Number of Quay Cranes (Unit/Berth)
d) Productivity of a Quay Crane (Unit/hour)
e) Area of Container Terminal (m2/Berth)

Among these factors, “Number of Quay Cranes“ has strong correlations with the cargo throughput.

Ranks shown in Figure 2.3-1 - Figure 2.3-5 are levels of container throughput per berth as indicated in Table 2.3-1.

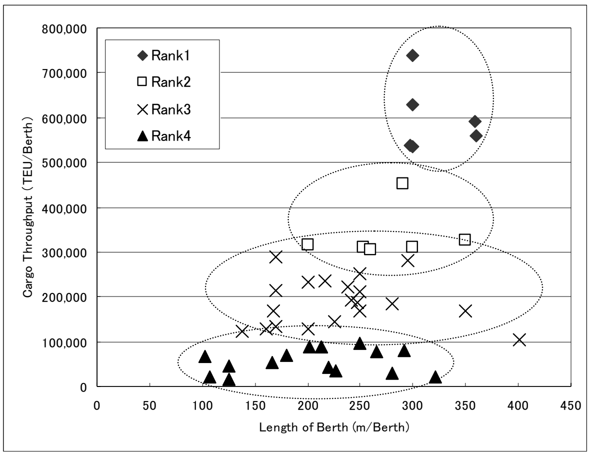


Figure2.3-1 Correlation with length of berth and cargo throughput per berth

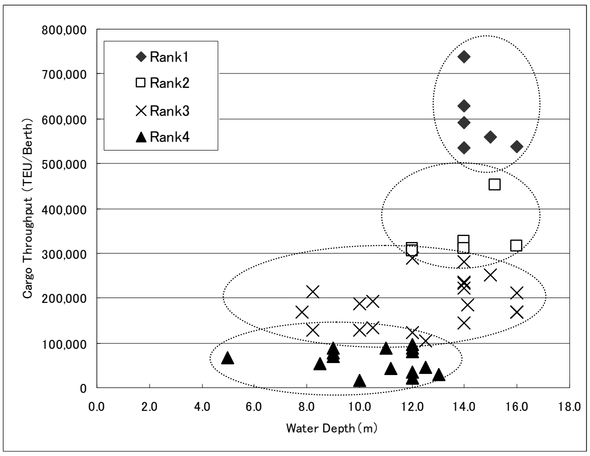


Figure 2. 3-2 Correlation with water depth and cargo throughput per berth

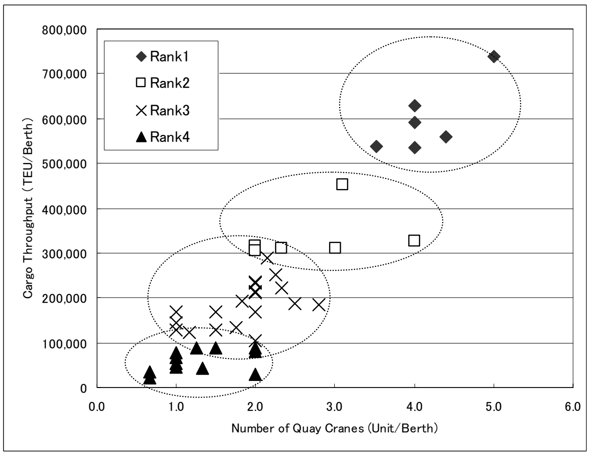


Figure 2. 3-3 Correlation with number of quay cranes and cargo throughput per berth

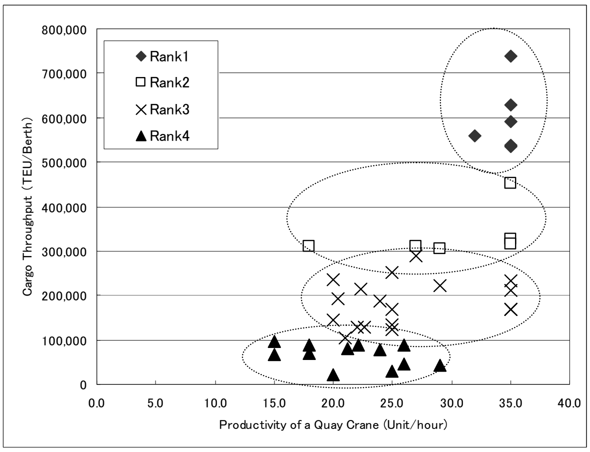


Figure2. 3-4 Correlation with productivity of a quay crane and cargo throughput per berth

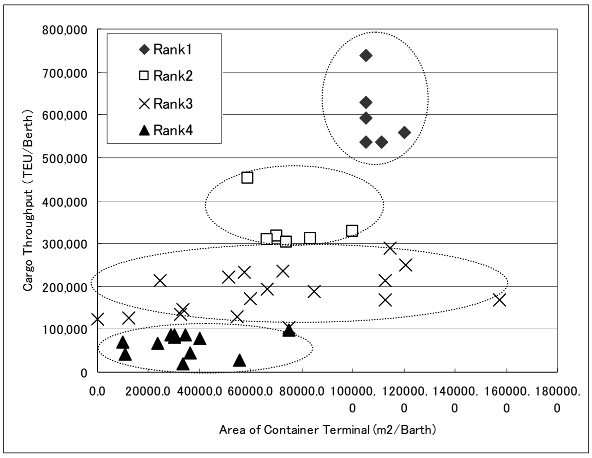


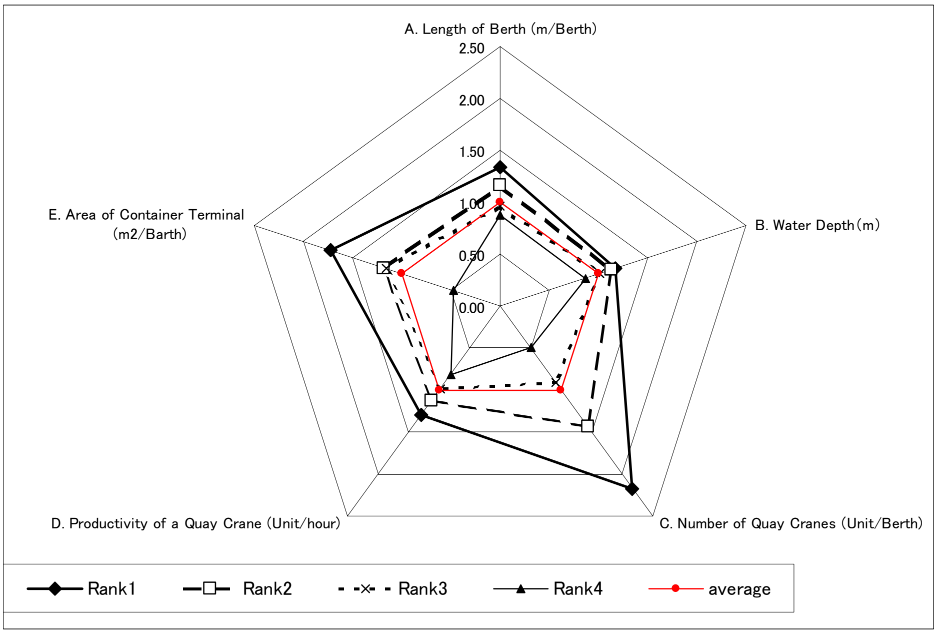
Figure 2. 3-5 Correlation with area of container terminal and cargo throughput per berth

Table 2.3-1 and Figure 2.3-6 show average level of each factor by container throughput ranking. Among these factors, the biggest range of coefficient between rankings is for "Number of Quay Cranes", and second biggest range is for "Area of Container Terminal". To raise up productivity of berth, many quay cranes and/or wide area of container terminal are provided strategically in the high competitive terminal.

Table 2.3-1 Average level of each factor by container throughput ranking

Ranked by Container Throughput per berth	Length of Berth (m/Berth)	Water Depth (m)	Number of Quay Cranes (Unit/Berth)	Productivity of a Quay Crane (Unit/hour)	Area of Container Terminal (m^2/Berth)
Rank1:Over 500,000 TEU	320	14.5	4.2	34.5	109,000
Rank2:300,000-500,000million TEU	280	13.9	2.7	29.8	75,000
Rank3:100,000-300,000 million TEU	230	12.4	1.7	26.0	73,000
Rank4:Under 100,000 TEU	210	10.6	1.0	21.6	30,000
Average	240	12.3	1.9	26.5	63,000

Source：Questionaire



Source: Questionair

Figure 2.3-6 Average level of each factor by container throughput ranking when total average is 1.00

Chapter 3 Necessity for Guidelines

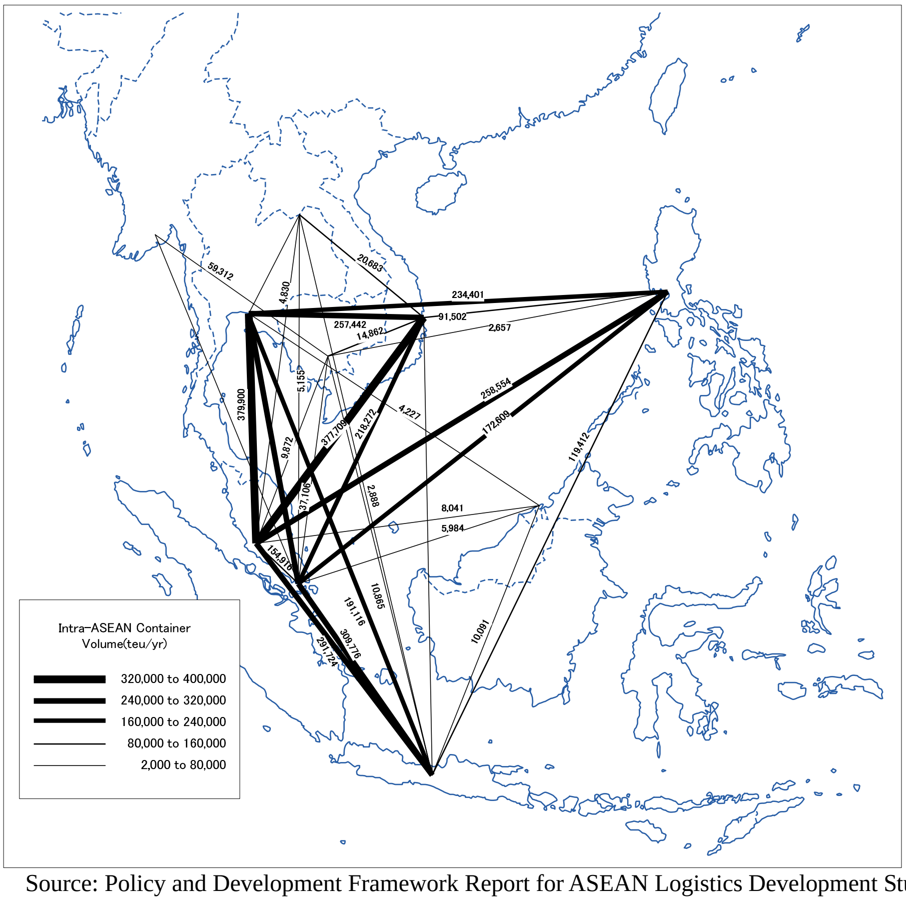
3.1 Importance of the ASEAN Maritime Network

Maritime network is an infrastructure for economic growth. This network has to serve the increasing trade demand. A good transportation network must offer accessibility, speed, reliability, and safety. To satisfy the demand and the need of seaborne transportation, maritime network has to be actively developed.

Most of general cargo (non-container) vessels, dry bulk carriers, and tankers operate as trampers. In the days when container vessels were not popular, many general cargo vessels operate as liners, but now liners of general cargo are decreasing. The operations of trampers are dictated by specific requirements of shippers or customers. The demand for new voyage routes and new port facilities will follow the policy of industries and strategy of companies. Bulk cargo carriers bring energy such as Crude Oil and Coal, and basic materials for industries such as Palm Oil. The routes are necessary for regional development and have to be developed according to the demand and needs.

Meanwhile, container vessels operate on fixed schedule and routes. The lot size is relatively small compared to bulk cargo, and one vessel can carry cargo for many final destination and many customers. Container vessels bring many types of commodity for industries and lives in the region. The routes are important for the future development of the region.

Figure 3.1-1 shows the outlook on Intra-ASEAN container OD pattern in 2020. Each economy is connecting other economies directly and there will be a strong demand to transport containers directly. Transportation is required to be safe and stable as well as speedy.



Source: Policy and Development Framework Report for ASEAN Logistics Development Study.

Figure 3.1-1 Outlook on Intra-ASEAN Container Desire Lines by 2020

The network of container liners represents a Hub & Spoke type network in the primary stage. The commodities are collected to a hub port where many vessels call. These commodities are the delivered to the various destinations from the hub port.

According to the increase of trade, larger transportation capacity is required in a ‘spoke transport’, and a greater increase of demand will require direct routes from the origins to the destination. Container network is more urgently required in many regions than bulk carriers’ network because a container network is a trigger for regional development. Network ports are to be developed to build up the transportation network.

Seaborne transportation is growing and changing. For example, vessel sizes are becoming larger according to the increasing demand of transportation. In particular, container vessels are deployed on the major trunk routes such as Asia-Europe and Asia-North America. Large vessels which were the operated on these routes will shift to other areas and will be replaced by evern larger vessels. ASEAN region where transportation demand is increasing is a candidate area for these large cascading vessels.

Network ports have to be developed to satisfy a certain level of transportation service. The examples are;

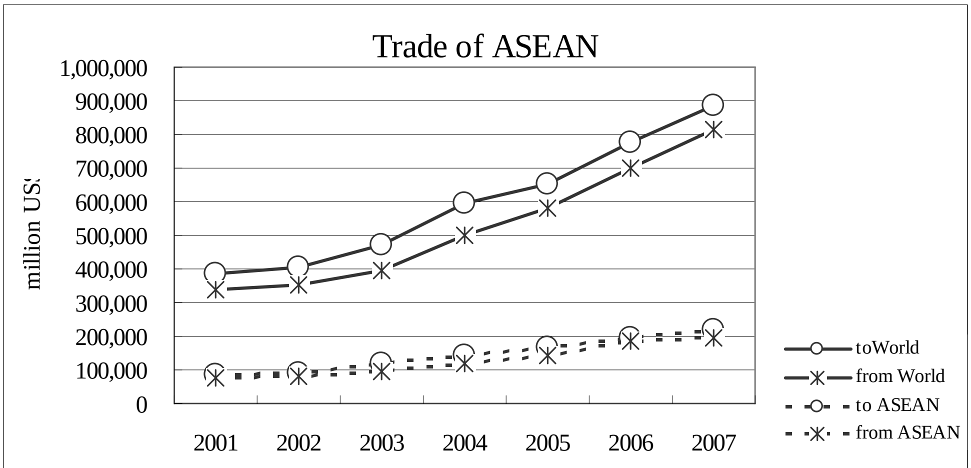
For Accessibility:	Access Channels (enough depth and width) and Berths (enough depth and length) for large vessels
	Good access (Road and Rail) to hinterland
For Speed:	Wharves having berths with sufficient length to a prevent waiting time
	Yards having enough area and handling machines for speedy cargo handling
For Reliability:	Breakwaters to keep the harbour tranquil for cargo handling
	Information System to avoid losses of cargoes
For Safety:	Information provision and assistance for voyages for safe transportation
	Security system and procedure

Network ports should be developed effectively as infrastructures of the transportation network. Each port should have a certain level of facilities and services as an element of the network.

3.2 Demand and Supply Gap and Issues in forming Maritime Network Infrastructure

ASEAN is an economically integrated group with a total population of 574 million (8.6% of the World), a GDP of US$ is 146 million (2.4%) and a total trade value of US$ is 210 million (6.1%). Compared with EU and NAFTA, the population of ASEAN is greater but the scale of economic activities is lower. However, its economic activities have been expanding year by year and amount of trade between ASEAN countries and other countries in the world has increased at a rate of 10% to 20% per year since 2001. On the other hand, trade among ASEAN countries also is increasing steadily. This means that demand for ports is expanding in terms of both quantity and quality. With the expected further economic growth of ASEAN countries, the demand for ports will increase in future.

However, investment for port development is limited in some ASEAN countries. Ports in such countries can not provide the required services because of shortage of capacity. This capacity shortage at ports might become obstacles to economic growth of ASEAN countries which aim at expanding its economic activities through expanding foreign trade and foreign investment. It is important for ports in ASEAN to correct the demand and supply gap by improving port facilities and promoting efficient operation.



Source: JETRO

Figure 3.2-1 Trade within ASEAN and with World

Because ports are the connecting points between maritime transport and land transport, smooth and efficient transport through networks which are formed by shipping routes and ports are apt to be influenced by the capacity of ports. Capacity of a terminal depends mostly on the scale and performance of the terminal, i.e. number of berths, water depth of quay, berth length, number of quay cranes and yard cranes, performance of those cranes, area of stacking yard, apron, sheds and warehouses, cargo handling equipment, working hours, number of gangs, gate operations, and other related factors. In addition, depth of channels, tidal factors, ship congestion and maximum size of calling vessels also influence the capacity of a port. Moreover, capacity of a port depends on the land transportation such as traffic congestion on connecting roads, capacity of railway transportation, location and capacity of inland depots, traffic regulations on truck transportation from/to a port.

Not only the hardware of a port but also the software for port operation such as the documentation for ship entry and departure, cargo delivery, the procedure of customs clearance, immigration, and quarantine, and the performance of terminal operators have an effect on the capacity of a port

Maritime transport network is basic infrastructure for achieving a single market in the

ASEAN region and to this end efficient and competitive shipping service is of critical importance. However, economic development of ASEAN countries is at different stages, and the maritime transport infrastructure remains at poor levels in some countries while some countries' infrastructure has reached the highest level in the world. Efficient shipping service requires the same level of port infrastructure at every terminal on a service route. In particular, it is very important for network ports to satisfy the minimum requirement which entails securing a sufficient water depth of the navigation channel, installing quay side cranes, and developing dedicated bulk cargo terminals.

3.3 Integrated Network Combining Land and Maritime Transport

ASEAN promotes measures which shall be implemented jointly in the fields of policy integration, improvement of infrastructures, market integration and trade procedures etc aiming at establishing an economic community. Enhancement of transport networks among ASEAN countries is indispensable in order for ASEAN to become an economic community. In physical distribution, maritime transport network plays an important role. It is important that each country of ASEAN expands trading activities to the world and that ASEAN as one body develop economic relations with other countries/regions in the world. Networks connecting ASEAN with the world and networks within ASEAN region should be formed.

Table 3.3-1 Trade among ASEAN countries and the World (million US$)

		Brunei	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	ASEAN	World
Brunei	2000	0	0	25	0	7	0	0	239	461	0	732	3,162
	2005	0	0	1,089	0	12	0	1	135	184	0	1,421	5,633
	2008	0	0	2,141	0	103	0	0	174	80	0	2,499	9,433
Cambodia	2000	0	0	2	3	10	0	1	18	23	19	76	1,123
	2005	0	0	1	0	9	0	2	70	15	46	143	3,014
	2008	0	0	1	0	22	0	1	105	81	210	421	4,290
Indonesia	2000	26	52	0	1	1,972	65	820	6,562	1,026	361	10,884	62,139
	2005	39	94	0	2	3,431	78	1,419	7,837	2,246	678	15,825	85,660
	2008	57	160	0	5	6,813	345	2,437	15,993	4,895	1,781	32,487	155,060
Laos	2000	0	0	1	0	0	0	0	1	69	96	167	391
	2005	0	0	0	0	12	0	0	1	204	89	306	697
	2008	0	1	3	0	39	0	0	1	569	216	829	1,639
Malaysia	2000	254	71	1,707	2	0	231	1,727	18,050	3,550	475	26,068	98,155
	2005	353	109	3,322	6	0	246	1,974	22,010	7,585	1,160	36,765	140,980
	2008	459	154	6,420	11	0	261	2,940	34,247	9,050	2,765	56,307	217,448
Myanmar	2000	0	0	20	0	63	0	2	100	233	3	422	1,980
	2005	0	0	13	0	122	0	1	99	1,623	42	1,899	3,706
	2008	0	0	35	0	156	0	3	80	3,447	78	3,799	6,566
Philippines	2000	4	2	183	0	1,377	10	0	3,124	1,206	75	5,983	38,229
	2005	9	8	476	1	2,457	9	0	2,706	1,169	312	7,146	41,224
	2008	7	10	663	1	2,864	9	0	4,471	2,024	498	10,545	64,572
Singapore	2000	486	426	0	30	25,042	436	3,387	0	5,872	2,091	37,769	138,159
	2005	496	303	22,109	40	30,405	596	4,185	0	9,431	4,421	71,987	229,708
	2008	864	519	35,747	26	40,912	1,286	7,297	0	13,193	8,744	108,587	339,414
Thailand	2000	40	347	1,338	381	2,813	504	1,082	5,997	0	838	13,340	68,964
	2005	68	913	3,954	769	5,781	707	2,042	7,641	0	2,348	24,222	110,160
	2008	119	2,019	6,138	1,757	9,717	1,317	3,288	9,844	0	4,962	39,163	173,235
Vietnam	2000	2	142	249	71	414	6	478	886	372	0	2,619	14,483
	2005	0	556	469	69	1,028	12	829	1,917	863	0	5,743	32,447
	2008	0	1,131	1,396	119	1,606	25	1,102	2,166	1,244	0	8,789	60,816
ASEAN	2000	811	1,041	3,526	487	31,698	1,252	7,496	34,977	12,812	3,958	98,060	426,785
	2005	966	1,984	31,433	888	43,256	1,648	10,453	42,415	23,321	9,094	165,458	653,229
	2008	1,507	3,995	52,544	1,918	62,232	3,243	17,067	67,082	34,584	19,255	263,426	1,032,472
World	2000	1,402	1,992	34,121	617	82,023	2,760	45,726	127,038	57,614	14,156	367,448	6,387,850
	2005	1,515	3,899	79,739	1,132	109,310	3,238	52,542	174,078	103,647	34,389	563,490	10,363,300
	2008	2,408	7,362	131,711	2,522	165,801	6,362	75,850	285,578	162,012	75,083	914,690	16,018,200

Source: JETRO（Direction of Trade (IMF, June 2009））

Cambodia, Laos, Malaysia, Myanmar, Singapore, Thailand and Vietnam border each other and crossing borders through roads is common. In the Mekong Region, North-South Corridor, East-West Corridor and Southern Corridor are planned and some parts of road networks have been constructed. Ports are located at strategic points such as at starting points or last stops in the corridor and serve as gateways connecting their hinterland areas with overseas areas. Transport by inland waterway such as the Mekong River is also popular in several ASEAN countries. Connection between inland waterways and maritime transport networks strengthens the function of the transport network in the region. Ports in island countries such as the Philippines, Indonesia and Brunei are most important infrastructures as gateways of the countries or regions

Integrated transport networks formed by roads, inland waterways and maritime transport networks in the ASEAN region enhance the unity of ASEAN and contribute to the economic growth of ASEAN countries. Ports which are located at strategic bases which connect land corridors and maritime corridors are expected to carry out their functions in a reliable manner.

Chapter 4 Cargo Throughput Capacity of Port

4.1 Estimation of the Cargo Handling Capacity of Terminals

Cargo handling capacity of a terminal depends on the type of cargo, i.e. container, bulk, liquid bulk or Ro/Ro, and port facilities. Even in the same type, it differs by commodities, i.e. general consumption goods, grains, cement, ores, vehicles, petroleum products and others. Terminal capacity is also restricted by the quality and quantity of port facilities, i.e. wharves, quay gantry cranes, yard cranes, warehouses, open yard space, silos and other facilities/equipment.

In order to maximize the cargo handling capacity of a terminal, it is indispensable that all related facilities are properly developed and managed, namely channels and anchorages for vessel navigation, roads and railways for hinterland transportation, tugboats and pilot services for ship entry and departure, and breakwaters to ensure the calmness of basin. These factors and their relationships are shown in Figure 4.1-1. Firstly, it is necessary to assess the maritime transport demand for a port and estimate the volume and types of calling ships. Secondly, it is indispensable to check the water depth, width, length of navigational channel, tidal range, navigable hours, and other traffic regulations on ship entry and departure. Thirdly, it is also important to expedite procedures of customs clearance, immigration, quarantine and other trade control to improve the cargo handling capacity.

Terminal cargo throughput is reduced due to difficulties in hinterland transportation and storage capacity in the back area. If the traffic congestion on access roads causes delays in cargo transportation, restrictions on day traffic or other restraints of transportation, it considerably reduces the terminal throughput. In view of these factors, terminal throughput capacity is determined by the following four capacities.

1) Cargo handling capacity of the terminal
2) Ship traffic capacity of the navigation channel including restrictions on navigable ships
3) Hinterland transportation capacity of roads and railways, and capacity of inland depots
4) Capacity and time necessary for processing documentation for port entry, customs clearance and other import export activities

Among factors shown in Figure 4.1-1, following factors are deemed to have a large influence on terminal cargo throughput.

- Volume and size of accommodated vessels
- Turnaround time (Ship stay time) of calling vessel
- Ship waiting time for port entry and the maximum size of navigable ships
- Cargo handling equipment, crane productivity, working hours
- Size of yard area, storage capacity, container stacking capacity
- Number of lanes of access road, railway capacity, road congestion and operation hours of gate
- Navigational restrictions, length of access channel, tugboat service,
- Introduction of electronic documentation, single window

Taking into account these factors, following sections introduce port facilities and their standard productivities focusing on ASEAN network ports.

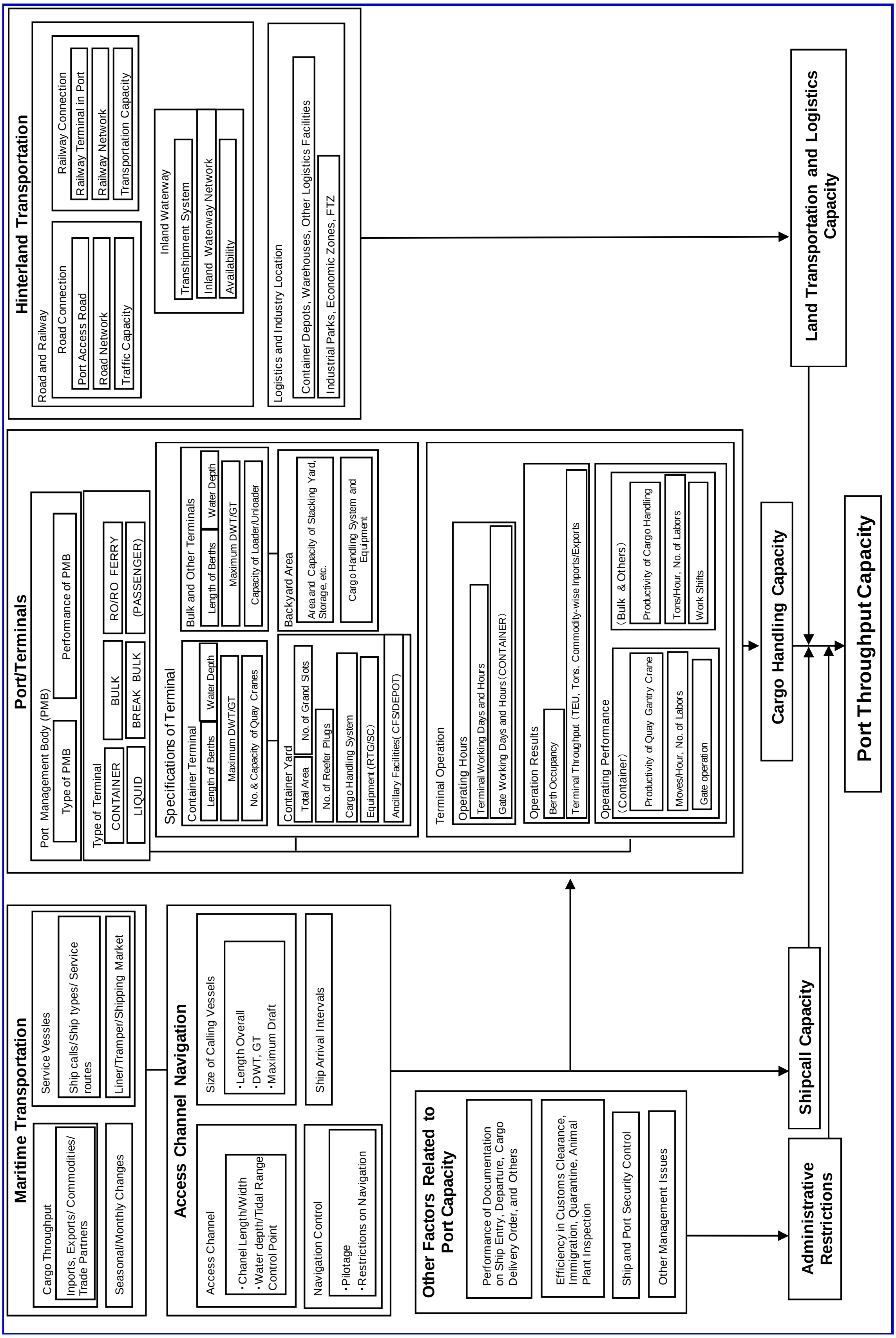


Figure 4.1-1 Factors related to Cargo Throughput Capacity of Port

4.2 Container Terminal

4.2.1 Container Terminal Facilities

Container terminal is comprised of berths, apron, marshalling yard and back yard area. Standard and requirements for these facilities are mentioned hereunder.

(1) Berth

Berth is the place where ships can be moored and loading and unloading operations are carried out. Continuous berth is suitable for accommodating various sizes of vessels. Water depth shall be enough to accommodate maximum size of calling vessels at any time of tide.

Dimensions of container vessels which are now deployed in liner services and their loading capacities are shown in Table 4.2-1 according to a recent study of the Technical Research Institute of MLIT, Japan. Container vessels deployed for local feeder services in the ASEAN region are about 10,000-10,000 DWT with a container loading capacity of 1000 TEUs. Maximum draft of these vessels is about 8-10 meters, however their operating draft is smaller than these figures due to the loading of empty containers and less cargo than their full loading.

Panamax type container ships, which were deployed for long range trunk liner services during the 1980’s to mid-1990’s, have a loading capacity of 4,000-4,600 TEUs. Dead weight tonnage of a Panamax ship is about 60,000 and its size is nearly 300m in length and 32m in breadth. Over Panamax container ships is more than 60,000 DWT. An over Panamax ship of 60,000 DWT has a length of 285m and breadth of 40m with a loading capacity of 4,300-5,400 TEUs and 85,000 DWT has a length of 304m, breadth of 43m with a capacity of 6,300-6,700 TEUs.

Table 4.2-1 Dimensions of Container Ships and Loading Capacities

Vessel DWT (Tons)	LOA (m)	Breadth (m)	Max Draft (m)	Loading Capacity TEU
10,000	139	22.0	7.9	500～890
20,000	177	27.1	9.9	1,300～1,600
30,000	203	30.6	11.2	2,000～2,400
40,000	241	32.3	12.1	2,800～3,200
50,000	274	32.3	12.7	3,500～3,900
60,000	294	35.9	13.4	4,300～4,700
100,000	350	42.8	14.7	7,300～7,700
(156,907*)	397	56.0	15.5	13,500～15,000

* Emma Maersk

Source: Takahashi, Goto, Abe, Statistical Research on Ship Diemnsions, Techinical Policy Research Institure, MLIT, Japan, March 2006

Size of berths necessary for accommodating is slightly different by the condition of calling container ships, i.e. full loading or half loading, ratio of empty containers, tidal range of port and other natural conditions. In consideration of these differences, Table 4.2-2 shows the minimum length and water depth of a container berth. In case of continuous berths, the length of a berth can be the shorter side of the range while it shall be the longer side in case of a single berth. Taking into account accommodating small container vessels for feeder services, berths shall be continuous in a line. Continuous berths are also recommendable for using quay gantry cranes in a flexible manner.

Table 4.2-2 Length and Depth by the Size of Container Ships

Vessel DWT (tons)	Minimum Berth Length (m)	Minimum/Standard Depth (m)
10,000	160-190	7-9
20,000	200-230	9-11
40,000	240-280	11-13
60,000	320-360	13-15
100,000	370-410	15-16
150,000	450-500	16-18

(2) Apron Area

Apron is the place where quay gantry cranes are installed and loading and unloading operations are taken place. The width of an apron is about 50-80m at from the waterfront line in large scale terminals. The apron width covers the length of back reach of quay gantry crane and space for placing hutch covers.

(3) Marshalling Area

Marshalling area is the place for stacking/marshalling containers unloaded from ships and carried in from the outside. Necessary size of marshalling area depends on the volume of container stacking, which is related to dwelling time of containers, stacking height, ratio of reefer containers, volume of empty containers, and type of equipment. A large scale container terminal has a marshalling area of 7-11ha per one berth. The width of a frontage of marshalling yard is usually the length of berth and the width of the side is about 150m in small scale terminals and 250-330m in large scale terminals.

(4) Backyard Area

Back yard area is the place for container freight station, maintenance shop, administration buildings, container truck gates, power supply station and other ancillary facilities. The size of the area is about 7,500m^2 in case the marshalling yard is less than 9ha, and about 9,000m^2 in case the marshalling yard is over 9ha[1].

(5) Quay Gantry Crane

Quay gantry crane is an important factor in improving the performance of container terminals. Number of cranes to be installed at a berth shall be decided in consideration of berth productivity, i.e. number of boxes loaded and unloaded at a berth in one hour. Terminals are requested to finish all container handling for a ship within 24 hours. Number of quay gantry cranes to be installed depends on the volume of containers loaded and unloaded for a container ship.

Smaller scale network ports in the ASEAN region use mobile truck cranes, crawler cranes and/or floating cranes for container loading and unloading. In order to increase the container handling capacity of the port and allow a full container ship to call at the port, it is indispensable for container terminals to install quay gantry cranes. It is prerequisite for a full container ship service on a liner route that all ports on the route shall have available quay gantry cranes.

Portal cranes can be used for container handling, but the installation of quay gantry cranes

[1] Takahashi, A model to assess the scale of container terminal for port planning, Report of Technical Policy Research Institute, MLIT, Japan, No.10, 2003

improves the productivity and considerably increases the berth throughput. Most effective means to increase the performance of cargo handling is to install/increase the number of quay gantry cranes.

Scale of quay gantry crane and its historical change is indicated in Table 4.2-3. Until Panamax sized ships were introduced, quay gantry cranes had an outreach up to 38m and were capable of coping with 13 rows of containers. Together with the introduction of larger container vessels, the capability of cranes was dramatically increased and the latest generation of quay gantry cranes can cope with 23 rows with an outreach of 65.5m and a lifting height of 40m.

Table 4.2-3 Development of Quay Gantry Cranes

Item	Panamax First Generation	Panamax Second Gen.	Over Panamax First Gen.	Over Panamax Second Gen.	Over Panamax third Gen.
Year	1970	1975	1988	1993	1996
Container Rows	13 rows	13 rows	16 rows	18 rows	23 rows
Out Reach (m)	35	38	45.5	50	65.5
Lifting Height* (m)	25	27.5	35	36.2	40
Lifting Speed (m/min)	36-72	50-125	70-150	70-150	90-180
Trolley Speed (m/min)	125	180	210	240	240

* Above the ground level

Source: Tetsuka, OCDI Quarterly No.69, 2004

4.2.2 Container Terminal Cargo Handling Performance

(1) Inductive Model for Terminal Performance Assessment

The capacity of a container terminal is usually assessed by means of terminal simulation or in terms of detailed design of the container terminal in consideration of the ratio of imports and exports, ratio of transshipment, changes by days of week, or other specific factors. For making a master plan, it is convenient for planners to estimate the capacity by a simple method. This inductive method is proposed to make a rough assessment of a container terminal.

ESCAP proposed rough figures of container terminal capacities in 2001 as shown in Table 4.2-4 and revised the table in 2007. Benchmarks in the table of 2001 indicate minimum requirements for container ports and the table of 2007 shows the target performance of container terminals. Benchmarks in the Table 4.2-5 will be realized in case that the container terminal is fully equipped with proper facilities, cargo handling operations are executed for 24 hours 7days a week, shipping documentation and customs clearance are processed through IT systems in a short time.

Table 4.2-4 Typical Terminal Capacity of Container Port, ESACP, 2001

Class	Description	Throughput per berth (TEU)	Indicative cost per berth ($US m)
1	World class hub port	350,000	80
2	Major port with mainline services	300,000	60
3	Important secondary port	250,000	60
4	Feeder or regional port	200,000	40
5	Minor port using multipurpose facilities	100,000	40

Source: Regional Shipping and Port Development Strategies, MPPM/ ESCAP/UNDP Maritime Policy Planning Model, 2001, Publication 2153, p65

Table 4.2-5 Typical Terminal Capacity of Container Port, ESACP, 2007

Class	Description	Throughput per berth (TEU)	Indicative cost per berth ($US m)
1	World class hub port	680,000	100
2	Major port with mainline services	460,000	80
3	Important secondary port	300,000	60
4	Feeder or regional port	230,000	40
5	Minor port using multipurpose facilities	180,000	40

Source: REGIONAL SHIPPING AND PORT DEVELOPMENT, Container Traffic Forecast, 2007 Update, UN ESCAP, ST/ESCAP/2484, p57

As mentioned in “4.1 Estimation of the Cargo Handling Capacity of Terminals”, terminal throughput capacity is determined by following four capacities.

1) Cargo handling capacity of terminal
2) Ship traffic capacity of navigation channel including restrictions on navigable ships
3) Hinterland transportation capacity of roads and railways, and capacity of inland depots
4) Capacity and time necessary for processing documentation for port entry, customs clearance and other import export activities

Among many factors deemed to have an influence on terminal cargo throughput, following 5 factors are chosen for inductive modeling for terminal capacity assessment. Because sample data sets of these factors are easy to have using a questionnaire survey results, and these factors should have much to do with four capacities above.

a) Length of Berth (m/Berth)
b) Water Depth（m）
c) Number of Quay Cranes (Unit/Berth)
d) Productivity of a Quay Crane (Unit/hour)
e) Area of Container Terminal (m2/Berth)

This model is estimated by multiple linear regression analysis using sample data sets of terminals with high performance of container throughput per berth. By combinations of 5 factors, 31 cases are examined. Factor of “ Water Depth ” is excluded finally, because it is not so significant. Estimated model is shown as Figure 4.2-1.

$$Y = -214{,}784 + 300.43 \cdot X1 + 96{,}520 \cdot X2 + 5{,}200.6 \cdot X3 + 0.83659 \cdot X4$$

(-2.73)　(0.72)　(3.05)　(1.71)　(0.97)

Coefficient of determination ＝ 0.94

i.e
- Y : Performance (TEUs/Berth)
- X1 : Length of Berth (m/Berth)
- X2 : Number of Quay Cranes (Unit/Berth)
- X3 : Productivity of a Quay Crane (Unit/hour)
- X4 : Area of Container Terminal (m2/Barth)

Remarks) Figure in a parenthesis means t-value of the coefficient on parameter.

Figure 4.2-1 Estimated Model related to Cargo Throughput Capacity of Port

This model is applicable for assessing the capacity of container throughput per berth in case the four parameters fall in the following range. Berth length is 150m-500m, number of quay gantry cranes per berth is 1-5, crane productivity is 18-35 unit/hour, and the size of container terminal area is 3ha -12ha. The model can calculate the capacity if parameters are not within these ranges, but the result is not reliable due to low t-value of the coefficient on some parameters.

The output of this model is not the design capacity of a terminal but an operational capacity. Operational capacity is the cargo throughput which may be appropriate in consideration of the interruption by repair work or any trouble, seasonal changes in cargo demand, and redundancy necessary for operations. The output may correspond to 75% to 85% of the design capacity.

Judging from the sensitivity of parameters of the model, number of quay gantry cranes installed plays the most influential factor on terminal throughput capacity followed by crane productivity. The size of berths and terminal areas are also important factors to determine the capacity of container throughput. If a container terminal is equipped with 4-5 quay gantry cranes per berth and those are operated with a productivity of 35 units per hour or more, the terminal can realize the performance of more than 600,000 TEUs per year.

(2) Design Capacity of Mega Operator’s Terminals

Container terminal capacities of a mega terminal operator are shown in Table 4.2-6. In world class hub ports like ports of Hong Kong and Singapore, design capacity of terminal is 610,000-750,000 TEUs per berth. Port of Tanjung Pelepas designs their terminals with a capacity of 800,000 TEUs per berth and 1 million TEUs per berth in the future.

In major ports for trunk liner services, design capacity varies widely from 330,000 TEUs per berth to 730,000 TEUs per berth (average is 471,000 TEUs per berth). In large scale ports for regional container shipping, design capacity ranges from 250,000 TEUs to 500,000 TEUs per berth (average is 350,000 TEUs per berth). In small feeder ports, design capacity ranges from 125,000 TEUs per berth to 265,000 TEUs per berth (average is 191,000 TEUs per berth). Terminal capacities in Table 4.2-5 fall in the middle of the range of the design capacity of mega terminal operators. Design capacity of a mega terminal operator may be summarized as follows:

Class 1: 611,000-749,000 TEUs
Class 2: 333,000-733,000 TEUs
Class 3: 250,000-500,000 TEUs
Class 4: 125,000-265,000 TEUs

In case of a large scale container terminal with a length of 500m berth and several gantry cranes per a berth, its design capacity sometimes reaches to 1 million TEUs per berth. These special terminals shall be dealt with case by case.

In the abovementioned classification, Class 1 means “World class hub port”, Class 2 “Major port with mainline services”, Class 3 “Important secondary port” and Class 4 “Feeder or regional port” as shown in Table 4.2-5. In the Table 4.2-6, each class is represented by following ports.

Class 1	:	Hong Kong, Busan New Port, Singapore
Class 2	:	Thi Vai, Dalian, Dongguan, Fuzhou, Tianjin, Genoa (Volti Terminal), Laem Chabang ESLC Chennai, Hazira, Inchon, Panama, Sines, Mersin
Class 3	:	Guangzhou, Tuticorin, Kandla
Class 4	:	Kolkata, Venice, Rotterdam (Feeder Terminal), Pakistan Gwadar, UK Groatyamouth

Table 4.2-6 Design Capacities of Mega Terminal Operator

Country	Terminal	Berth Length (m)	No. of Berths	Water Depth (m)	Class	Design Capacity (1000TEU)	TEU/Berths (1000TEU)	Average TEU/Berths (1000TEU)
China	A	6,425	17	-15.5	1	12,730	749	
Korea	B	3,200	9	-17	1	5,500	611	665
Singapore	C	16,000	54	-16	1	35,000	648	
Vietnam	D	1,200	4	-12	2	2,200	550	
China	E	3,953	13	-17.8	2	5,000	385	
China	G	678	2	-13	2	950	475	
China	H	1,502	6	-16	2	2,000	333	
China	I	3,400	10	-16	2	5,850	585	
India	M	832	3	-15.5	2	1,500	500	
India	N	650	2	-15	2	1,230	615	471
Italy	J	1,200	4	-15	2	1,500	375	
Korea	R	900	3	-14	2	1,500	500	
Panama	S	330	1	-14.5	2	450	450	
Portugal	T	940	3	-16	2	1,400	467	
Thai	K	1,250	3	-14	2	2,200	733	
Turkey	U	1,500	6	-14	2	2,500	417	
China	L	810	4	-12.5	3	1,000	250	
India	P	370	1	-11.9	3	450	450	350
India	Q	545	2	-12.5	3	1,000	500	
India	V	411	2	-8	4	250	125	
Italy	W	852	3	-10	4	450	150	
Netherlands	X	300	1	-5.5	4	265	265	191
Pakistan	Y	602	2	-14.5	4	500	250	
UK	Z	200	1	-11	4	250	250	

Source: PSA International Terminals

4.2.3 Standard Productivities of Terminal Facilities

1) In major terminals for trunk liner services, the productivity of quay gantry cranes is about 30 units per hour or higher. Berth productivities are more than 100 units per hour. Highest berth productivity reaches more than 200 units per hour.
2) In feeder ports, the productivity of quay gantry cranes is about 20-25 units per hour and berth productivities are 40-50 units per hour.
3) In multi-purpose berths or general cargo berths, the productivity of portal cranes is about 20 units per hour or less.

While the sizes of calling container vessels vary greatly by ports, acceptable time for loading and unloading is less than 24 hours. Berth productivities are therefore required to cope with this time frame, and shall be 200 units per hour or over at a large scale busy transshipment port, 100 units per hour or over at major trunk liner ports.

A study on container crane productivity and berth productivity was made on major ports in Asia and some ports in Europe and USA. The result is shown Table 4.2-7. Quay gantry crane productivities are from 26-38 units per hour and berth productivities are from 104-228 units per hour except the ports of Ho Chi Minh and Manila. While the berth productivity of Cat Lai terminal in Ho Chi Minh City is 49 units per berth, it needs to be about 86 units per hour if the length of a berth is 300m instead of the actual length of 162m.

In case of a Panamax ship, which loaded and unloaded a total of 1,000-1,200 units (1,500-1,800 TEUs), her berthing hours were about 15-20 hours. When an over Panamax ship was deployed and loaded and unloaded a total of 1,700-2,000 units (2,800-3,000 TEUs), her berthing hours are around 20 hours. Despite the number of loading /unloading containers, container ship requires the berthing time of less than 24 hours. Berth productivities are therefore required to meet this acceptable berthing time.

Another important indicator of the service level of a container terminal is turnover time of a truck, which is necessary hours/minutes for a truck to wait at the entrance gate, enter the gate, pick up a container, and go out of the gate. Turnover time at major terminals in the world is from 15 minutes at Tanjung Pelepas, 25 minutes at Singapore, and 40 minutes at the Port of Los Angeles as shown in Table 4.2-7. Average turnover time of the 18 ports in the table is 30 minutes.

Table 4.2-7 Quay Gantry Crane Productivities and Berth Productivities

Port	Crane Productivity 2)	No. of QGC	Berth Productivity	Berth Open Hours	Gate Open Hours	Turnaround 1) Time
	Units/Hour	Units/Berth	Units/Hour	Hours	Hours	Minutes
Keihin, Japan	38.5	3.5	135	17.5	8.0	25
Hanshin, Japan	37.5	3.0	113	16.5	8.0	30
Hakata, Japan	38.0	3.0	114	24.0	11.0	25
Busan, ROK	28.0	4.5	126	20.0	20.0	16
Busan New Port, ROK	-	-	-	20.0	20.0	-
Qingdao, PRC	38.0	6.0	228	24.0	24.0	20
Shanghai, PRC	30.0	5.0	150	24.0	24.0	45
Shenzhen, PRC	35.0	4.0	140	24.0	24.0	30
Guangzhou, PRC	30.0	3.7	111	24.0	24.0	30
Hong Kong, PRC	38.0	4.3	163	24.0	24.0	40
Kaohsiung, RC	33.6	4.3	144	24.0	24.0	25
Singapore, Singapore	35.0	5.5	193	24.0	24.0	25
Tanjung Pelepas, Malaysia	32.0	4.0	128	24.0	24.0	15
Laem Chabang, Thailand	35.0	4.0	140	24.0	24.0	16
Ho Chi Minh, Vietnam 3)	27.0	1.8	49	24.0	24.0	-
Manila, Philippines	33.0	1.5	50	24.0	24.0	45
Rotterdam, Netherlands	30.0	5.0	150	24.0	24.0	50
Los Angeles, USA	26.0	4.0	104	21.0	17.0	40

Note 1) Turnaround time: Time from gate in to gate out including waiting time

Note 2) Net productivity: Number of containers handled per hour except a recess. Gross productivity: including a recess

Note 3) Berth length of Cat Lai, Ho Chi Minh is 162m/berth

Source: Kokado, OCDI Quarterly No.78, 2009

4.3 Conventional Terminal (Breakbulk)

Productivity of conventional terminals is largely affected by length and depth of berths and lifting capacity of cranes. In the terminals where direct delivery is implemented without temporary placement at transit sheds, an appropriate cargo handling plan should be prepared including the arrangement of delivery measures.

4.3.1 Standard Facility

Conventional Terminals normally consist of berths, quayside aprons, storage yards, transit sheds/warehouses.

(1) Berth

A berth is the place to serve for berthing of ships and loading/discharging cargo. The dimensions of berths are determined in length and depth. According to a statistical analysis on existing ships, the standard dimensions of cargo vessels by tonnage class are as shown in Table 4.3-1.

Table 4.3-1 Standard Ship Dimensions for Cargo Vessels

Vessel DWT (Tons)	LOA (m)	Breadth (m)	Max Draft (m)
1,000	67	10.7	3.8
2,000	82	13.1	4.8
3,000	92	14.7	5.5
5,000	107	17.0	6.4
10,000	132	20.7	8.1
12,000	139	21.8	8.6
18,000	156	24.4	9.8
30,000	182	28.3	10.5
40,000	198	30.7	11.5
55,000	217	32.3	12.8
70,000	233	32.3	13.8
90,000	251	38.7	15.0
120,000	274	42.0	16.5
150,000	292	44.7	17.7

Source: Takahashi, Goto, and Abe, Study on Ship Dimensions by Statistical Analysis, Research Report of National Institute for Land and Infrastructure Management, March 2006

The standard dimensions in the table are determined by calculating the 75th percentile line in each dead weight tonnage, which means that 75 percent of the whole data are less than the standard dimensions. The ship type of ‘Cargo Vessels’ in this statistical analysis includes general cargo ships, bulk carriers, and ore carriers.

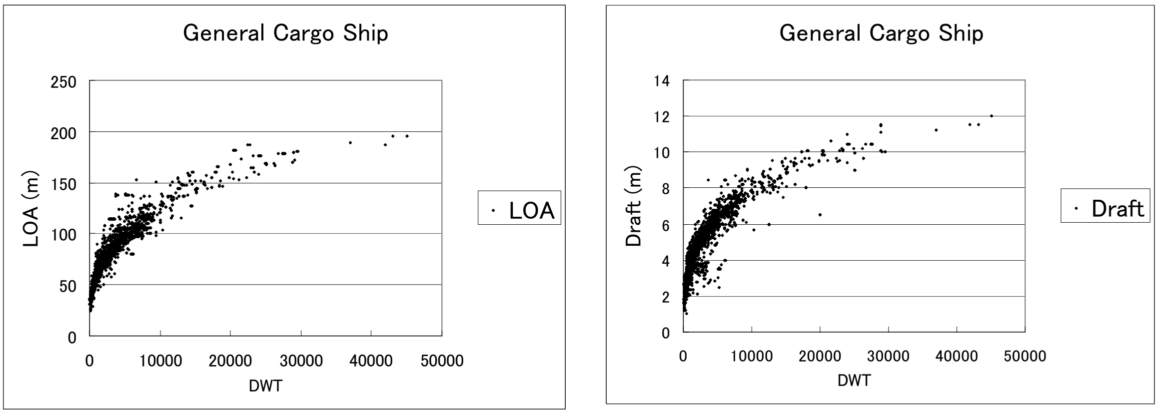
Table 4.3-2 shows the number of general cargo ships of which flag country is an ASEAN country. The operational area of a ship is not always limited to the sea around her flag country; nevertheless, the ships less than 10,000 DWT which cover 90 percent of all ships are supposed to be mainly operated in the domestic sea area or the sea within the ASEAN region. Meanwhile, the number of ships of 10,000 to 30,000 DWT is nearly two hundred and therefore the major ports in the ASEAN region need to accommodate ships of these sizes.

Table 4.3-2 The Number of ASEAN Countries' Flag General Cargo Ships

DWT	Number of Ships 1), 2)	Share
<5,000	2,382	77.4%
5,000-9,999	504	16.4%
10,000-14,999	97	3.3%
15,000-19,999	44	1.4%
20,000-24,999	26	0.8%
25,000-29,999	22	0.7%
30,000-34,999	0	0.0%
35,000-39,999	1	0.0%
40,000-44,999	2	0.1%
50,000+	1	0.0%
Total	3,079	100.0%

Notes: 1) The number includes the data for ships which will be delivered in 2009.
2) The number excludes the data lacking the ship's LOA or the ship's draft.
Source: World Shipping Encyclopedia July, 2009 (Lloyd's Register Fairplay)

Figure 4.3-1 shows the relation between dead weight tonnage and length overall/draft of ASEAN countries' flag general cargo ships. The figure indicates the data are substantially consistent with the standard dimensions for cargo ships.

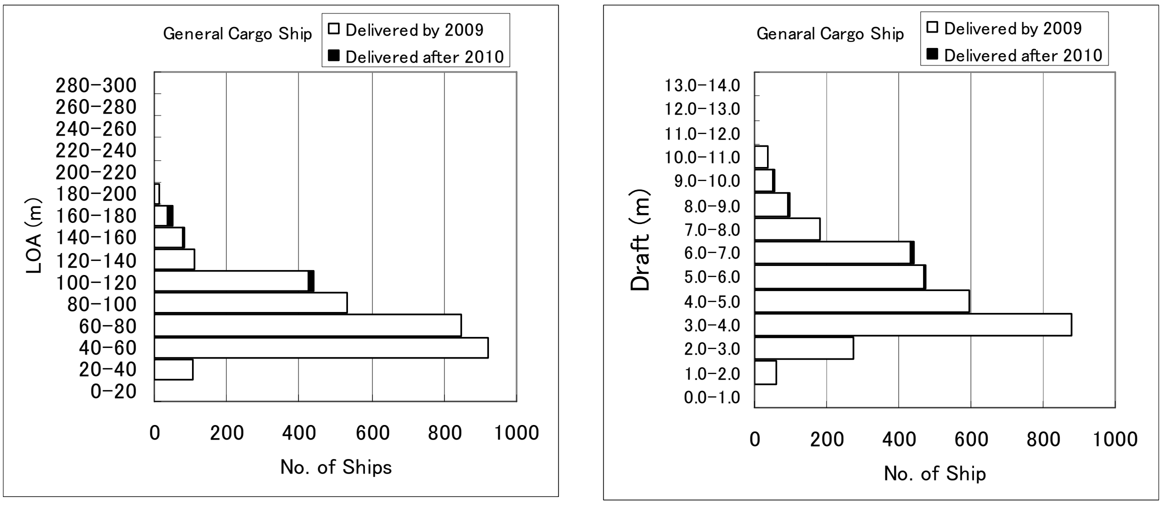


(1) Relation between DWT and LOA (2) Relation between DWT and Draft

Source: World Shipping Encyclopedia July, 2009 (Lloyd's Register Fairplay)

Figure 4.3-1 Ship Size of General Cargo Ship of ASEAN Counties' Flag

Figure 4.3-2 shows distributions related to relations between dead weight tonnage and length overall/draft. The figure indicates that the ships less than 120 meters in length overall and ships less than 7 meters in draft form the majority, however, the number of larger ships are is not negligible.



(1) Distribution of Length Overall (2) Distribution of Draft

Source: World Shipping Encyclopedia July, 2009 (Lloyd's Register Fairplay)

Figure 4.3-2 Distribution of Size of General Cargo Ship

The berths for conventional ships are various in sizes due to the difference in load factors of the ships when calling ports and tidal ranges in ports, but generally require the lengths and depths shown in Table 4.3-3.

Table 4.3-3 Required Length and Depth of Berth in accordance with Vessel DWT

Vessel DWT (tons)	Minimum Berth Length (m)	Minimum Depth (m)
1,000	80	4.5
2,000	100	5.5
3,000	110	6.5
5,000	130	7.5
10,000	160	9.0
12,000	170	10.0
18,000	190	11.0
30,000	240	12.0
40,000	260	13.0
55,000	280	14.0
70,000	300	15.0
90,000	320	17.0
120,000	350	18.0
150,000	370	20.0

(2) Quayside Apron

A quayside apron is a place for the placement of cranes, the passage of trucks, lifting cargo, and the temporary placement of cargo. The width of the apron should be more than 15 to 20 meters where transit sheds are located next to the apron and cargo is handled by forklifts, and more than 10 to 15 meters where roads or yards are located next to the apron and cargo is lifted directly between the ship and the truck on the apron.

(3) Storage Yard

A storage yard is an open space for the storage of cargo. The required area is determined based on the planned cargo throughput of the terminal, but it varies due to the differences in cargo capacity per unit area and/or turnover of cargo. The required area is normally calculated with the following formula.[2]

A=N/(r*w*R)
A：Required Area of Storage Yard（m^2）
N：Annual Cargo Throughput（tons/year）
R：Cargo Capacity Rate　0.5～0.7
w：Cargo Capacity per Unit Area（tons/m^2）1～4
R：Turnover（times/year）20～25

(4) Transit Shed, Warehouse

Both a transit shed and a warehouse are covered facilities. A transit shed is used for sorting, inspection, the temporary placement of cargo and normally located just behind a quayside apron. Meanwhile, a warehouse is used for long-time storage. The required floor area of a warehouse is calculated by the same formula as a storage yard, but the value of turnover is normally rated at 8 to 12 times per year.

4.3.2 Standard Productivity

The cargo handling productivity of a conventional terminal is generally measured in tons/hours/gang. A gang is a team of dock workers and one gang is assigned to one crane. The cargo handling productivity varies due to differences in the lifting capacity of a crane as well as commodity and type of package. Table 4.3-4 shows an example of targets of conventional cargo handling productivity by commodity and package type established for a terminal equipped with cranes of 6-ton lifting capacity.

Table 4.3-4 Example of Targets of Conventional Cargo Handling Productivity

Commodity	Type of Packing	Weight per Package	No. of Package per Lift	Average Cycle Time	Effi-ciency Ratio		Produc-tivity (tons/hr /gang)
Steel Coils	Coil	5 tons	1 coil	3 min/lift	80%	5*1*60/3*0.8	80
Lumber	Bundle	2 tons	3 bundles	5 min/lift	80%	2*3*60/5*0.8	57
Sugar	Bag	30 kg/bag	100 bags	5 min/lift	80%	0.3*100*60/5*0.8	38
Banana	Palletized with Carton	2 tons /pallet	2 pallets	3 min/lift	80%	2*2*60/3*0.8	80

Source: OCDI, Textbook on Improvement of Terminal Operation, March 2009

At some terminals in ASEAN countries, cargo is directly discharged onto trucks for delivery arranged by consignees or forwarders. This direct delivery would result in inefficient cargo handling at quayside if the trucks do not come on time. Similarly, in the case of placing cargo temporarily in a transit shed, a shortage in the number of forklifts would result in delays in transportation cycle for moving cargo between the quayside apron and the transit shed, and would lower the quayside cargo handling productivity. In addition to securing lifting capacity of cranes, the preparation of an appropriate cargo handling plan is indispensable for efficient cargo handling.

[2] JSCE, Handbook of Civil Engineering, 1989

4.4 Dry Bulk Terminal

Capacity of a dry bulk terminal is primarily affected by water depth and length of the quay, as well as cargo handling machines.

When assessing the capacity of a dry bulk terminal, it should be considered whether quay water depth and length of the quay and cargo handling facilities fit in well with the kind and the volume of the handling cargo, and the dimension of the called vessels.

4.4.1 Classification of Dry Bulk

Dry bulk cargo is commodity cargo that is transported unpacked in large quantities. Grain, coal and iron ore are the three major dry bulk commodities; the share of them in the world sea transport is about 24 %. Fertilizer, sugar, cement, woodchip, wood pulp, and mineral substances - bauxite, alumina, phosphate rock, manganese ore - are also transported unpacked. The annual volume of dry bulk cargoes in the sea transport is about 3.1 billion tons or about 37 % of the total.

4.4.2 Carrying Vessel

A carrying vessel of dry bulk cargoes is called bulker, and classified as shown in Table 4.4-1. Panamax Bulkers over 80,000 Dead Weight Tons are sometimes called Post Panamax Bulkers.

Table 4.4-1 Classification and Number of Bulkers

Classification	Dead Weight Tonnage	Number
Handysize Bulker	10,000 - 40,000 DWT	2,833
Handymax Bulker	40,000 - 60,000 DWT	1,801
Panamax Bulker	60,000 - 100,000 DWT	1,601
Capesize Bulker	100,000 DWT -	896
	Total	7,131

Source: Clarkson Research Services

Handysize Bulkers and Handymax Bulkers usually have cranes, derricks or conveyors that allow them to load or discharge cargoes in ports without shore-based equipment. This gives geared bulkers flexibility in the cargoes they can carry and the routes they can travel.

The size of a Panamax Bulker is limited by the Panama Canal’s lock chambers, which can accommodate ships with a beam of up to 32.31 m, a length overall of up to 294.13 m, and a draft of up to 12.04 m. Capesize Bulkers are too large to traverse the Suez or Panama Canals and must go around the Cape of Good Hope. These large size bulkers usually do not have their own gears and need ship loaders and unloaders equipped at terminals because they are usually used only for one commodity.

Based on the ships database by Lloyd’s register - Fairplay, the relationships between Dead Weight Tons (DWT) and Draft; DWT and Length Over All (LOA) of bulkers in service, except lakers and woodchip carriers, are shown in Figure 4.4-1 and Figure 4.4-2. The results of regression analyses show a high correlations between DWT and Draft; DWT and LOA. Each correlation coefficient (r) is 0.986 and 0.980 respectively.

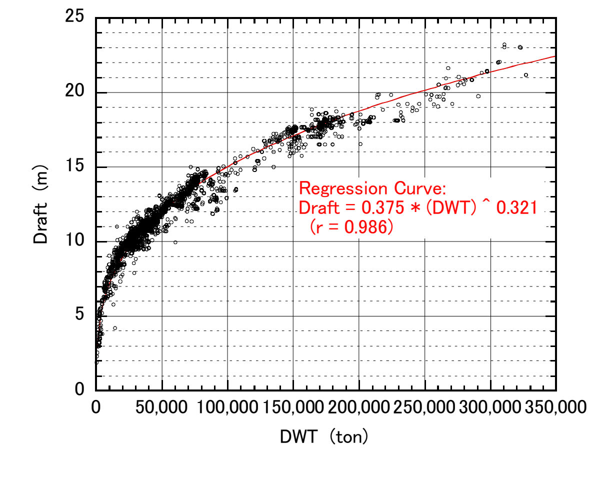


Figure 4.4-1 Relationship between DWT and Draft of Bulkers

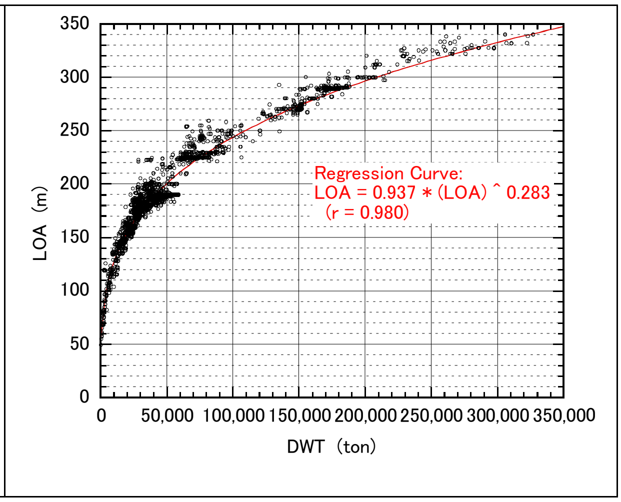


Figure 4.4-2 Relationship between DWT and LOA of Bulkers

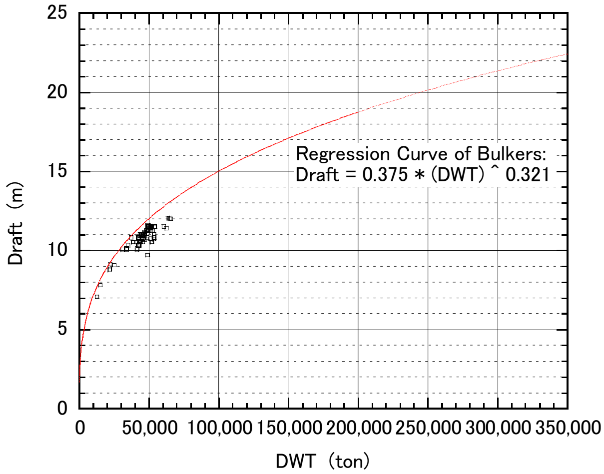


Figure 4.4-3 Relationship between DWT and Draft of Woodchip Carriers

Figure 4.4-3 shows the relationship between DWT and the draft of woodchip carriers in service with the regression curve obtained by other bulkers shown in Figure 4.4-1. The figure shows that the draft of woodchip carriers tend to be smaller compared to other bulkers. This is because the specific gravity of bulk wood chips is smaller than that of coal or iron ore, and bulk wood chips do not require topside tanks as there is a minimal risk of cargo flow; so woodchip carriers are designed flatter than other bulkers to ensure larger cargo space. The figure also shows that the typical size of woodchip carriers is around 50,000 DWT.

Consequently, when assessing the capacity of a dry bulk terminal, it should be considered whether the water depth and the length of the quay fit in well with the dimension of the called bulkers. On the other hand, when planning a new dry bulk terminal, the water depth and the length of the quay should be determined through studies on the kind and the volume of the handling cargo, and the dimensions of the called bulkers including vessels being built.

4.4.3 Cargo Handling Facilities

Dry bulk cargoes are loaded by shiploaders and discharged by unloaders. Shiploaders are usually used for loading dry bulk cargoes continuously and effectively. Types of shiploaders are classified by functions of their features and capabilities as shown in Figure 4.4-4. Shiploaders, whose handling capacities exceed 6,000 tons per hour, are operated at several coal loading terminals where the handling volume exceeds 10 million tons per year.

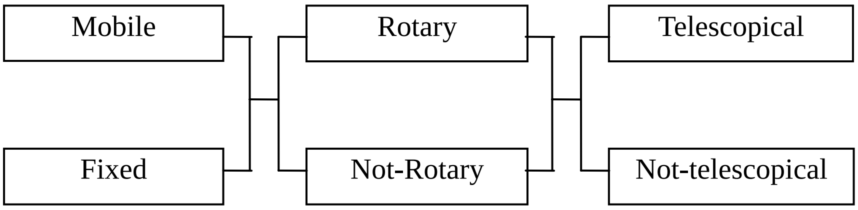


Figure 4.4-4 Classification of shiploaders by functions

Unloaders are usually used for discharging dry bulk cargoes. Types of unloaders are classified as follows:

a) intermittent unloading with a grab.
b) continuous unloading with bucket wheel/bucket elevator.
c) continuous unloading by pneumatically driven.

Unloaders with handling capacities ranging from 1,000 to 2,800 tons per hour are operated at several coal thermal power plants as shown in Table 4.4-4.

4.4.4 Cases of Berthing Facilities and Cargo Handling Facilities

Dry bulk terminals at ASEAN 47 network ports are listed in Table 4.4-2 based on the answers to Part II E "Dry Bulk Terminal" of the questionnaire. There are only several dry bulk terminals among ASEAN 47 network ports because dry bulk cargoes are handled mostly at their multipurpose terminals.

Table 4.4-2 Examples of Dry Bulk Terminals at ASEAN 47 Network Ports

Country	Network	Terminal	Handling Commodities	Cargo Throughput (metric tons)		Quay				Operation	Yard
				2008	2007	Number of Berths	Total Length of Berths (m)	Water Depth (m)	Maximum Vessel Alongside (DWT)	Berth Productivity (tons/hour)	Area (m2)
Indonesia	Banjarmasin	Dermaga Batubara	Batu Bara dan Biji Besi	1,438,849	934		140	9.0	7,000		45,000
Malaysia	Port Klang	Northport	Cement, Palm Kernel Expeller	1,616,260	1,516,190	2	426	12.0			30,935
Malaysia	Port Klang	Westports	Soya, Grain, Sugar, Fertilizer, Clinker, Slag	3,177,770	4,033,988	4	935	15.0			11,630
Malaysia	Penang	Prai Bulk Cargo Terminal	Maize, Sugar, Cereals	3,149,889	4,074,558	3	756	11.0	66,000	180	
Malaysia	Kuantan		Fertilizer, Palm Kernel Expeller, Steam Coal, Iron Ore, Others	9,405,465	10,065,095	8	725	11.2	45,000		70,000
Malaysia	Bintulu	Bulk Cargo	Urea, Ammonia	626,558	123,135	1	270	13.5	60,000	130	
Philippines	General Santos		Fertilizer, Corn, Soya	186,083	125,838	3	288	8.5	29,848	35	17,499
Vietnam	Da Nang	Tien Sa terminal	Wood Chip, Coal, Fertilizer, Sand			4	728	11.0	35,000		

Source: Answers to Part II E "Dry Bulk Terminal" of the Questionnaire

Table 4.4-3 and Table 4.4-4 provide a general description of berthing facilities and coal handling facilities at some coal loading/unloading terminals in Asia and Oceania. Most of the terminals are owned for private use and more than half of them are facilitated for Capesize bulkers (> 100,000 DWT). At loading terminals, ship loaders with loading capacities ranging from 2,500 to 10,500 tons per hour are installed. And at many coal unloading terminals, unloaders whose capacities exceed 2,000 tons per hour are installed.

Table 4.4-3 Examples of Coal Loading Terminals

Country	Port/Terminal	Annual Coal Throughput (million	Public or Private	Berth			Ship Loader	
				Water Depth (m)	Length (m)	DWT	Capacity	Number
Indonesia	Tanjung Bara Coal Terminal	32	Private	17.8	340	210,000	4,700 t/h	2
	Kotabaru/NPLCT	14	Private	18.0	276	180,000	4,000 t/h	1
	Balikpapan Coal Terminal	15	Private	14.0		90,000	2,800 t/h	1
China	Qinhuangdao	35	Public	17.0	680	140,000	6,000 t/h	12
	Tianjin Xingang	12	Public	16.0	455	150,000	6,000 t/h	3
	Qingdao Qianwan	5	Public	14.1	499	80,000	4,500 t/h	2
	Rizhao		Public	17.0	850	170,000	6,000 t/h	2
Australia	Newcastle/ Kooragang Terminal	89	Private	16.5	1,080	232,000	10,500 t/h	3
	Carrington Terminal		Private	16.5	700	180,000	2,500 t/h	2
	Port Kembla	11	Private	16.3	250	232,000	6,600 t/h	2

Source: Tex Report

Table 4.4-4 Examples of Coal Unloading Terminals

Country	Company/ Location/ Port	Output Capacity (MW)	Annual Coal Consumption (million	Public or Private	Berth			Unloader	
					Water Depth (m)	Length (m)	DWT	Capacity	Number
Philippines	Machine Rock	3,000	-	Private	15.0	240	60,000	700 t/h	2
Thailand	Blcp Power Limited (Map Ta Phut)	7,000	-	Private	17.0	346	170,000	2,000 t/h	2
Japan	Hokkaido/Tomakomai	1,650	4.0	Private	14.0	280	60,000	1200 t/h	2
	Hokuliku/Nanao	1,200	2.3	Private	14.0	290	60,000	2,800 t/h	2
	Cyugoku/Misumi	1,300	2.8	Private	14.0	433	60,000	2,800 t/h	2
	Cyugoku/Tokuyama Kudamats	1,000	2.7	Private	19.0	420	150,000	2,000 t/h	1
	Japan Energy/Tachibana	2,800	7.6	Private	14.0	300	140,000	2,700 t/h	2
Republic of Korea	Samcheonpo	3,240	9.7	Private	18.0	915	100,000	2,300 t/h	4
	Boryeong	3,000	8.7	Public	17.0	472	150,000	2,500 t/h	4
	Taean	3,000	8.6	Private	18.6	480	150,000	2,000 t/h	4
	Hadon	3,000	8.7	Private	18.5	214	150,000	2,100 t/h	4
	Dangjin	3,000	6.5	Private	21.0	482	200,000	2,900 t/h	4
China	Wu Sha Shan	2,400	-	Private	13.0	400	43,000	1,100 t/h	3
	Yu Huan	1,000	-	Private	14.1	500	100,000	2,500 t/h	4
	Taishan	1,200	-	Private	14.5	280	70,000	1,300 t/h	3
	Kemen	1,200	-	Private	18.7	334	100,000	1,700 t/h	4
Taiwan	Taichung	5,500	-	Public	18.0	340	95,000	1,300 t/h	5
	Mailiao	1,800	-	Private	18.3	375	150,000	1,000 t/h	5

Source: OCDI

Table 4.4-5 and Table 4.4-6 provide a general description of berthing facilities and woodchip handling facilities at some woodchip loading/unloading terminals in Asia and Oceania. Concerning the woodchip terminals, the following features are observed:

a) Most of the woodchips are handled at public terminals, and other commodities are also handled at the same terminals.
b) The maximum vessel size is 60,000 DWT.
c) Loaders and unloaders with capacities ranging from 300 to 1,000 tons per hour are used for woodchip handling.

Table 4.4-5 Examples of Woodchip Loading Terminals

Country	Port/ Terminal	Public or Private	Berth			Ship Loader		Handling Commodities
			Water Depth (m)	Length (m)	DWT	Capacity	Number	
Vietnam	Quy Nhon/Berth No.1	Public	7.0	350		200 t/h	1	Woodchip
	Danang/Tien Sa Seaport No.1	Public	10.0	183	35,000	300 t/h	1	Woodchip
	Vung Ang/Berth No.1	Public	10.8	185	50,000	300 t/h	2	Woodchip, Titanium Mineral
Australia	Eden/Woodchip Berth	Private	12.5	275	50,000	1,000 t/h		Woodchip only
	Geelong/Bulk Grain Pier - Berth No.3		12.3	168				Woodchip, Grain, Barley, Oil seeds
	Corio Quay No.1, 2 North		11.0	375		1,000 t/h		Woodchip
	Portland/Berth No. 1	Public		255		700 t/h	2	Woodchip, Grain, Livestock
	Berth No. 6		12.0	229				Woodchip, Fertilizer, Livestock, Logs
	Launceston/Woodchip Berth: Nothern	Private	11.5	217		700 t/h	1	Woodchip
	Woodchip Berth: Southern		11.2	229		700 t/h	1	Woodchip
	Bell Bay/Berth No. 6	Public	12.4	314		750 t/h	1	Woodchip, General/Containers
	Spring Bay/Gunns-Triabunna berth	Private		244	47,000	800t/h	1	Woodchip
	Burnie/No.7 Berth	Public	11.5	219		1,200 t/h	1	Woodchip, General/Containers
	Bunbury/Sotico-Woodchips Berth		12.2	381		1,000 t/h		
	Albany/Princess Royal Harbor No.6		12.5	210	67,000	900 t/h		Woodchip, grain
	Brisbane/Fisherman Islands Grain	Private	13.0	285		1,000 t/h		Grain, Woodchip, etc.

Source: OCDI

Table 4.4-6 Examples of Woodchip Unloading Terminals

Country	Port/ Terminal	Public or Private	Berth			Unloader		Handking Commodities
			Water Depth (m)	Length (m)	DWT	Capacity	Number	
Japan	Kushiro/South Berth	Public	12.0	240	30,000	1,100 t/h	1	Woodchip, Wood pulp
	Tagonoura/No.1	Public	12.0	240	30,000	400 t/h	1	Woodchip and others
	Iwakuni/C2 Berth	Private	11.5	325	42,000	440 t/h	1	Woodchip
S. Korea	Ulsan	Public	12.0	260		360 t/h		
China	Rizhao/New Woodchip Berth	Public	13.0	300	40,000	500 t/h	4	
	Zhanjiang/Area No.4-Berth 407	Public	10.7	254	50,000	150 t/h	2	Steel, Woodchip, etc.
Taiwan	Kaosiung/Bulk Cargo No.48-53	Public	10.5	260		5,000 t/d		Iron scraps, Coal, Coke, Cement, Salt
	Hualien/Pier No.23, 24	Public	14.0	270	60,000	830 t/h		Crude granite, Gypsum, Coal, Cement

Source: OCDI

4.5 Liquid Bulk Terminal

Liquid bulk cargoes are loaded and unloaded by pumps through pipes. Therefore, the capacity of a liquid bulk terminal is determined mainly by the water depth of the berthing facility, and the scale and capability of pumps, pipelines and storage tanks.

4.5.1 Classification of Liquid Bulk

Liquid Bulk Cargoes are classified into crude oil, oil products, LNG/LPG, edible oil, and others.

The annual volume of liquid bulk cargoes in sea transport is about 3 billion tons (crude oil: 1.9 B. ton, oil products: 0.8 B. tons, LNG/LPG: 0.2 B. tons, respectively) which represents about 37 % of the total.

In ASEAN countries , more than 500 million tons of liquid bulk cargoes are transported annually, as the annual trade volume of crude oil and oil products is 200 million tons for each, and the annual trade volume of LNG/LPG and edible oil is about 50 million tons for each.

4.5.2 Carrying Vessel

Liquid bulk cargoes are usually carried by tankers. Tankers are categorized into crude oil tankers, Oil Products Tankers, Chemical Tankers, LNG tankers/LPG tankers, and vegetable oil tankers, and so on.

According to the ships database by Lloyd's Register - Fairplay, approximately 13,000 tankers are in service around the world.

* Breakdown
- Crude oil tanker: about 2,000
- Products tanker: about 5,000
- Chemical tanker: about 4,000
- LNG tanker: about 300
- LPG tanker: about 1,200

Figure 4.5-1 and Figure 4.5-2 show the relationships between Dead Weight Tons (DWT) and Draft; DWT and Length Over All (LOA) of crude oil tankers respectively.

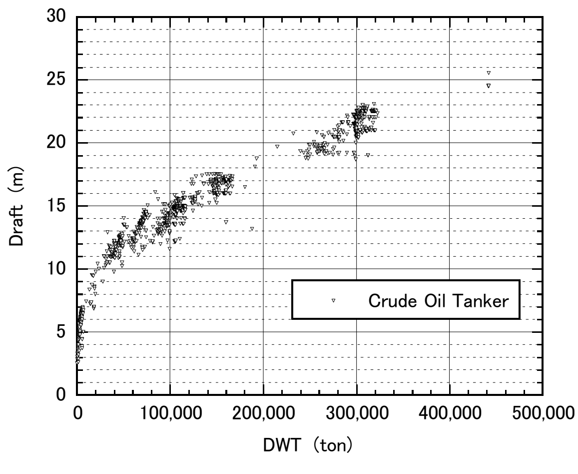


Figure 4.5-1 Relationship between DWT and Draft of Crude Oil Tankers

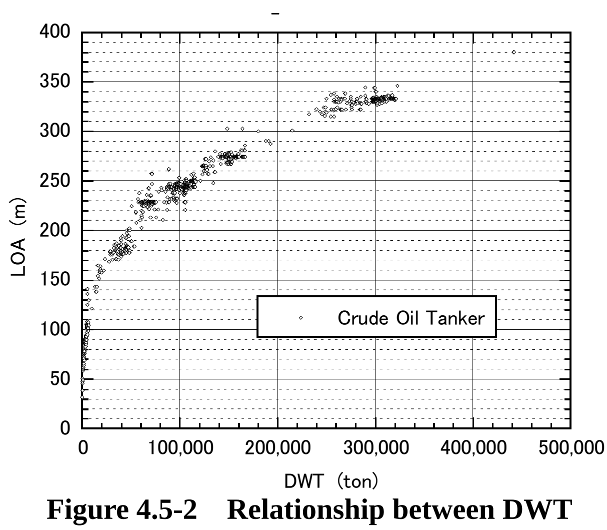


Figure 4.5-2 Relationship between DWT and LOA of Crude Oil Tankers

Figure 4.5-3 and Figure 4.5-4 show the relationships between Dead Weight Tons (DWT) and Draft; DWT and Length Over All (LOA) of oil products tankers and chemical tankers respectively.

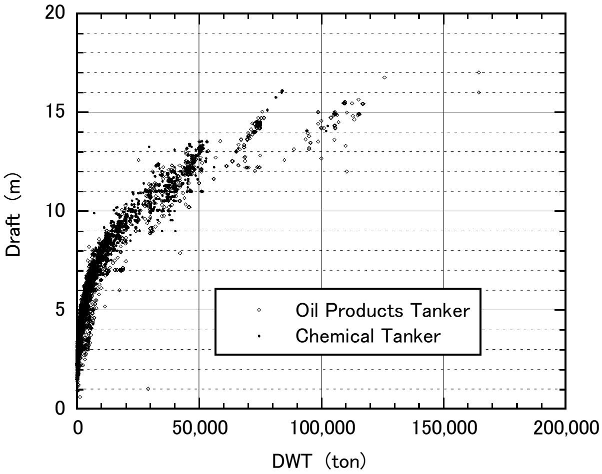


Figure 4.5-3 Relationship between DWT and Draft of Oil Products Tankers and Chemical Tankers

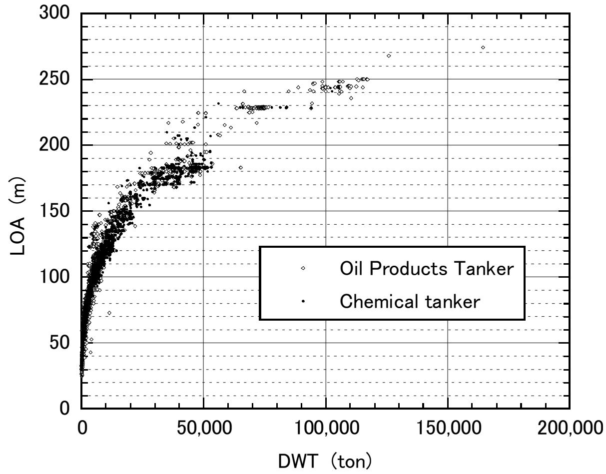


Figure 4.5-4 Relationship between DWT and LOA of Oil Products Tankers and Chemical Tankers

4.5.3 Loading and Unloading Facilities

Liquid bulk cargoes are loaded and unloaded by pumps through pipes. Loading arms are used to connect berth side pipes and ship side pipes.

For loading and unloading to/from, for example, a 200,000 DWT class VLCC (Very Large Crude Oil Carrier), some data show that it takes about twenty hours for loading and forty-two hours for unloading. In the case of a 5,000 DWT class tanker, it takes about six hours for loading heavy oil and five hours for unloading it.

4.5.4 Berthing facilities

Liquid bulk cargo handling does not always need an apron because liquid bulk cargoes are loaded and unloaded by pumps through pipes. Therefore liquid bulk cargoes are often loaded/unloaded at offshore sea berths. Sea berths are classified mainly into dolphins (Figure 4.5-5) and mooring buoys (Figure 4.5-6) according to structural type.

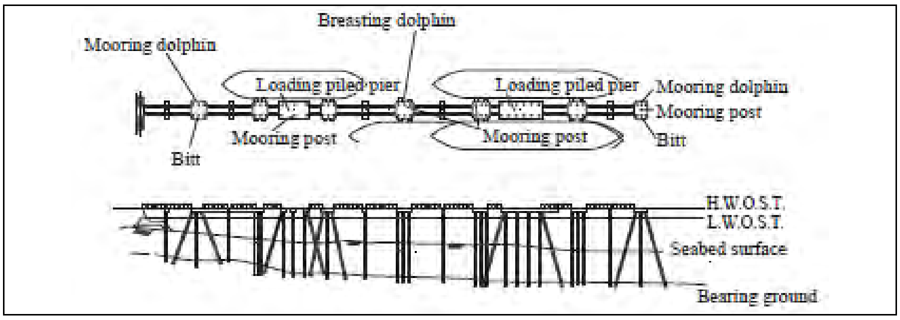


Figure 4.5-5 Example of Pile Type Dolphin

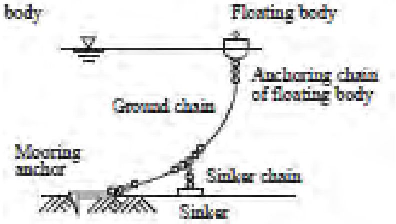


Figure 4.5-6 Example of Mooring Buoy

4.6 Ro/Ro Terminal

The operations of Ro/Ro terminals varies depending on the types of Ro/Ro ships, such as ships for vehicles only, vehicles and non-self-propelled cargo, vehicles and passenger, etc. The international shipping services in the ASEAN region are mainly served by vehicles carriers. The dimensions of required facilities for vehicles carriers including quays and yards should be determined in consideration of the purpose of the terminal(e.g. for exporting only, exporting & importing, transship, etc.), the size of targeted calling ships, calling frequency and calling order in the service loop.

4.6.1 Types and Capacity of Ro/Ro Ships

So-called Ro/Ro ships may mean various types of ships. In addition to cargo vessels with roll-on/roll-off facilities, pure car carriers can be included in this category, which carry cars only, and also ships carrying both passengers and vehicles. Table 4.6-1 categorizes the ships with Ro/Ro facility and indicates their average sizes. Among the categories in this table, most ships employed in ASEAN region services are included in 'Vehicles Carrier'.

Table 4.6-1 Types, Numbers and Average Sizes of Ships with Ro/Ro Facilities

Ship Type	No. of ships	Average Size			
		DWT	LOA (m)	Beam (m)	Draft (m)
Ro/Ro Cargo Ship	942	7,561	135	21	6.3
Vehicles Carrier	1,066	14,756	178	29	8.7
Rail Vehicles Carrier	20	9,069	164	23	5.9
Landing Craft	863	420	50	11	2.2
Container/ Ro/Ro Cargo Ship	12	38,314	274	32	11.5
Passenger/ Ro/Ro Ship (Vehicles)	2,870	1,465	89	16	3.8
Passenger/ Ro/Ro Ship (Vehicles/Rail)	87	3,961	138	21	5.3
Passenger/ Landing Craft	50	291	43	10	2.0
Total	5,910				

Source: World Shipping Encyclopedia July, 2009 (Lloyd's Register Fairplay)

The category of Vehicles Carrier includes the ships generally called as Pure Car Carrier (PCC) and Pure Car and Truck Carrier (PCTC), which carry completed cars, used cars and construction equipment. These ships are characterized by the fact that the vehicles themselves are traded goods. The services are offered in the routes linking between ASEAN and Far East/Europe/North America and in intra-region routes in ASEAN. Some shipping lines offer the liner services with the frequency of one to four sails per month as shown in Table 4.6-2.

Table 4.6-2 Samples of Vehicles Carrier Liner Services in ASEAN Region

Operator	Major Ports of Calling		Frequency (/month)
	in ASEAN Region	in Other Regions	
A	Singapore, Port Klang	Japan, Keelung, Hong Kong	N/A
	Ho Chi Minh, Singapore, Port Klang	Japan, Shanghai, Hong Kong	
	Manila, Muara, Singapore, Port Klang	Japan, Keelung, Hong Kong	
	Singapore, Port Klang, Kuching, Kota Kinabalu, Sandakan, Jakarta, Laem Chabang	Chennai, Chittagong	
	Laem Chabang, Singapore	Australia	
	Singapore	Japan, Africa East Coast	
B	Batangas, Singapore, Port Klang	Korea, Taiwan	2
	Singapore	Korea, South Africa	3-4
C	Laem Chabang, Jakarta, Singapore		2
	Singapore	Shanghai, Korea, Japan, USA	1-3
D	Singapore	Europe, Hong Kong, Taiwan, Shanghai, Japan	2
E	Batangas, Laem Chabang, Jakarta, Port Klang, Singapore	Japan, Hong Kong	N/A
	Laem Chabang, Singapore, Port Klang, Jakarta, Kuching, Muara, Kota Kinamalu	Japan, Hong Kong	
	Manila	Japan, Taipei, Hong Kong, Huangpu	

Source: produced with shipping lines' publicity

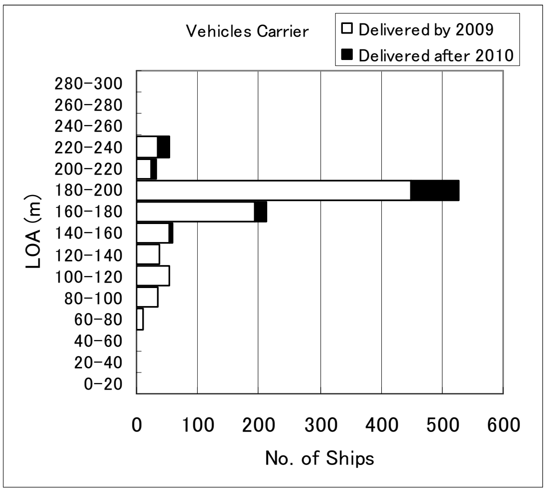
The category of Ro/Ro Cargo Carrier includes ships carrying cargo loaded on trucks and/or non-self-propelled cargo loaded/discharged by tractors/forklifts. The international trade within the region has developed in Europe, especially between the continent and UK, and the continent and Scandinavia due to the easiness in cross-border trucking. Meanwhile, the services with ships of the category in the ASEAN region are limited to domestic transportation.

The category of Passenger/ Ro/Ro Ship (Vehicles) includes ships carrying both vehicles and passengers. This category includes 147 Philippine flag ships and 138 Indonesian flag ships, and the number of ASEAN countries' flag ships accounts for 11 percent among the whole of this category. The ships of this category play considerable roles in domestic shipping services in ASEAN countries, but very small roles in international services.

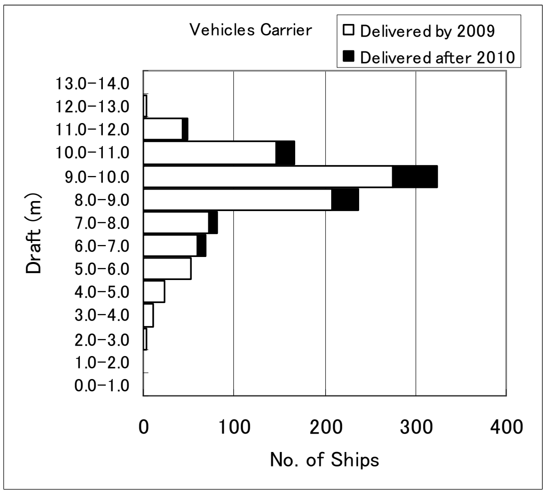
The category of Landing Craft includes small ships with a ramp. This category includes 361 Indonesian flag ships, 57 Philippine flag ships and 51 Malaysian flag ships, and the number of ASEAN countries' flag ships dominates at 59 percent among the whole of this category. The ships of this category generally have small loading capacity and mainly serve for short-distance transportation in domestic shipping.

The other categories in Table 4.6-1 include very small numbers of ships which are regarded as rare.

Figure 4.6-1 indicates the distributions of length overall and draft of ships of Vehicles Carrier which play significant roles in international shipping services. The table implies that ships with a length overall of less than 200 meters accounts for a large share of this category, and ships with a draft less than 10 meters do as well.



(1) Distribution of Length Overall

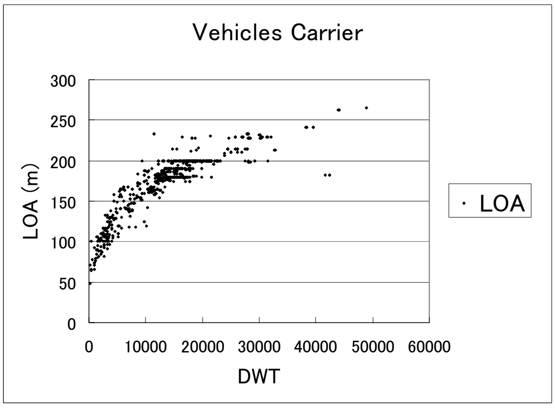


(2) Distribution of Draft

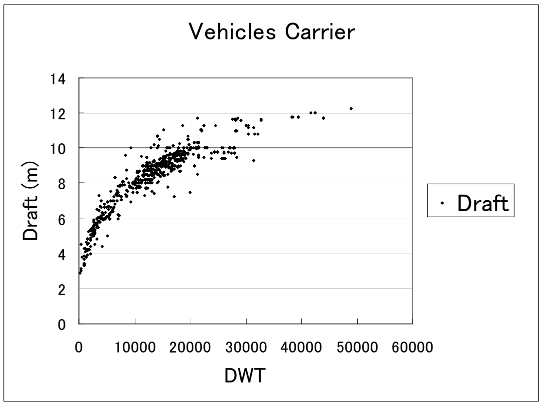
Source: World Shipping Encyclopedia July, 2009 (Lloyd's Register Fairplay)

Figure 4.6-1 Distribution of Size of Vehicles Carrier

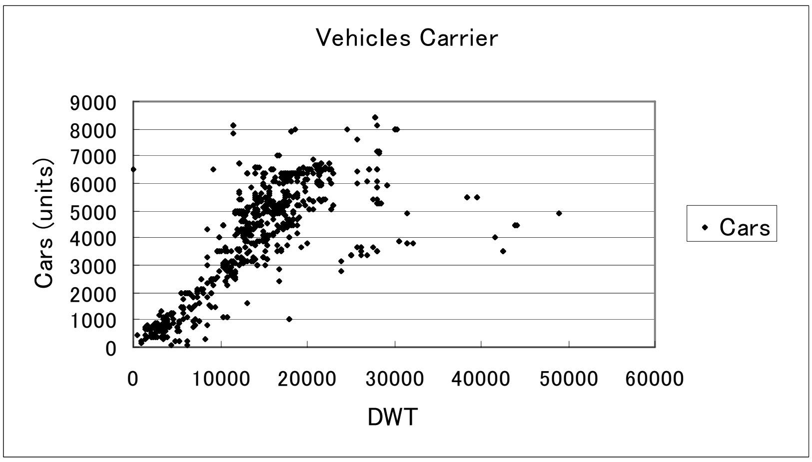
Figure 4.6-2 shows distributions related to relations between dead weight tonnage and length overall/draft/ loading capacity of vehicles. The figure indicates length overall, draft, and capacity of 2,000-dwt ship is approximately 200 meters, 10 meters, and 5,000 units respectively.



(1) Relation between DWT and LOA



(2) Relation between DWT and Draft



(3) Relation between DWT and Capacity

Source: World Shipping Encyclopedia July, 2009 (Lloyd's Register Fairplay)

Figure 4.6-2 Size of Vehicles Carrier

As cars are both produced and purchased in the ASEAN region, Ro/Ro terminals in the region serve as distribution centers where cars are unloaded as well as centers for both importing and exporting, and transship hubs for transporting from manufacturing factories in ASEAN to external area of consumption including Africa and South America.

Therefore the size of calling ships varies in accordance with the purpose of the terminal. Some shipping lines deploy ships with a loading capacity of 2,000 units. Meanwhile, a large ship with a capacity of 7,200 units calls Laem Chabang Port in Thailand. Similarly, the required area of yards varies depending on the loading/discharging number of cars and frequency of ship calling. In addition, the operating draft in the first port of unloading in a service loop differs from the one in the last port. Attention needs to be paid to those differences due to the characteristics of the terminals in planning the facilities.

4.6.2 Standard Productivity

The cars are loaded on/ discharged from a vehicles carrier by being driven by dedicated workers. In the case of a pure car carrier, cars are loaded/ discharged by one gang at the rate of one hundred cars per hour. The gang means a cargo handling team which normally consists of fifteen to twenty persons. When a large number of cars are to be handled, several gangs would be deployed.

4.7 Approach Channel

The water depth of channels shall be an appropriate depth greater than the draft of the design ship, considering natural conditions such as waves, vessel conditions and navigation conditions.

The width of channels shall be an appropriate width with that will not hinder safe vessel navigation, considering the above mentioned conditions.

The direction of channels shall not hinder safe vessel navigation in light of the natural conditions such as terrestrial phenomena and waves, and the condition of use of the neighboring water area.

Channel conditions and design vessel factors and other conditions vary by port and thus it may be necessary to adopt an adequate value corresponding to the actual situations of each port.

4.7.1 Method

Approach channels need to provide appropriate depth, width and alignment in order for vessels to be able to navigate safely and smoothly.

Requirements for each channel shall be identified based on its location and vessels which navigate there and other conditions. In order to analyze these conditions and calculate required depth and width in detail it is necessary to use statistical and probabilistic methods, physical mathematical methods or simulation model. In this guideline, rough calculation methods are used for evaluating the present situation and examining the necessity of improvement.

Permanent International Association of Navigation Congresses (PIANC) published “APPROACH CHANNELS-A Guide for Design” jointly with International Associations of Ports and Harbors (IAPH) in 1997 based on the result of activities of Working Group organized in Permanent Technical Committee II (PTCII) of PIANC. Review and update of the document is currently being undertaken by Working Group 49 whose theme is horizontal and vertical dimensions of fairways organized in PIANC. The activities of the working group have not yet been completed, however, the calculation methods introduced and proposed in the present report are interesting and useful. The methods are applied in the guideline. On the other hand, UNCTAD published “Port Development-A handbook for planners in developing countries” in 1985 while Japanese standard came into effect in 2007 under Port and Harbour Act. Methods of calculating the channel dimensions are introduced in both and included in the guideline.

4.7.2 Depth of Channel

Required depth of a channel depends on vessel and navigation factors such as draft of vessel, squat, the degree of vessel motion and channel and its location factors such as wave, channel bed conditions etc.

In the present report of Working Group 49, method for calculating the required depth of a channel is described; is calculated based on the draft of vessel (T) and considering other factors such as velocity of vessel, wave conditions, location of channel. The table mentions also about air clearance. It is necessary to keep in mind that the table may be modified in the final report.

Required depth of a channel is calculated roughly with the values shown in Table 4.7-1. based on a maximum draft of entering vessels. There are some ports which vessels enter with half cargo or some channels which vessels can only navigate at high tide. In such cases, vessels can navigate through a channel with a depth less than calculated by a method above mentioned. The value is calculated roughly and it may be necessary to adopt an adequate value corresponding to the actual conditions of each port and a design vessel.

Table 4.7-1 Channel Depth etc.

Description	Vessel Speed	Wave Condition	Outer Channel	Inner Channel
Ship factors Fs				
Depth h	< 10kts	None		1.10T
	10-15kts			1.12T
	>15knt			1.15T
	All	Low	1.15T or 1.2T	
	All	Moderate swell	1.3T	
	All	Heavy swell	1.4T	
Bottom Factors Fb				
Depth h	All	All		
Mud			0.3m	0.3m
Sand or Clay			0.5m	0.5m
Rock or Coral			1.0m	1.0m
Air Draft Factors Fa				
Air Draught clearance	All	All	0.05Hst	0.05Hst
for Ship Factors: Assumes T>10m. If T,10m, use UKC value for T=10m Swell means waves with peak period greater than 10s				

Material of Working Group 49 Horizontal and Vertical Dimensions of Fairways, PIANC

4.7.3 Width of Channel

Required width of a channel depends on vessel and navigation factors such as the dimensions of vessels and navigational situation, and such factors as wave, current channel beds etc.

A method of calculating the required width of an approach channel is introduced in "Port Development-A handbook for planners in developing countries UNCTAD 1985." According to the handbook, the total width of full-depth channel required for two-lane traffic may be taken to comprise, on straight reaches, maneuvering lanes of about twice the vessel beam for each direction, plus about 30 meters between vessels and up to one-and-a-half times the beam for bank clearance each side.

In case of curved channels, an additional width, depending on the radius of curvature of the bend but approximately equal to the beam of each vessel, will be required in order to allow for the projected width of vessels negotiating the bend. This feature of projected width will also occur on straight reaches of channel subject to the action of cross-wind and currents, which will also cause vessel to drift.

Base on the concept shown in this handbook, required width of channels shall be calculated with the following equations; (B means the value of beam of the design vessel)

One-way channel
Required width = Width of Maneuvering Lane (2B) + Bank Clearance (1.5B) x 2
Two-way channel
Required width = Width of Maneuvering Lane (2B) x 2 + 30m + Bank Clearance (1.5B) x 2
In case of curved channels, a width of Maneuvering Lane shall be 3B.

Relation between "B" and characteristic of vessels varies by type, size or built year of vessels. There are cases that a width calculated with a value of "B" may not hold good for some vessels. It may be necessary to adopt an adequate value corresponding to the actual conditions of each port and a design vessel.

4.7.4 Alignment of channel

Alignment of channel should allow vessels to navigate safely considering natural conditions and usage of neighboring water area. The description on alignment of channel in the Technical Standards for Port and Harbour Facilities (2007 MLIT Japan) may be applied.

-linear whenever possible

-in cases where a bend is included in a channel

Angle of intersection of its centerlines at the bend shall not exceed roughly 30°

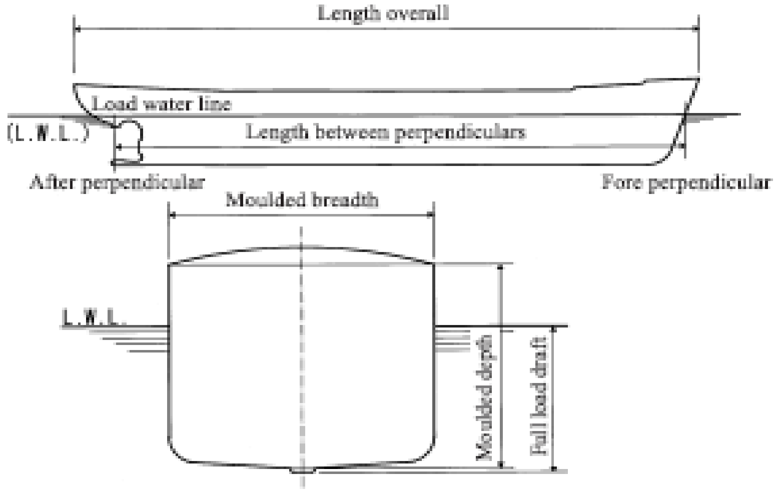
-in cases of bend with angle exceeding 30º

Corner cut and the radius of curvature of four times of overall length of a vessel (Loa) and greater

Principal dimensions of vessels

Principal dimension of vessels which are prepared based on a statistical analysis of the dimensions of existing vessels with a coverage ration of 75% are shown in Technical Standards for Port and Harbour Facilities (2007 MLIT Japan) as standard values. The tables described in the book of the Standards and commentaries are attached below for reference. Gross tonnage means international gross tonnage basically but in some cases it refers to Japanese domestic tonnages.

Definitions of Principal Dimensions of Vessel



Standard Dimensions of Various Type of Ships

1. General Cargo Ship

Dead Weight Tonnage DWT (t)	Length overall Loa (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft D (m)
1,000	67	61	10.7	3.8
2,000	82	75	13.1	4.8
3,000	92	85	14.7	5.5
5,000	107	99	17.0	6.4
10,000	132	123	20.7	8.1
12,000	139	130	21.8	8.6
18,000	156	147	24.4	9.8
30,000	182	171	28.3	10.5
40,000	198	187	30.7	11.5
55,000	217	206	32.3	12.8
70,000	233	222	32.3	13.8
90,000	251	239	38.7	15.0
120,000	274	261	42.0	16.5
150,000	292	279	44.7	17.7

2. Container Ships

Dead Weight Tonnage DWT (t)	Length overall Loa (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft d (m)	Reference: Container Carrying Capacity (TEU)
10,000	139	129	22.0	7.9	500～ 890
20,000	177	165	27.1	9.9	1,300～1,600
30,000	203	191	30.6	11.2	2,000～2,400
40,000	241	226	32.3	12.1	2,800～3,200
50,000	274	258	32.3	12.7	3,500～3,900
60,000	294	279	35.9	13.4	4,300～4,700
100,000	350	335	42.8	14.7	7,300～7,700

3. Tankers

Dead Weight Tonnage DWT (t)	Length overall *Loa* (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft *d*（m）
1,000	63	57	11.0	4.0
2,000	77	72	13.2	4.9
3,000	86	82	14.7	5.5
5,000	100	97	16.7	6.4
10,000	139	131	20.6	7.6
15,000	154	146	23.4	8.6
20,000	166	157	25.6	9.3
30,000	184	175	29.1	10.4
50,000	209	199	34.3	12.0
70,000	228	217	38.1	12.9
90,000	243	232	41.3	14.2
100,000	250	238	42.7	14.8
150,000	277	265	48.6	17.2
300,000	334	321	59.4	22.4

4. Roll-On Roll-Off (RORO) ships

Gross Tonnage GT (t)	Length overall *Loa* (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft *d*（m）
3,000	120	110	18.9	5.8
5,000	140	130	21.4	6.5
10,000	172	162	25.3	7.7
20,000	189	174	28.0	8.7
40,000	194	174	32.3	9.7
60,000	208	189	32.3	9.7

(3,000,5,000 and 10,000gt GT are in Japanese gross tonnage)

5. Pure Car Carrier (PCC) ships

Gross Tonnage GT (t)	Length overall *Loa* (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft *d*（m）
3,000	112	103	18.2	5.5
5,000	130	119	20.6	6.2
12,000	135	123	21.8	6.8
20,000	158	150	24.4	7.9
30,000	179	175	26.7	8.8
40,000	185	175	31.9	9.3
60,000	203	194	32.3	10.4

(3,000 and 5,000 GT are in Japanese gross tonnage)

6. Liquid Petroleum Gas (LPG) carriers

Gross Tonnage GT (t)	Length overall Loa (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft d（m）
3,000	98	92	16.1	6.3
5,000	116	109	18.6	7.3
10,000	144	136	22.7	8.9
20,000	179	170	27.7	10.8
30,000	204	193	31.1	12.1
40,000	223	212	33.8	13.1
50,000	240	228	36.0	14.0

7. Liquid Natural Gas (LNG) carriers

Gross Tonnage GT (t)	Length overall Loa (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft d（m）
20,000	174	164	27.8	8.4
30,000	199	188	31.4	9.2
50,000	235	223	36.7	10.4
80,000	274	260	42.4	11.5
100,000	294	281	45.4	12.1

8. Passenger ships

Gross Tonnage GT (t)	Length overall Loa (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft d（m）
3,000	97	88	16.5	4.3
5,000	115	104	18.6	5.0
10,000	146	131	21.8	6.4
20,000	186	165	25.7	7.8
30,000	214	189	28.2	7.8
50,000	255	224	32.3	7.8
70,000	286	250	32.3	8.1
100,000	324	281	32.3	8.1

9. Ferries

9-1 Short to medium distance ferries (Navigation distance less than 300km in Japan)

Gross Tonnage GT (t)	Length overall Loa (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft d（m）
400	56	47	11.6	2.8
700	70	60	13.2	3.2
1,000	80	71	14.4	3.5
3,000	124	116	18.6	4.6
7,000	141	130	22.7	5.7
10,000	166	155	24.6	6.2
13,000	194	179	26.2	6.7

(All are Japanese gross tonnage)

9-2 Long distance ferries (Navigation distance of 300km or more in Japan)

Gross Tonnage GT (t)	Length overall Loa (m)	Length between perpendiculars Lpp (m)	Molded breadth B (m)	Full load draft d（m）
6,000	147	135	22.0	6.3
10,000	172	159	25.1	6.3
15,000	197	183	28.2	6.9
20,000	197	183	28.2	6.9

(All are Japanese gross tonnage)

4.8 Capacity of Hinterland Transport facilities

Capacity of hinterland transport services is affected by such hinterland transport services as number of traffic lanes, frequency of the train and so forth. Additional hinterland transportation shall be planned appropriately, considering the future demand of transportation.

4.8.1 Classification of Hinterland Transportation

Main transport services of hinterland transport are road and railroad.

(1) Road

Road is an infrastructure mainly for cargo transport or passenger transport between a terminal and the hinterland. The dimensions of a road are determined based on the volume of traffic. In Japan, when volume of traffic is forecasted to be less than 650 vehicles per hour, 2 traffic lanes will be planned. On the other hand, 4 traffic lanes should be planned if the capacity per one lane is 600 vehicles. Width of roads is 3.25m or 3.5m in principle. In a port area, 2 traffic lanes are planned in general and sometimes stopping area (2.5m width) is planned when congestion is expected. The process of estimating future demand of traffic is as follows; (Following forecasting methodology is known as Four-step Model.)

1) Trip generation / attraction determines the frequency of trips from origins or to destinations.
2) Trip distribution matches origins with destinations.
3) Mode choice computes the proportion of trips between each origin and destination by a particular transportation mode.
4) Route assignment allocates trips to a route between an origin and a destination.

Trip generation is composed of two origins as below.
a) Trip generation originating from cargo throughput
b) Trip generation originating from labor in port area

(a) Trip generation originating from cargo throughputs

Road capacity（volume of traffic per hour）

＝Throughput （freight tonnage per year）

$$\times \frac{\alpha}{w} \times \frac{\beta}{12} \times \frac{\gamma}{30} \times \frac{(1+\delta)}{\varepsilon} \times \sigma$$

α : Share of truck transport ＝volume of truck transport / volume of all modes of transport
β : Monthly variability＝peak monthly throughput / average monthly throughput
γ : Daily variability＝peak daily throughput / average daily throughput
W : Average loading weight (freight ton / truck)
ε : Truck loading ratio＝number of trucks on load / total number of trucks
δ : Related trucks ratio＝number of related trucks / total number of trucks
σ : Hourly variability＝peak hourly trucks / Average daily trucks

Samples of coefficients in port road planning in Japan are shown in Table 4.8-1.

Table 4.8-1 Sample of coefficient in port road planning in Japan

Index		Coefficient
α	Share of truck transport	1.0
β	Monthly variability	1.2～1.37
γ	Daily variability	1.4～1.85
W	Average loading weight	general goods：2.0～8.0 Bulk cargo：4.0~17.8
ε	Truck loading ratio	0.33～0.54
δ	Related trucks ratio	0.5～7.9
σ	Hourly variability	0.11～0.16

Source: Port planning data

(b) Trip generation originating from labor in port area

Road capacity（volume of traffic per hour）＝Number of workers

$$\times \frac{\alpha}{w} \times \frac{(1+\delta)}{\varepsilon} \times \alpha$$

α：Share of car user ＝Number of car user / Number of workers
W：Average capacity of a car（people / car）
ε：Loading ratio＝Average number of getting in a car / Average capacity of a car
δ：Related car ratio＝Number of related cars /Number of cars
σ：Hourly variability＝Peak hourly cars / Average daily cars

Table 4.8-2 Samples of coefficients in port road planning in Japan

Index		Coefficient
α	Share of car users	0.791～1.0
W	Capacity of people	1.0～3.0
ε	Loading ratio	0.5
δ	Related car ratio	0～0.5
σ	Hourly variability	0.125～0.5

Source: Port planning data

When planning port roads, it is necesary to take into account the following.

- Trips generated from terminals of sea ports must connect to main roads without passing through downtown.
- Trips between terminals should use port roads and should not pass through downtown.
- In the hinterland area of sea ports, the ratio of large-sized cars is so high that it is necessary to plan roads considering the slope and shape of roads, future demand of traffic etc carefully.

(2) Railroad

Railroad is an inflastructure mainly for cargo transport or passenger transport between a terminal and the hinterland. The dimensions of railroad are determined based on the frequency and volume of railway carriage. Some container terminals have railroad sidings, for instance, Tanjung Priok (Jakarta), Tanjung Perak, Johore (Pasir Gudang), Port Klang, Penang, Kuantan, Songhkla, Hai phong.

In the case of planning new railroads, it is necessary to plan appropriately considering future demand, as is the case with Road Facilities.

4.9 Electronic Port Documentation and Single Window

Electronic notification on port entry to port authority, immigration, customs, quarantine and other necessary offices can expedite documentation and maximize the capacity of port cargo throughput. Single window for port documentation and introduction of IT system plays an important role in enhancing the performance of port operations.

ASEAN member countries agreed on the establishment of the ASEAN Single Window[3] in February 2005. This agreement aims at formulating uniform trade documentation and procedures and enables member countries to exchange information on the same platform. All authorities related to foreign trade are expected to finish their examination based on the unified format by the time of customs clearance.

The timeline for the introduction of the single window was agreed to be 2008 by Brunei Darussalam, Indonesia, Malaysia, the Philippines, Thailand and Singapore while Cambodia, Laos, Myanmar and Vietnam will adopt it by 2012. It is also agreed that the single window shall be operated based on international standard documentation and IT system.

Aiming at harmonious international maritime transport, the Convention on Facilitation of International Maritime Traffic (FAL) was concluded in 1965. This convention requests member countries to simplify port documentation and indicates unified format documents for port entry, cargo declaration and departure. Among ASEAN countries, Indonesia, Singapore, Thailand and Vietnam have already ratified the FAL convention. The Facilitation Committee established based on the FAL convention issued Message Information Guidelines (MIG) for submitting electronic declaration for port entry. MIG for port security information will be prepared and issued in the near future.

Together with electronic port documentation, it is indispensable to integrate the customs clearance information system, terminal operation information system, port management information system, and other port related information systems into one information platform. This integration will considerably speed up the port procedures and promote efficient terminal operations.

Table 4.9-1 shows the procedures necessary for port entry, cargo loading and unloading, and port clearance. All procedures shall be dealt with through electronic information system at network ports.

[3] Agreement to Establish and Implement the ASEAN Single Window, Kuala Lumpur, 9 December 2005

Table 4.9-1 Single Window for Procedures from Port Entry to Departure

Time	Procedures		Ship Agent/ Captain	Port Au-thority	Immigra-tion	Customs	Quaran-tine
Before 24 h	Pre-Arrival Nortification of Security		→	○	○		
Before 8-24 h	Notice of Arrival		→	○	○	○	○
Before 4-24 h		General Declaration	→	○	○	○	○
		Crew List	→	○	○	○	○
		Passenger List	→		○		
		Cargo Declaration	→			○	
		Dangerous Cargo Manifest	→	○		○	
		Ship's Stores Declaration	→			○	
		Crew's Effects Declaration	→			○	
		Health Quarantine Declaration	→				○
		Previous Port Clearance	→	○			
Before 6 h	Application for Pilot Service		→	○			
Before 2 h	Vessel Confirmation of Arrival		→	○	○	○	○
	Designation of anchorage or mooring position form P.A.		○	⇔	○	○	○
	Change of anchorage or mooring position from P.A.		○	⇔	○	○	○
Ship Arrival at Berth/Anchorage							
Within 2 h	Declaration of Port Arrival		→	○	○	○	○
Before Departure	Notice of Port Departure		→	○	○	○	○
		General Declaration	→	○	○	○	
		Crew List if changed	→	○	○	○	
		Passenger List	→		○		
		Ship's Store Declaration	→			○	
		Cargo Declaration	→			○	
		Passenger Effects Declaration	→			○	
	Approval of Departure			○	○	○	○
	Port Clearance Certificate		○	←			

○ Responsible Agency
Source: OCDI